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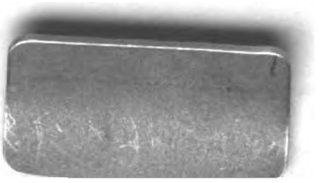

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SUPPLEMENT TO "THE ELECTRICIAN," APRIL 27, 1900.

THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

VOLUME XLIV.

(Second Series.)

FROM OCTOBER 27, 1899, TO APRIL 20, 1900.

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LONDON:

Printed and Published for the Proprietors by GEORGE TUCKER, at the Offices of "THE ELECTRICIAN," Salisbury-court, Fleet-street, E.C.

(RECAP)

1900.

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VOL. XLIV.

(Second Series.)

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THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,119. [Vol. No. 1. XLIV.] FRIDAY, OCTOBER 27, 1899. PRICE SIXPENCE (by post, 6½d.), Abroad, 8d., or 15 cents. or 30fr., or 70z.f.

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NOTES.

ON another page this week will be found an analysis of the accounts of the past year's working at the much-talked-of combined municipal dust destructor and electric supply works at Shoreditch. There are two ways of regarding this concern in arriving at an estimate of the results obtained. One way consists in not attempting to separate the electricity from the dust destructor department, but to judge of the saving effected in the new over the old method of disposing of the dust by regarding the electricity works as an adjunct to the dust destructor and as a means of making a marketable commodity out of the by-product of the latter—the steam. From the figures at our disposal, and judged from this basis, the joint scheme has certainly justified itself—resulting, as it has, in a cheap electricity supply and a saving in the cost of the dust disposal of something like £2,217. On the other hand, we must qualify this statement of the results obtained by expressing our strong opinion that the tariff for electricity supply is too low in view of the meagre sum, totalling 3 per cent., that appears to have been put aside to meet the interest and sinking fund charges.

THE other basis for a consideration of the results, and one which is probably fairer to the destructor department, is to treat the two departments distinctly, and to regard the steam furnished by the dust destructor as a by-product to be sold to the electricity works. The difficulty here met with is to decide upon what is a fair price to be paid for the steam. The fuel consumed is not the only item of the cost of steam generation in a central station. There are the capital charges in respect of the boilers, boiler-house, &c., and also repairs and maintenance and labour in stoking. For the sake of convenience, if we take the charges per unit sold generated from the steam as the basis, these extra costs could hardly, we suspect, be set lower than about 0·4d. per unit, and this has to be added to the usual fuel item to represent the cost of the steam necessary to provide each unit sold to the consumer. Among London stations in 1898 the fuel charge varied from 0·51d. to 1·42d. per unit sold at the respective outputs of 3,448,858 and 447,078 units sold, the mean being about 0·92d. per unit. Applying this latter figure in the case of Shoreditch, the total costs would come out at about 2·3d. per unit, while the bill payable to the dust destructor would be £3,600—almost sufficient to meet its present deficit of £3,651.

THE action of an electric arc as a microphone is generally known, and most electrical engineers have listened to the hum of a central station alternator reproduced several miles away in an arc lamp. A brief but interesting note from the pen of Mr. F. J. JERVIS-SMITH, in another column, describes some experimental investigations of the sounds emitted by the electric arc; but the sounds referred to are not those naturally produced by an arc in normal conditions, but rather those of a microphonic character reproduced when the electric circuit is affected at some point by something in the nature of a microphone—such, for example, as the interrupter or buzzer used by Mr. JERVIS-SMITH. We regret that he has not pushed to a much further degree his investigation as to the conditions of maximum loudness and sensitiveness: a clue might have been discovered that would have been useful in the search for a good loud-speaking or magnifying telephone. With regard to removing the interrupter to a greater distance, the effect observed by Mr. JERVIS-SMITH might have been predicted, as being due to capacity and inductance.

THE advantages of the influence machine as a generator in X-ray work have not perhaps been sufficiently appreciated. This view, at least, is strongly advocated by Dr. WILLIAM COTTON, in a Paper which we abstract in another column. The machine described therein, designed by Mr. THOMAS CLARK, of Bristol, may, shortly, be considered as a Wimshurst machine without metallic sectors, and with brush collectors instead of points. Dr. COTTON describes it as a "sectorless Wimshurst," and does not seem to be aware that this type of machine has been known as the Bonetti machine since 1894, when it was first described before

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the *Société Française de Physique*. Mr. CLARK, however, has introduced several improvements in the accessories to the machine which render it exceedingly convenient for X-ray work—more especially the auxiliary electrodes for introducing spark gaps of varying length into the circuit of the focus tubes. Dr. COTTON finds that the sectorless machine has a considerably larger output than the ordinary sectored Wimshurst, a result which has already been obtained by various experimenters—some putting it as high as three or four times. A still further improvement in the output of the Bonetti machine was obtained by SCHAFFERS, who separated the two halves of each collecting fork by an angle of about 50deg. The principal objection to the influence machine for X-ray work is the length of the exposure required owing to the exceedingly small amperage of the current. For instance, for the thicker parts of a human trunk Dr. COTTON, with the machine he describes, required an exposure of 45min., whereas a good coil with a Wehnelt break requires only about 10sec. Many of Dr. COTTON'S objections to the coil—at least for laboratory work—have been removed by the introduction of the Wehnelt break, which enables batteries to be dispensed with whenever a public electric supply is available. The influence machine has, however, many advantages, and if only its output could be increased it would be a formidable rival to the coil.

IN another column will be found the precise terms on which inter-communication may be effected between subscribers on municipal and the National Telephone Co.'s telephone exchanges, when the number of the former exceeds 500. When examining these in comparison with the National Telephone Co.'s new tariff for the provinces, a curious anomaly is apparent. If a National subscriber elects to use the toll system, he pays a fixed sum per annum and a penny for each conversation. If, however, there is more than half the number of subscribers on the municipal exchange, the company consents to connect each of these for a conversation with one of its own subscribers gratis. Although a loss to the company, it is no gain to the municipal subscriber, for he will have to pay the price of a conversation to the municipal exchange all the same. Municipal authorities have now the law of the subject made quite clear to them, and it only remains for them, if they wish to start municipal telephone exchanges, to obtain licences and engage their engineers. In the meantime, the National Telephone Co. will no doubt take steps to establish itself on a still firmer footing.

THE electric tramways now being built by the St. Helens Corporation will have to pass under a railway bridge of the London and North Western Railway, with which line they are in competition. It is stated that considerable difficulty is being experienced from the fact of the headway under the bridge being only 15ft. 8in., the height required by law being 16ft. 6in. Moreover, it has been suggested that the bridge, which has been in existence many years, was originally of sufficient height, but that a subsidence of land had caused the lowering of it by 1ft. 8in. We fear, however, that this suggestion has only been made in order to bring into evidence the nice legal point whether, if the case be as stated, the railway company or the Corporation would be liable to raise the bridge.

THE *Journal of Gas Lighting* comments on a county court decision under the Workmen's Compensation Act, which, although arising out of the laying of gas mains, applies equally to those concerned with electric supply mains. While hammering in an iron wedge to open a road a workman missed the wedge with his sledge-hammer and dislocated his shoulder. The point at issue, it would appear, was whether this wedge constituted the street a factory within the meaning of the Act, the wedge being regarded as a "mechanical power." As might be expected, Judge STONOR ruled that the Act implied merely those "mechanical powers" which act automatically and continuously after having been set in motion by hand. Had the accident occurred in the immediate neighbourhood of the works, or had it been occasioned by actual contact with a main which was connected to machinery, our contemporary thinks that the judge's ruling might have been otherwise.

IT may be hoped that the offer now made to the telegraphists by the Post Office in respect of their annual leave will meet with a favourable reception. To allocate all their holidays to eight months of the year, March to October, must necessarily involve great expense for increasing the relief staff, and waste of force during the vacant winter months; and the department now asks, in return for the proposed concession, that the employés shall contribute something towards paying the bill. This they are invited to do by all agreeing to cut short their summer holidays by three days, taking these days in the winter months, together with one day or more for Bank Holidays instead of *pro rata* pay as at present. The effect of this arrangement would be a saving to the department in respect of Bank Holidays, and the utilisation of the relief force throughout the whole year. As regards the telegraphists themselves, the boon of summer holidays is so great that the price they are invited to pay for it cannot be considered unreasonable. It must be owned, however, that the scheme puts a rather severe strain upon the magnanimity of the senior men, who have always had choice of the best months of the year, but who will now sacrifice—or rather postpone—three days' leave in order to benefit their juniors.

Cable Interruptions.	Date of Interruption.
Latakia—Cyprus	June 21, 1899
Cayenne—Pinhieros	Oct. 11, 1899
Para—Maranham	Oct. 20, 1899

Personal.—Mr. George von Chauvin, who has been since April last a director of Messrs. Siemens Bros. and Co. (Limited), has recently been appointed managing director to that company. We understand that negotiations are proceeding between Mr. von Chauvin and the Western Union Telegraph Co. (of which he is the representative in this country) as to the nature of the future relations between them, but for the present no decision has been taken.

Mr. W. N. Shaw, F.R.S., has been re-appointed assistant-director of the Cavendish Laboratory, Cambridge.

The marriage of Mr. Charles Bright to Miss J. Gosling took place yesterday afternoon.

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Wireless Telegraphy in South Africa.—The Wireless Telegraph and Signal Co. have made arrangements with the Government to establish telegraph stations for transmitting war news in South Africa. Six sets of apparatus will be despatched on November 2nd in a Government transport sailing from Liverpool. The instruments will be under the charge of five assistants taken from the staff of the company.

Obituary.—We regret to announce the death, in Sydney S. Australia, of Mr. Raul Bedford Elwell, who was for many years senior partner in the Wolverhampton firm of Elwell and Parker before that business was bought by the Electric Construction Corporation. Mr. Thomas Parker remained some time with the new firm, but afterwards left them and formed a company of his own. Mr. Elwell subsequently was appointed electrical engineer to the New South Wales Government Telegraph Department, which post he held at the time of his death.

"An Interesting Pressure Curve."—With reference to the short article with this title in our last issue, Mr. A. H. Gibbings, the city electrical engineer for Bradford, asks us to explain that the whole of the supply was not shut down at midnight on the 7th inst., but merely that short portion of the mains was disconnected which was between the distributing boxes bounding the faulty section. Only half-a-dozen consumers, therefore, had their supply completely cut off, the remainder suffering only from the extremely low pressure while the fault was being burnt out.

The Glasgow Cable Tenders.—As reported last week, the Tramways committee of the Glasgow Corporation have recommended for acceptance the tender of the National Conduit and Cable Co. of New York. There is, of course, a possibility of the recommendation not being confirmed by the Council. The amount of the tender was £150,000, and £8,000 lower than the lowest tender of an English firm. Mr. Parshall, the consulting engineer, reported to the committee that all the firms tendering were of good standing, and as all agreed to the terms of delivery, the committee decided merely on the question of price. It may be added that the National Cable and Conduit Co. was registered in London in October, 1898, with a capital of £1,000 in £1 shares.

Telegraphists' Grievances.—The departmental commission, appointed by the Duke of Norfolk to inquire into the complaint that a large percentage of the London telegraphists is compelled to go on holidays in the winter months, has made the following proposal :—(*a*) Annual leave to be allocated in eight months of the year—namely, March to October. (*b*) All periods of annual leave as at present allotted to be curtailed by three days, such curtailment to be restored to each officer some time during the remaining four months. (*c*) *Pro rata* payment for duty performed on Bank holidays during the period of March to October to cease and leave in lieu thereof to be granted each officer, this to be added to the three days mentioned above. The commission was under the presidency of Mr. J. C. Lamb.

Telegraph in South Africa.—The phonopore has proved itself of great service in the recent engagement at Mafeking on the 14th inst. According to Reuter's correspondent, Capt. Fitz-Clarence had been despatched with a squadron of men to cover the retreat of the armoured train which had been sent out under Capt. Ashley Williams. When ordered to retire to Mafeking, Capt. Fitz-Clarence was unable to do so without reinforcements, being hampered with his wounded. He therefore sent to the train, which formed a sort of base, and the phonopore was connected with the railway telegraph wire and the message wired to headquarters. In response to this, Capt. Lord Charles Bentinck was sent out with his squadron, and these reinforcements enabled Capt. Fitz-Clarence to retreat in good order.

Sheffield Trams.—We have now some further particulars of the shut-down at the Kelham Island power station of the Sheffield tramways on Monday last week. In their anxiety to throw open new lines to the public, the Sheffield Corporation have done so before the additional plant which is being erected in the power station is completed. In consequence, the station is considerably overloaded. On the day in question the stoker had allowed the boiler pressure to get rather low during the afternoon, so that when an extra heavy overload was thrown on the plant, at about six o'clock in the evening, he was unable to recover the pressure. This gradually dropped to 40lb. per square inch, and the fans for the forced draught, which are steam-driven, stopped running. Consequently the station had to be shut down, as reported in our last issue.

The Metropolitan Electric Supply Co.—To explain trouble in connection with supply during the heaviest hours of load, the Metropolitan Electric Supply Co. have issued the following circular letter to their consumers :—

I am instructed by the directors of this company to express their great regret that the company has recently been unable to maintain a satisfactory supply of electricity during all hours of demand. Anticipating a considerable growth of business, the directors commenced the erection of new generating works at Willesden two years ago. These works, the largest of their kind in Europe, have been fitted up with machinery of unusual magnitude and of the most modern construction; but owing to unforeseen delays in the delivery of constructional and other ironwork, the works have only just been completed. When it was found that this delay might prejudicially affect a portion of the general supply, arrangements were made for obtaining temporary help from a neighbouring undertaking, but latterly this assistance has unfortunately failed us, and our resources have been unduly taxed. The machinery and connections at Willesden are now in course of adjustment, and trial runs are being continually made. The results of these trials justify the directors in feeling confident that they have to ask for the indulgence of consumers for a short time only.

The Institution of Electrical Engineers.—The meetings of this Institution will recommence on Thursday, Nov. 16, when the premiums awarded for Papers read or published during the past session will be presented, after which the President, Prof. Silvanus P. Thompson, will deliver his inaugural address.——A circular is being issued to members and associate members to the effect that, in accordance with No. 10 of the new articles of association, the Council will shortly be prepared to issue a diploma to each member or associate who may apply for one. Application should be made on a form obtainable from the secretary, and the diplomas will be issued in order of application, probably about the end of November. No. 10. of the new articles of association reads as follows :—

"Subject to such regulations as the Council may from time to time prescribe, the Council may issue to any member or associate member a certificate showing the class to which he belongs. Every such certificate shall be according to the form F in the schedule, or such modification thereof as may from time to time be approved by the Council, and shall remain the property of, and shall on demand be returned to, the Institution."

Progressive or Moderate ?—The forty-third annual report of the St. James's Vestry, which deals with the year ended March 25, 1899, has been issued, and in some respects is a remarkable record. The Vestry took steps during the year to oppose in one way or another the following electrical Bills before Parliament: The St. James's and Pall Mall Electric Light Co.'s Bill to empower the company to acquire land and erect generating stations; the Brompton and Piccadilly Circus Railway (Extension) Bill; the Central Electric Supply Co.'s Bill; the General Power Distributing Co.'s Bill; and the three Bills of the National Telephone Co. Besides this, it approved and adopted the resolution passed at a conference of London local authorities finding fault with the report of the Joint Select Parliamentary Committee on the supply of electricity "in bulk," and repeatedly refused the National Telephone Co. permission to lay its wires underground. In support of the latter action the Vestry has deemed it advisable to print the correspondence which passed between it and the Company on the subject after the damage to 1,000 overhead wires by the fire in Heddon-street.

Extension of Canadian Telegraph System.—The Dominion Government is about to undertake the construction of two important additions to its telegraph system, both involving engineering features not commonly met with. The first is a line from Lake Bennett to Dawson City in the Yukon district, for which 165 tons of iron wire will be used. The second is the extension of the Gulf of St. Lawrence telegraph system from Big Roumaine (Quebec) to Château Bay (Labrador) opposite Belle Isle, a distance of 315 miles, and which has been frequently asked for by the shipping interests. In connection with the latter extension, the *Canadian Electrical News* states that it is not improbable that wireless telegraphy will be employed to communicate between Château Bay, on the

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Labrabor coast, and Belle Isle. It is said that the experts are as yet undecided as to how the connection will be made. The laying of a cable would be the most simple method, but it is feared that it might be broken by the grounding of icebergs in this narrow strait. About the only alternative, therefore, seems to be the adoption of a system of wireless telegraphy, and this course is understood to be under consideration. The demonstrations that have been made of this system would seem to place its practicability beyond question, and its adoption in Canada to a greater or less extent may be expected to follow in the near future.

Electricity for Sanitation at Havana.—When the American authorities succeeded the Spanish in Cuba they experienced great difficulty, as is well known, in cleansing the city of Havana of yellow fever. As an aid to the much needed process of disinfection it was decided to employ the Woolf electrical process for the production of hypochlorites from sea water, and this installation is described in the *Electrical World* of New York. A battery of four boilers and two Ames engines of 250 H.P. furnish the motive power. The engines are belted to a counter-shaft, from which there are at present operated four Crocker-Wheeler dynamos of 100 kilowatts each, supplying 4,500 amperes each at 12 volts. The machines are separately excited by an 18 kilowatt exciter. There are eight electrolising vats, into which sea water is pumped from the bay, each containing 417 positive electrodes and 425 negative zinc electrodes. The current is 6 volts per vat, the vats being run two in series. The positive electrode, being the one subject to attack from the gases evolved, is formed from an alloy of platinum and iridium, which material is not acted upon by nascent chlorine. This electrode is immersed at a distance of about ½in. from the negative electrode. In the process of electrolysis oxygen and chlorine collect at one electrode, and hydrogen collects at the other, whence it rises to the surface, and escapes into the air. The chlorine and oxygen unite with the bases, forming hypochorites, which are powerful disinfecting agents. The capacity of the plant is 160,000 gallons per 24 hours.

Glasgow University.—Prof. Andrew Gray, who has succeeded Lord Kelvin in the Chair of Natural Philosophy, delivered his introductory address on Friday last. He said that it was a high honour and privilege to return to his old university and again to teach in the department of natural philosophy. He might claim to know some of the generous traditions of the place, and the feelings and aspirations of the students, and he felt confident that he might count on their sympathy and toleration in entering on a task of such magnitude and difficulty, for he knew the work of his illustrious predecessor would tax the powers even of the greatest and ablest of living cultivators of science. He would be satisfied if he succeeded in guiding the students into accurate habits of thought and expression and to the acquirement of some knowledge concerning the fundamental theories of natural philosophy, and perhaps add some contribution to the advancement of science. He then proceeded to speak on the subject of the inter-connection of theory and practical applications in physical science, referring to the work of Galileo, Bacon, Newton, Maxwell, and Hertz, who had produced results which were beneficial to the world to-day, and marked the progress of civilisation. In conclusion, he said there was hardly in this kingdom a university more advantageously placed with respect to physical science than Glasgow, for it was surrounded by great laboratories of applied science—called workshops—and in that university they wanted to give a new example on a great scale of that inter-connection of theory and practical application in physical science on which he had addressed them.

A Modern Printing Office.—The members of the Manchester Society of Junior Electrical Engineers paid a visit to the Co-operative Wholesale Society's Longsight printing works on Saturday last. Through the efforts of their manager, Mr. G. Brierly, the directors of these works have been induced to instal their own electrical plant under the supervision of Mr. A. A. Blackburn, their electrical engineer. Steam is provided by two 30ft. by 8ft. Lancashire boilers at a pressure of 100lb. per sq. in. The boilers are fitted with "Helix" mechanical stokers and conveyors and the usual accessories. There is also a 144-tube Green economiser and superheaters supplied by Messrs. Wood Bros. The boiler feed pump and a steam fire engine, both by Messrs. Goodbrand and Co., can deliver 63,870 gallons and 285 tons of water per hour respectively. The engines are compound, tandem, horizontal non-condensing, fitted with Wood Bros. semi-circular slide cut-off valve. They are rated at 155 H.P., their speed is 70 revolutions per minute, and the stroke 36in. Two Holmes bi-polar shunt dynamos are belted to each engine; two machines for lighting supply each 450 amperes at 105 volts, and two for power develop 300 amperes each at 200 volts. There are separate switchboards for the light and power circuits. All the motors are of the Lundell enclosed type, fitted with Cutler automatic starting switches. About two-thirds of the machines have each their own motor, fitted with a raw-hide pinion which gears into cast-iron spur wheels on the machine. The other machines are connected in groups, each of which is driven by one motor through belting. There are 94 machines in all, and the horse-power of the motors varies from 0·75 to 7 B.H.P. Three different kinds of lamps are employed for lighting—Hill inverted arcs, Jandus enclosed arcs, and 16-c.p. incandescents. The works were started in August last year, and employ some 350 hands.

City and Guilds Technical Examinations.—The figures given in the report of the Examination Department on the work for the session 1898-99 show that there has been the same growth and development in the work of the department as in previous years. The total number of students in the classes was 36,155, against 34,990 in 1897-98, and the number examined was 14,778, as compared with 14,148. The Institute's connection with the Colonies has been extended by the creation of new centres of examination in Jamaica and Barbadoes. An increase of 46 candidates for examination in mechanical engineering is recorded, whilst the proportion of failures shows a fractional decline. In electric lighting and power 332 more students sat for examination, the report noting an improvement in the work done. Out of a total of 106 candidates for the practical wiremen's test 61 were successful. 1,362 students were examined in telegraphy and telephony, against 1,377 last year, but the percentage of failures, viz., 29·1, shows no alteration. There is, however, a satisfactory increase in the honours grade, the number of passes having risen from 134 to 229, the failures only showing an increase of 2. In the reports on the different sections attention is drawn, as in most previous years, to the very low standard of the drawing in this department, and to the weakness of the papers of the candidates in the ordinary grade of the electro-plating and deposition examination. The honours candidates in the latter section, on the other hand, show a very marked improvement. Mr. G. Matthey is chairman of the examination committee, and Sir Philip Magnus superintendent of the technological examination. The examiners were: Telegraphy and telephony, Mr. J. Gavey; electric light and power, Prof. W. E. Ayrton and Mr. J. Swinburne; electro-plating and deposition, Prof. W. G. Macmillan; mechanical engineering, Prof. Hudson-Beare and Prof. W. E. Dalby.

MEETINGS OF SCIENTIFIC AND ENGINEERING SOCIETIES, &c.

(To-day) FRIDAY, October 27th.

PHYSICAL SOCIETY.

5 p.m. Meeting in the Rooms of the Chemical Society, Burlington House. Agenda: (1) "The Magnetic Properties of the Alloys of Iron and Aluminium," by Dr. S. W. Richardson; (2) Exhibition of a Model illustrating a number of actions in the flow of an Electric Current, by G. L. Addenbrooke; (3) Repetition of some Experiments with the Wehnelt Interrupter devised by Prof Lecher, by W. Watson.

INSTITUTION OF MECHANICAL ENGINEERS.

8 p.m. Ordinary General Meeting at Storey's Gate, St. James's Park.

FRIDAY, November 3rd.

INSTITUTION OF JUNIOR ENGINEERS.

8 p.m. Meeting at Westminster Palace Hotel. Presidential Address by the Hon. C. A. Parsons, F.R.S.

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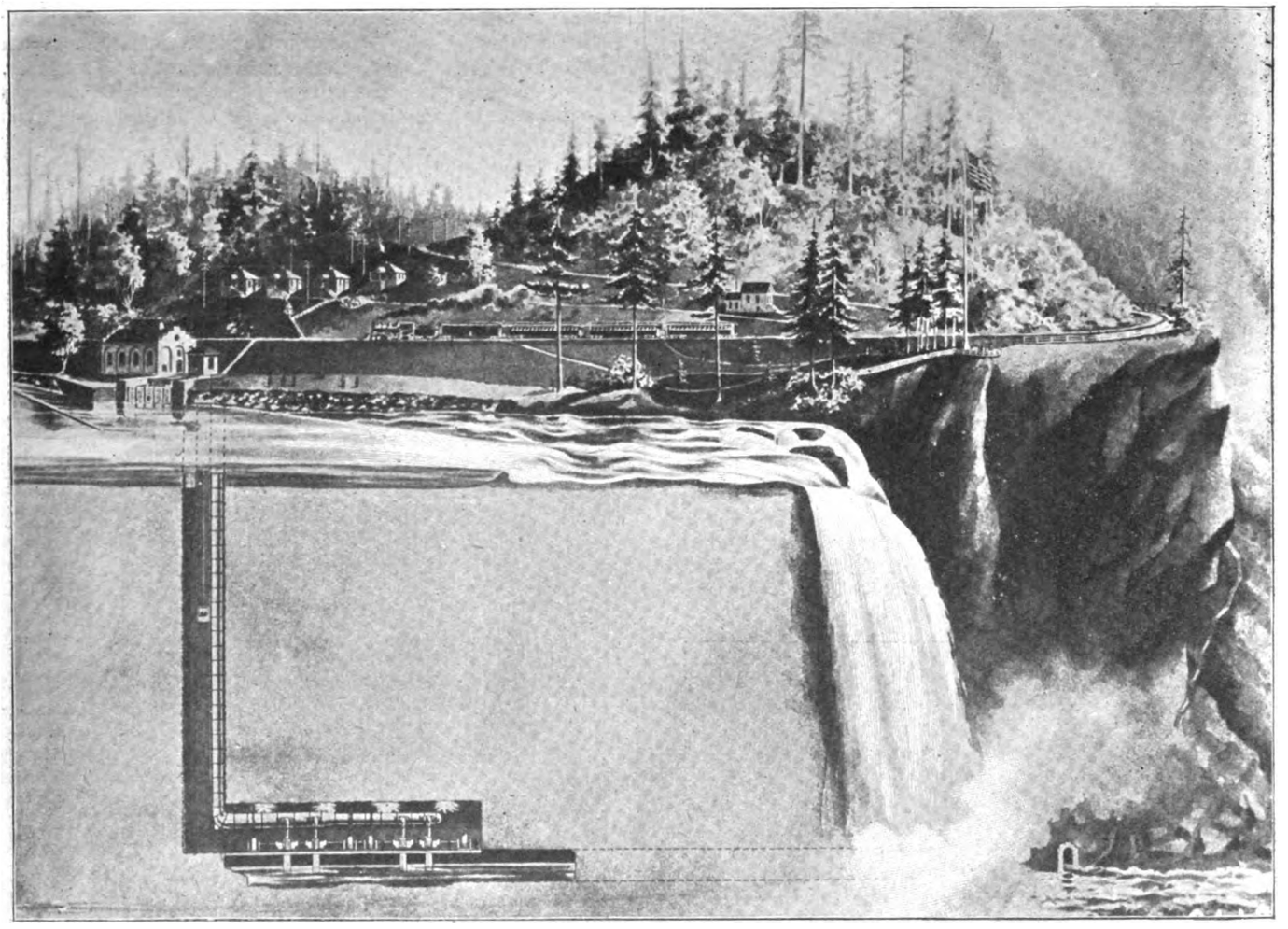
THE SNOQUALMIE FALLS TRANSMISSION PLANT.*

The long distance electrical transmission from the Snoqualmie Falls to the cities of Seattle and Tacoma, Washington, is of interest for many reasons. A plant transmitting horse-power measured in five figures to a distance of over 80 miles would alone be noteworthy; but when the transmission is effected at a pressure of 29,000 volts, and when aluminium is employed instead of copper on the transmission line, the scheme may well be considered unique. This great undertaking was inaugurated on July 30th, although only the Seattle circuits were then in working order. The conducting-lines to Tacoma are in an advanced state, but are not yet completed. The transmission lines from Snoqualmie Falls to Seattle measure 31 miles, and to Tacoma 45 miles.



General View of Falls, showing position of Generating Plant.

The falls, which are 270ft. in height, are isolated from civilisation, which somewhat impeded the construction of the plant. The river has a watershed of 400 square miles. The capacity of the water plant now completed is 14,000 H.P., but the minimum power available at the falls is more than double this, and can be increased by damming the outlets of the numerous tributary lakes, which would insure a continuous supply of 100,000 H.P.

The generating plant is remarkable in that the water-wheels and generators are located in a cavern in the solid rock at the bottom of a 260ft. shaft, as indicated in the illustration. From the edge of the falls, about 200ft., a vertical shaft 10ft. by 25ft. has been sunk in the river to a depth of 260ft. The walls and floor of the intake are concreted 6ft. in thickness. To prevent drift-wood from passing down the shaft an immense grating of logs, 30ft. wide, has been erected upon the side next the river, and on the diagonal braces within this grating a wire mesh holds back smaller floating matter. The intake directs the water to the mouth of the vertical shaft, where it enters a steel penstock 7½ft. in diameter, which passes down the shaft to a receiver at the foot. Space is provided for a similar penstock whenever it shall be found necessary to add to the plant. Within the vertical shaft is also a passenger elevator for giving access to the power house.

At the foot of the vertical shaft a chamber 200ft. by 40 ft., with a height of 30ft., contains the electrical generating plant and water wheels. Below the floor of the chamber a tail race carries the water to a tunnel with exit at the foot of the falls. The water passing down the penstock reaches a steel receiver, 10ft. in diameter, constructed of 1in. steel, which is carried horizontally for 80 feet along a bench in the chamber, 19ft. above the floor, and is continued a further 60 feet with a diameter of 7½ft., the hydraulic pressure being 120lb. to the square inch. There are five outlets from the receiver, one for each of the main water-wheels, and one to the water-wheel operating the two exciters. The water-wheels are of a special type, designed by Mr. Thomas T. Johnston, the chief engineer of the company.

Directly connected to the four large water-wheels, with a speed of 300 revolutions per minute, are four 1,500-kw. Westinghouse three-phase alternating-current generators, one of which we illustrate, delivering current at 1,000 volts, at a frequency of 45 ∽ per second. The armature winding is of the closed circuit type, and consists of 266 bars, with one bar per slot. The armature of one of the 1,500-kw. generators is 96in. in diameter, and weighs approximately 23,000lb.

* From an article by J. R. Cravath in the *Electrical World* of New York.

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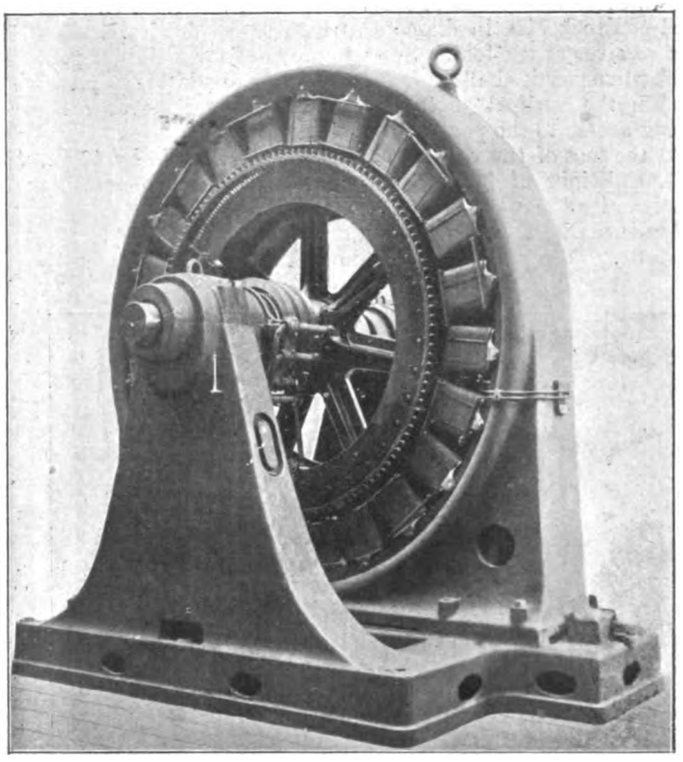
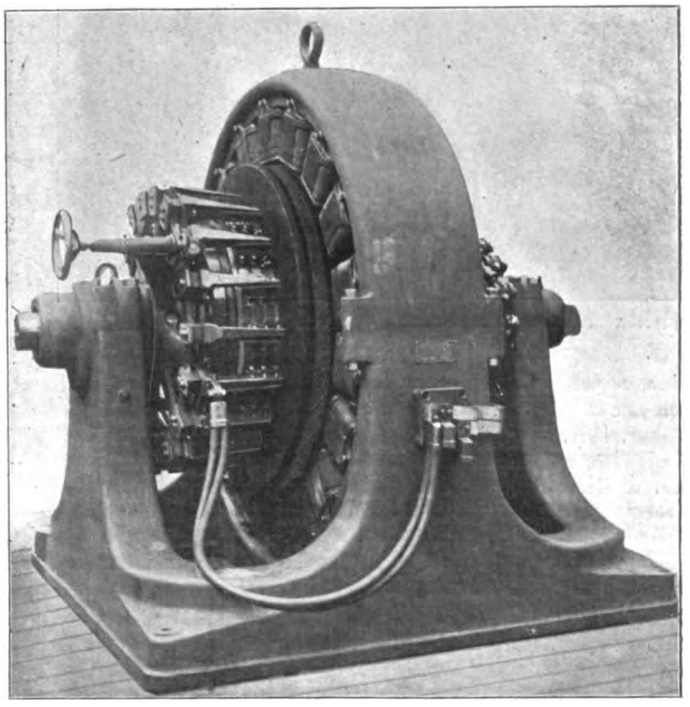
Owing to the great amount of energy which is stored in these 10-ton armatures when running at their rated speed of 300 revolutions per minute, no automatic speed regulators are employed, since the momentum of the armatures is sufficient to prevent sudden changes of speed, and the momentum of



1,500 Kilowatt Three-Phase Westinghouse Alternator.

the column of water descending to the water-wheels also helps in this direction, though the latter momentum is not equal to that of the revolving armatures. Whatever speed regulation is necessary is done by hand. Of course, the fact that the generators are large compared with any of the power units in

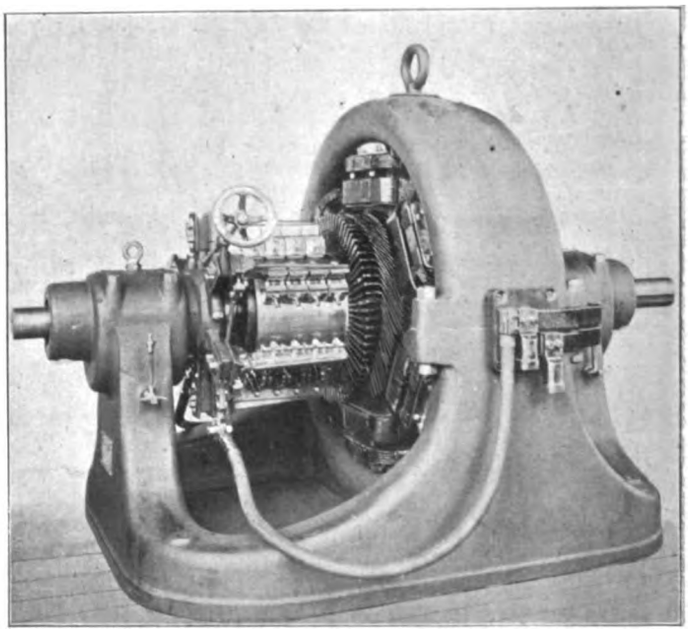


500 Kilowatt Rotatory Converter

use at points of consumption makes any likely variation in load on a generator very small as compared with the total generator load. Therefore the requirements of water-wheel governing are less severe in this plant than in the majority of water-power electric plants.

Collector rings of the ventilated type deliver current to the circuits. Three brushes bear on each ring, and to insure equal division of current between them in cases of variable contact resistance, separate cable leads of considerable length connect the brushes to the outside circuits, in order that the fixed resistance in series with each brush may be large compared with the possible variable resistance. The field frames of the generator are divided vertically, resting on the bed plates which support the armature bearings, and may be withdrawn for inspection of the field or armature without any hoisting or other auxiliary apparatus.

The poles are laminated, and cast into the field frames. The field windings are of one layer of copper strap, bent cold and afterwards insulated. At each end of the coil are brass brackets which rigidly hold it on the pole-pieces, exposing both inside and outside surfaces to circulation of air. This method of construction provides a coil which is very easily insulated and furnishes a large surface for ventilation. With no load these generators require a field current of 95 amperes, at about 90 volts, and with full non-inductive load 100 amperes to maintain the same E.M.F. Two continuous-current exciters, 75 kilowatts each, at 125 volts, 300 revolutions per minute, are directly connected to smaller water wheels, and are used for exciting the large generators. A view of one of these exciters is shown in an illustration.



75 Kilowatt Exciter.

The switchboard, of which we give a front and back view, follows the usual Westinghouse practice, and consists of two exciter panels, four generator panels, and 12 feeder panels. The exciter panels contain an ammeter, circuit breakers, main switches with governing rheostats, voltmeter plugs, and ground detectors. The generator panels have circuit breakers on two of the three conductors, pilot lamps, field ammeters, main ammeter on each of the three conductors, indicating wattmeters, triple-pole double-throw switch, together with rheostats, field plugs, voltmeter plugs, and ground detector plugs. The wattmeters are connected by a combination of series-shunt transformers, so that their indications are the same as if they were on a two-phase circuit. Thus the indications of the meters remain equal with a balanced load even with a power factor lower than unity on the three-phase circuit.

Each of the 12 feeder panels carries a circuit breaker, alternating-current ammeter, and double-pole two-throw switches. All these instruments are in sets of three, each set controlling a bank of three transformers. The middle panel of each set carries a polyphase recording wattmeter. Each

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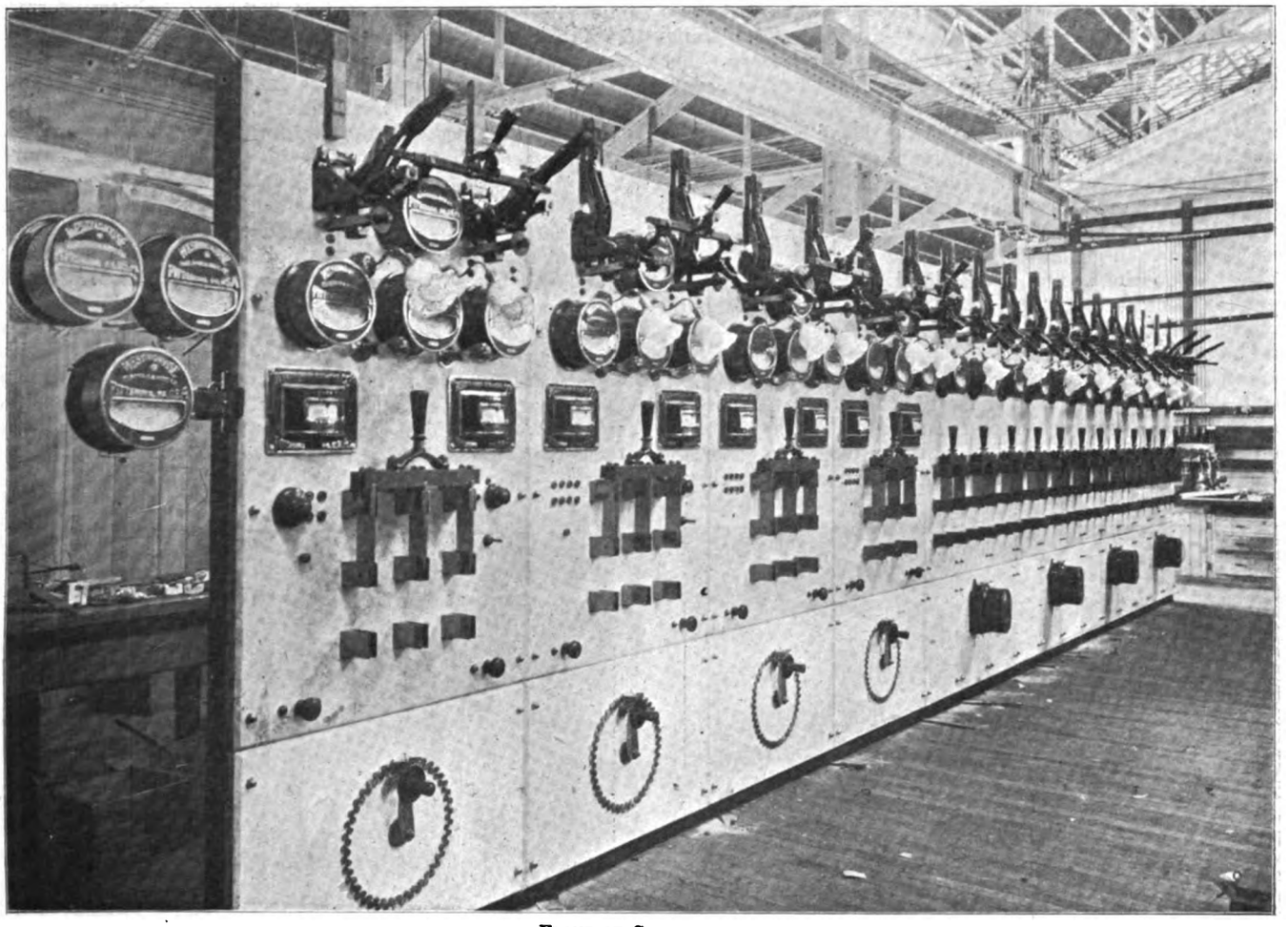
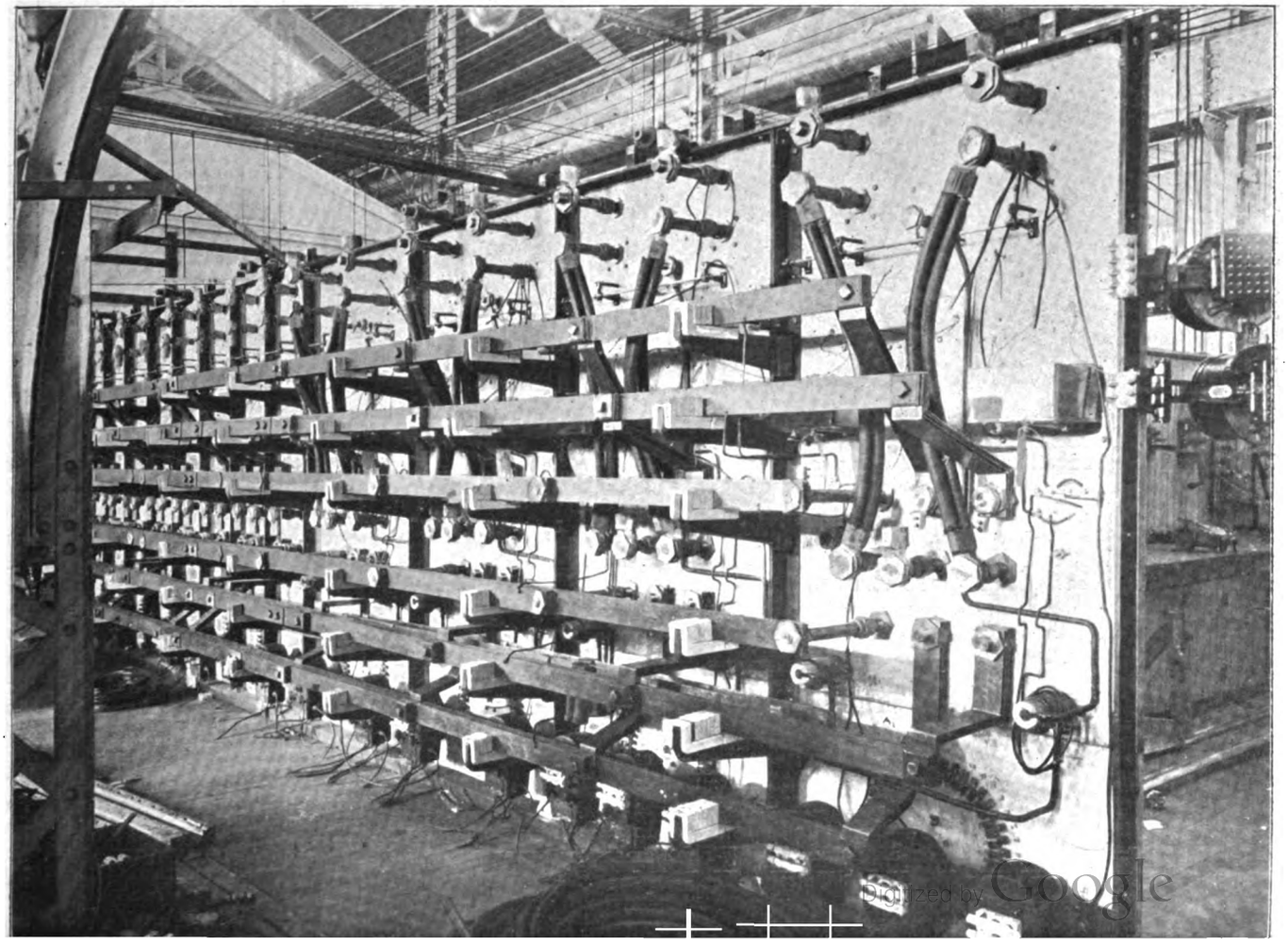


FRONT OF SWITCHBOARD.



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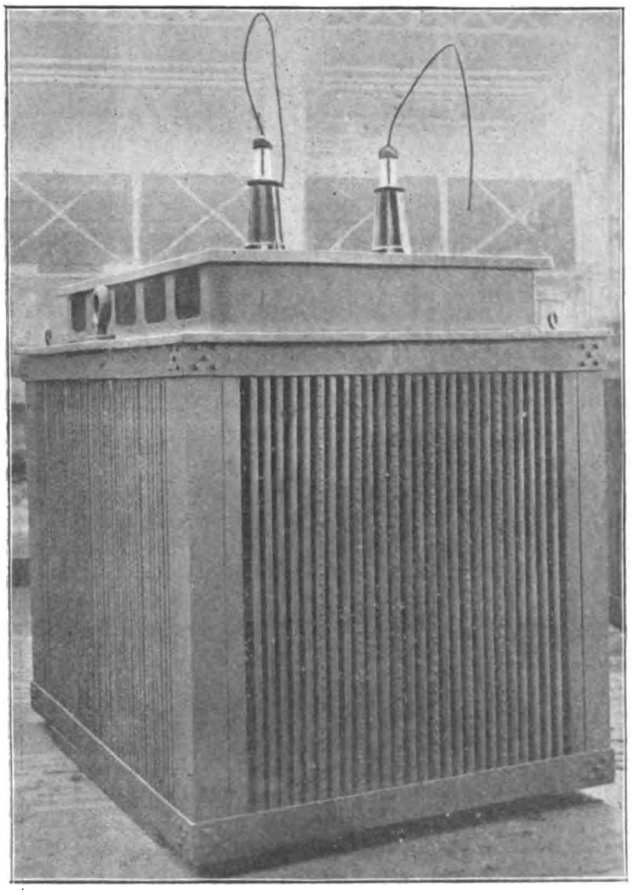
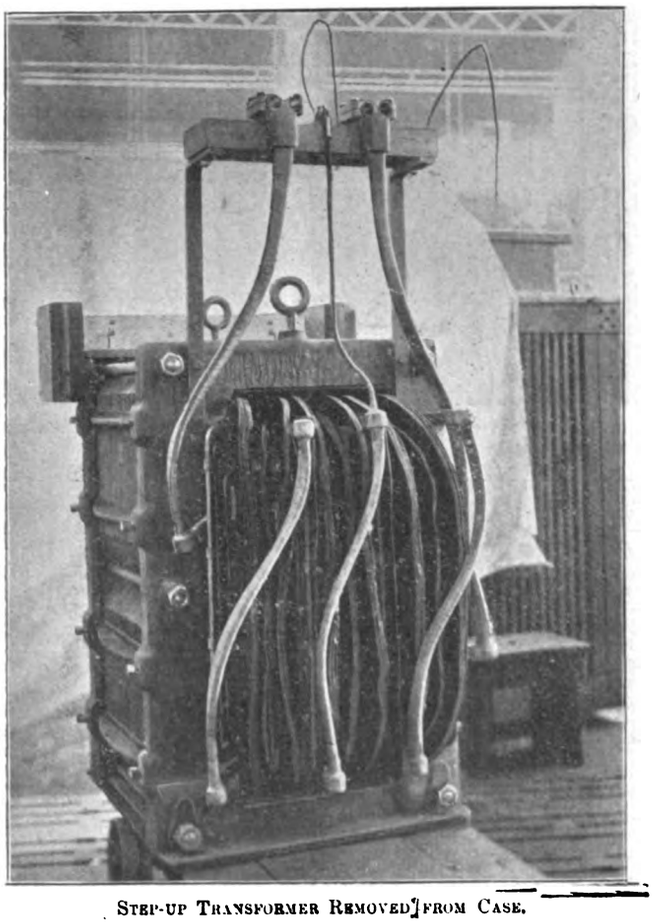
feeder panel controls the primary circuit of one transformer, there being 12 of these step-up transformers connected delta fashion on both primary and secondary circuits. Each transformer can thus be controlled through the switchboard. The voltmeters for the feeders are placed at one end of the board on a swinging bracket. The back of the board carries two sets of main 'bus-bars connected with the upper and lower jaws of the switch so that a difference in potential may be used for generating and transmitting. All the circuit breakers are fitted with hand trip devices which enable the operator to throw out all the lines of bank transformers, or two of the three lines of each generator.

Attached to the end of the switchboard, and visible from any point along its front, are three alternating voltmeters on swinging brackets, two of which are attached to two sets of 'bus-bars, and the third to a pair of voltmeter 'bus-bars connected to the voltmeter receptacle on each generator, by which the voltage on any phase of any generator may be measured. The generators are connected to the switchboard by means of lead-covered cables running from the generator to the wall through a conduit laid in the concrete, and thence



STEP-UP TRANSFORMER IN CASE.



STEP-UP TRANSFORMER REMOVED FROM CASE.

to the aluminium conductors on arms and glass insulators, which carry the current to the switchboard. On these aluminium bars are placed the series transformers which control the various wattmeters on the switchboard. From the switchboard 25 conductors, each of eight aluminium wires, pass along the wall of the cavity and up the shaft to the step-up transformer plant, where they are connected to the banks of transformers, and from these transformers the conductors pass upwards to the plug switchboard on the transmission lines.

The transformer house is on the bank of the river immediately above the falls, being a brick building 40ft. by 50ft., with concrete floors and iron roof, the whole being practically fireproof. The current at 1,000 volts is conducted upwards through the shaft to the transformer house. The transformers, each of 500 kilowatts, by bare aluminium cables strung on glass insulators fastened to a wooden framework in the shaft, are of the self-cooling oil-insulated type. The dimensions of the transformer cases are 55in. by 72in. by 66in. Of the total weight of 10,850lb. in each transformer, 3,600lb. is in iron and copper, 3,850lb. is in oil, and the weight of the case is 3,400lb.

The step-up transformers are in delta connection for both primary and secondary circuits. Separate primary feeder panels are provided for each transformer, so that any one may be separately controlled. One of the remarkable features about these transformers is their low self-inductance. With one of the windings short-circuited, only 3 per cent. of the normal E.M.F., at 45 ∽ per second will send full load current through the other coil. The high tension coils have many layers, and but a few turns per layer, while the low-tension coils are of bars or straps wound on edge and afterwards insulated. The coils are spread at the ends outside of the iron core to facilitate ventilation and to increase the distance between coils where it is difficult to apply solid insulation. To protect attendants and apparatus in case of accidental contact between high and low-tension windings, adjusted spark gaps are put between each low-tension winding and the ground.

The current is raised by the transformers from 1,000 volts to 29,000 volts for delivery to the transmission lines. Each transformer is supplied with two high-tension fuse circuit breakers, by which it may be disconnected either by hand or automatically, in case of excessive current load. The fused circuit breakers consist of two hinged rods by which the fuse terminals are widely separated, breaking the arc when the fuse is ruptured by the current.

Protecting each in-coming wire is a Wurts lightning arrester of improved construction (see illustration). On the front of a vertical marble slab, 24in. wide and 65in high, are mounted the spark gap cylinders in units of seven in separate porcelain cases, while on the back of the same panel are six-choking coils mounted on three marble wings, each effectually supporting the coils, and insulating them while they are brought into close inductive action with each other. The whole is small, self-contained, and fireproof. Elaborate precautions

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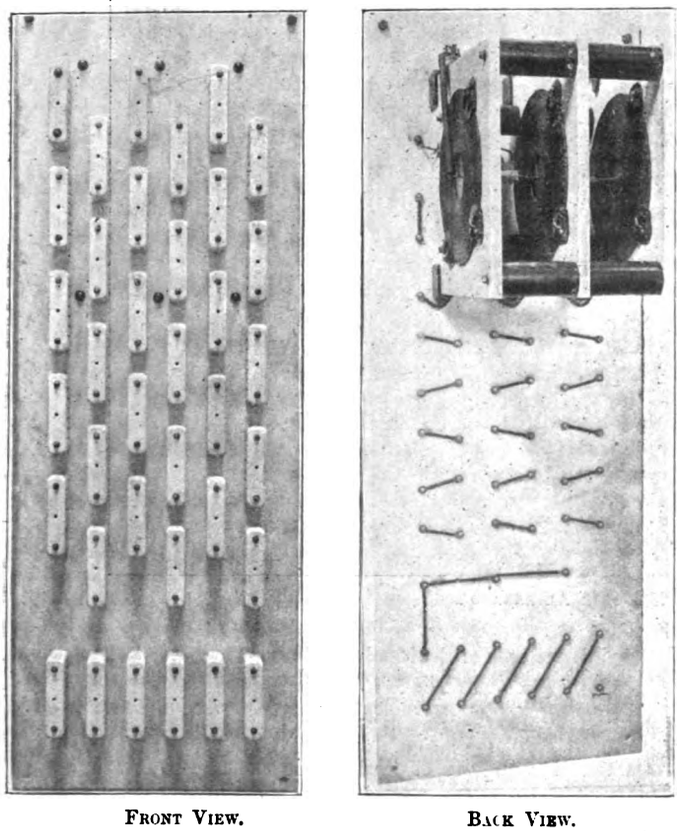
have been taken to insulate the high-tension conductors: each wire is passed through the wall of the building enclosed in a thick glass tube, 24in. long, with an outside diameter of 2in. Each of these tubes is placed in the middle of a marble slab 2ft. square, set into the wall of the building, the exterior ends of these bushings being protected by a hood.

We come now to the transmission lines, about which there is considerable to interest the electrical engineer, because of the fact that aluminium wire is used exclusively. The transmission circuits are led from the transformer house over a rough but not mountainous country to the sub-station at Issaquah, 10 miles distant, the lines paralleling each other at a distance of 40ft. These parallel lines continue to Renton, a further nine miles, where current is used locally, and from that point branch to the north-west and south-west to Seattle and Tacoma.

Aluminium wires have been used on these long-distance transmission circuits, of No. 1 and 2, B.S. gauge. Line conductors are spliced with the McIntyre joint, consisting of a flattened aluminium tube 9in. long, with walls $\frac{1}{16}$in. thick, large enough to enclose two wires. The latter is given three complete twists by special clamping tools to complete the joint



FRONT VIEW. BACK VIEW.

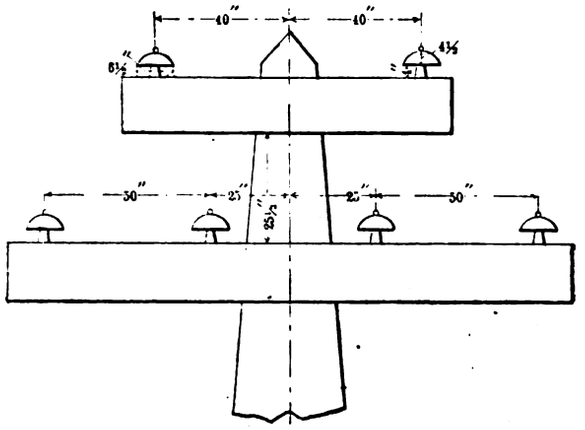
NON-ARCING METAL LIGHTNING ARRESTER FOR TRANSMISSION CIRCUIT.

(*see* figure). The Seattle line contains about 67,000lb. of aluminium, and the Tacoma line 72,000lb., each line consisting of two three phase circuits. The conductors are carried on triple-petticoat "Imperial" porcelain insulators, 4½in. high, 6½in. in diameter, weighing 4lb. each. Paraffined locust pins are used to support the lower part of the insulator 4in. above the cross arms. The tie wires are of No. 8 aluminium.

Two circuits are run on each pole line—one on each side—with triangular space of 30in. between wires, as shown in the figure. Four wires on the lower cross arms are spaced on either side 25in. and 75in. from the centre of the pole; 25½in. above on another cross arm are twe wires 50in. on either side of the pole. The length of span on the Seattle lines varies from 9ft. to 150ft., with an average of 110ft. On the Tacoma line the average span is 150ft. At the Renton sub-station a high-pressure switchboard allows any combination of the in-coming and out-going circuits to be made. Each wire is provided with a high-pressure fuse switch. All high tension apparatus at this station is contained in a brick building, 40ft. by 40ft., designed and erected for this purpose.

The generators and feeders leading to the step-up transformers may be operated in multiple from either of two sets of 'bus-bars.

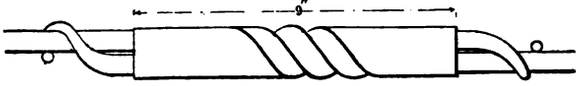
The sub-station at Seattle is a substantial stone building in the business district of the city. A tower on the third floor receives the in-coming wires, which are thence led through a terra cotta enclosure to the Wurts lightning arresters on the second floor. Below, on the ground floor, are high-pressure fuse switches by which the station may be controlled with regard to the in-coming circuits. All the load may be placed on either transmission circuit, or may be divided so that the steady load is on one circuit and the fluctuating load on the other, or both circuits may be connected in multiple. A characteristic feature of the whole plant is the extreme flexibility of the switching apparatus.



ARRANGEMENT OF WIRES OF TRANSMISSION LINE.

This station contains a number of self cooling Westinghouse oil-insulated transformers, reducing the current to a low voltage for the rotatory converters. Three 500-kw. Westinghouse rotatory converters are already installed, one of which we illustrate. These machines receive alternating current from the transformers at about 330 to 350 volts, and deliver direct current at a potential of 550 to 600 volts, for use by the street railway company. There are also six Westinghouse step-down transformers of 300-kw. capacity each, with 2,000 volts, thus making the total station transformer capacity about 4,000 kilowatts.

Power is also supplied to operate two 200 H.P. Westinghouse type "C" induction motors, installed in the Centennial flour mills. These motors work at 200 volts, 500 revolutions per minute, having supplanted steam engines. The motors are belted to a jack shaft, and operate the whole of the flour mill machinery, including grinding, cleaning, ventilating,



Joint in Aluminium Transmission Line.

receiving and delivering by elevators, and all the other operations of the mill. It is estimated that the substitution of electrical power for steam will effect a saving of 25 to 30 per cent. in the cost of the motive power. Other Westinghouse transformers and rotatory converters are contracted for, and will be delivered in due course.

The switchboard at the Seattle station is similar in construction to that at the Snoqualmie station, and controls the rotatory converters and transformers for both alternating and direct-current circuits. The Tacoma sub-station and transmission lines are not yet completed, but are being rapidly pushed forward. Electrical apparatus has been provided for this station for driving arc generators, type "C" motors, and for making the necessary transformation in the current. The contract for the entire electrical equipment for the Snoqualmie Falls transmission plant has been executed by the Westinghouse Electric and Manufacturing Co.

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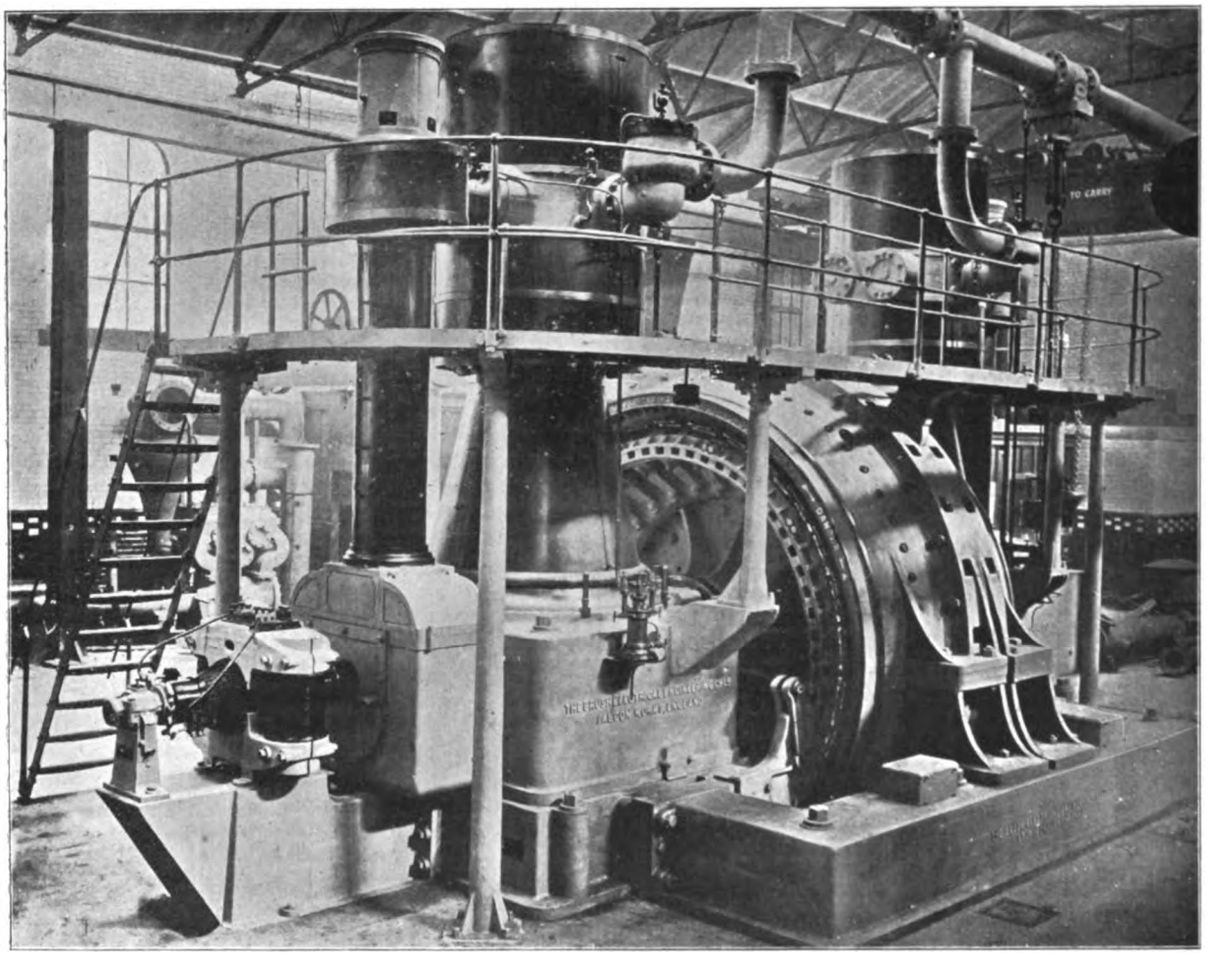
A LARGE INDUCTOR ALTERNATOR.

The illustration below represents a 600-kw. Mordey inductor alternator coupled to a Raworth "Universal" engine. It was constructed at the Loughborough works of the Brush Co., and has recently been erected and tested at the lighting works of the Sheffield Corporation. An interesting feature of the machine is that it is designed to generate current at a frequency of 100 ∿ per second, the frequency employed at Sheffield This frequency is especially high for an alternator of the inductor type.

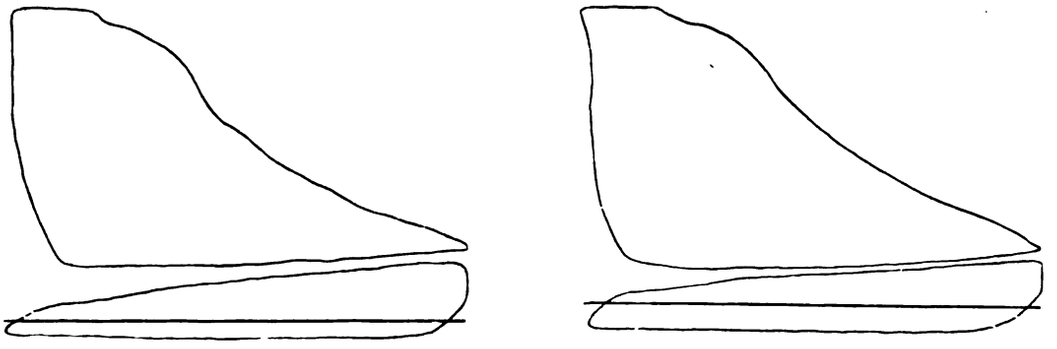
The plant ran its six hours official test on August 9th, and has been in regular service ever since. We are informed that the results were not only superior to the guarantees, but surpassed the best expectations of the designers, the combined efficiency of a non-inductive full load being 82¾ per cent., including excitation, and 74 per cent. on one-third load. Consistently with the high efficiency, the rise in temperature was not great, being only 34deg. F. after the six hours trial at somewhat over full load. The maximum output during the test was 720 kilowatts.

The rotating portion of the dynamo is nothing but a serrated flywheel without conductors or windings of any kind, and, as seen in the illustration, it is suspended between the engine cranks. The stator conductors are insulated rods of copper passed through closed slots in the iron laminæ. The field is excited by a single coil.



RAWORTH-MORDEY 600-KILOWATT INDUCTOR ALTERNATOR.

A detailed description of the Mordey inductor alternator is, however, unnecessary, as its construction was described in detail in *The Electrician*, Vol. XXXVIII., p. 498. The same applies to the Raworth "Universal" engine, for a description of which our readers may refer to *The Electrician*, Vol. XXXVI., p. 666. We may mention that the engines of this set are the largest of that type which have yet been manufactured. It will be remembered that each crank of the engines is operated by compound cylinders arranged tandem, and that each cylinder is single acting. Two Corliss valves are placed between the cylinders, to obtain the shortest possible steam ports. Ample proportions have been allowed for in the design. For instance, each crank shaft has a bearing next to the



Reproduction of Indicator Cards. Scale 1in. = 80lb. per sq. in.

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rotor of 13in. in diameter and 34in. long. The makers now rate this 600-kw. plant at 750 kilowatts. The speed is 200 revolutions per minute. We reproduce two indicator cards taken during the official test at a speed somewhat below the normal, and at a load of 620 kws.

The Brush Co., who, it will be remembered, control the patents for inductor alternators in this country, inform us that they have a considerable number of these machines on order of large size. Several of these orders are for polyphase machines, and, when the extensions they are carrying out in their heavy machine shop are completed, they expect to turn out as large a horse-power per annum in alternators as any two of their English competitors. We for our part shall be satisfied if they sell as much addititional horse-power per annum in alternators as is now being supplied to British municipal corporations from abroad.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

Zeeman Effect.—While the general laws of the splitting up of spectrum lines under the influence of a magnetic field are fairly well known and explained, it remains yet to account for the peculiar differences observed in the intensities of the various components of doublets and triplets and more complex structures. W. Voigt formulates a mathematical theory which in its simplest form indicates a strong luminosity of the central component of a triplet in comparison with the lateral components. A slight amplification of the Hertzian equations accounts for the varying intensities, if the resistances opposing the oscillations of the vectors characteristic of each spectrum line are assumed to vary with the strength of the magnetic field. This assumption also explains the curious fact that in the magnetic field certain spectrum or absorption lines become visible which are not known under ordinary circumstances. Another observation thus explained is that made by Egoroff and Georgiewsky concerning the partial polarisation of a monochromatic flame in a magnetic field.

[W. Voigt, *Wied. Ann.*, No. 9, 1899.]

Vacuum Interrupter.—In 1896, MacFarlane Moore exhibited before the American Institute of Electrical Engineers a new device for electric illumination, by which vacuum tubes, with or without electrodes, were made to yield a bright and continuous light of some 16 c.p. without the use of an induction coil. The device was based upon the employment of a Wagner hammer-interrupter vibrating in a vacuum, and producing a very abrupt and perfect break. The self-induction in a short primary coil then sufficed to produce a train of sparks, or the illumination of a vacuum tube. The high expectations attached to this interesting contrivance do not seem to have been realised, probably owing to the fact that the hammer is liable to stick, and the current then melts off the point of contact. To avoid this, J. Elster and H. Geitel keep the hammer vibrating by means of a separate electromagnet outside the vacuum tube actuated by a mercury interrupter of the Roget spiral type. The spiral and the hammer are tuned to unison, but even so the light obtained is somewhat fitful, and less steady, though safer, than the light obtained by Moore.

[Elster and Geitel, *Wied. Ann.*, No. 10, 1899.]

High-Frequency Glow-Light Phenomena.—When a high-frequency alternating current, of say 1,000 reversals per second, is discharged through a vacuum tube in process of exhaustion, the current intensity increases up to a certain exhaustion, and then decreases. At the same time the potential and the energy consumed pass through a minimum. This circumstance is explained by H. Ebert on the ground of a residual effect of the positive charge in the glow light, which persists for a short time after the glow has ceased. When different gases are compared, it is seen that the reversal takes place at pressures which are in the same ratio as the mean free paths of the respective gaseous molecules—in other words, when the mean free path has reached a certain value. After that is reached, the charged molecules are no longer capable of exchanging their charges in time for the next discharge. A similar reversal takes place when the pressure is kept constant and the electrodes are moved up to each other. The reversal coincides with the point at which the glow-light layers formed during alternate discharges begin to overlap. When another tube is mounted in parallel, part of the discharge then begins to pass through the second tube. The author has also succeeded in demonstrating a repulsion between the electrodes due to the fact that the positive charges produced by one anode persist after the other electrode has become an anode.

[H. Ebert, *Wied. Ann.*, No. 10, 1899.]

Magnetic Properties of Pyrrhotite.—Pyrrhotite or magnetic pyrites, Fe_7S_8, is, like magnetite, a crystallised magnetic substance. The crystals are of hexagonal appearance, but their symmetry is in reality of an inferior order. Good crystals are very rare, the best coming from the now exhausted Minas Geraës of Brazil. Pierre Weiss has discovered a very remarkable magnetic property possessed by this mineral. It is capable of magnetisation by induction in all directions except that of the crystalline axis of symmetry. If the base of the hexagon faces the magnetic pole, there is no attraction whatever, while attraction is very noticeable in any other position. The author has found that magnetisation is only possible in a plane normal to the crystalline axis, which he calls the magnetic plane. When the lines of force are normal to this plane, no magnetisation takes place, or if there is any, it is quite 600 times feebler. A ballistic method shows practically no deflection when the magnetic plane is at right angles to the magnetising coil. A striking piece of apparatus devised by the author is an arrangement in which a sphere of pyrrhotite is suspended by a wire and a Cardan joint in such a manner that it can, by turning through 90deg., be made "magnetic" and "non-magnetic" with respect to a large permanent magnet attached to the apparatus.

[P. Weiss, *Journ. de Phys.*, October, 1899.]

ELECTRICITY WORKS ACCOUNTS.

Shoreditch Vestry Electric Supply Works.

Another year's accounts of the interesting undertaking of the Shoreditch Vestry have been published. We are very glad to find that, although these accounts still appear in the same somewhat irritating detail, there is also a version arranged in the Board of Trade form.

In view of the fact that our table last year, although dealing with a year's accounts, only covered about nine months of actual working, the analysis which appears this week is of interest, as being probably more representative. The figures we publish show, we think, without room for doubt, that not only has the combination of the electricity works with those of the dust destructor quite justified itself in results, but that the electricity department is, considering its comparative youth, in an excellent position.

Comparing the output of the year 1898-9 with that of the nine months ended at March 25, 1898, *pro rata*, it will be found that the number of units sold has increased nearly 2¾ times, while the rate of increase in the lamp connections and number of consumers indicates well for the future.

The reason of this almost phenomenal progress is seen when we pass to the revenue account, and note the 3·2d. representing the average total revenue per unit sold, while the joint revenue in respect of the lighting, public and private, is no more than 3·18d. per unit. These are excellent figures, but can they be justified from the point of view solely of the electricity department in view of the high capital expenditure? We do not say that £145 (the mean) per kilowatt is at all an abnormal capital expenditure for a London station, but an average revenue per unit of 3·2d. cannot, we think, with justice be associated with such a capital expenditure except under abnormal conditions. The lowest revenue figures we have yet come across in our Electricity Works Accounts have been those of Ayr for 1898-9 and Edinburgh for 1897-8, being respectively 3·15d. and 3·16d. per unit. It must be remembered, however, that these values are associated with capital expenditures of respectively only £70 and £87 per kilowatt of plant capacity; and it is more than doubtful, if these two concerns existed with the capital expenditure common to London stations and worked under London conditions, that they could find it consistent with financial soundness to adopt the tariffs which result in the average revenue figures quoted.

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One of the most interesting features of the Shoreditch station is the relation between the maximum demand and the output, which results in the high load factor of 16·3 per cent. Turning now to the costs, the fuel item naturally first secures our attention under the conditions; and we may here record that the coal consumed, corresponding to the item of £1,376, amounted to 1,450 tons, or at the rate of 2·55lb. per unit generated. We must confess that these figures and the fuel charge of 0·32d. per unit sold is a disappointment of our expectations in respect of the dust destructor-electricity scheme. Of course, the difference between this figure of 0·32d. and the 0·51d. of the St. James's station or the 0·92d. representing the mean of the London stations seems sufficient quite to justify the combination. As a matter of interest, though hardly of *useful* comparison, the Shoreditch fuel item has been bettered or equalled only by one or two provincial stations under conditions of cheaper coal supply.

It is hardly necessary for us to add that nowhere in the costs is there any charge by the dust destructor for the steam supplied, although the electricity department has charged the former with £548 value of electricity supplied for running its various motors, &c., and also a third (or £93) of the chief engineer's salary.

The other items of works costs appear normal, but management and property charges are about half the normal.

We think it is probable that if the electricity department were charged for the steam supplied at a price based on the probable total cost of generating steam under the usual conditions, this department at Shoreditch would show total costs of at least 2·3d. per unit sold. Thus, taking 0·9d. as the probable fuel charge per unit, the £1,376 at present in the costs sheet would correspond to 367,000 of the units sold. The remaining 664,848 units sold being generated by steam supplied from the destructor, would be fairly paid for at 0·9d., plus capital charges, labour and maintenance in respect of the boilers, &c., say 0·4d. per unit as a moderate value, the total charge per unit generated by steam from the destructor being therefore 1·3d. per unit. On this basis our accounts of Shoreditch for 1898-9 would show a working profit of £4,017, representing 3·9 per cent. of the mean capital, as against the 7·47 per cent. shown by our analysis.

Shoreditch Dust Destructor (Revenue) Account for the year ended March 25, 1899.

Revenue.	Total.	Per ton of refuse.
Total	£2,757	2·33s.
Charges for destroying refuse to Dusting and Scavenging Department, 23,729 tons at 2s.	2,373	2·00s.
Destruction of trade refuse	279	0·24s.
Cash sales	97	0·08s.
Sundry net receipts	8	0·01s.
Expenditure.		
Total	£4,663	4·19s.
Wages	3,141	2·65s.
Cartage of clinker and ash (9,906 tons)	911	0·77s.
Electricity for fan, trolley, and lift motors	548	0·46s.
Oil, waste, water, stores, &c.	219	0·19s.
Rates and taxes	98	0·08s.
Repairs	46	0·04s.
Insurances	34	0·03s.
Working loss for the year	£2,240	
Add interest on debt	601	
Repayment of debt	810	
Total deficit for the year	3,651	

Joint Result of Dust Destructor and Electricity Works, year ended March 25, 1899.

Electricity works: Net profit for the year	—	£4,581	—	—
Dust destructor, deficit	£3,651	—	—	—
Add: Revenue from scavenging department for the disposal of 23,729 tons dust at 2s.	2,373	—	—	—
Net cost of disposing of 23,729 tons by the combined works	—	1,443	—	£1,443
Cost by the old method, 23,729 tons (at 3s. 1d.)	—	—	£3,660	—
Saving effected by combined scheme	—	—	—	2,217
	£6,024	£6,024	£3,660	£3,660

In view of gaining an idea of the saving to the Vestry accruing from the erection of the dust destructor and its working in combination with the electric supply works, we give a short table showing the revenue account of the former. It appears that since the combined scheme has been at work the authorities have decided that the charge to the scavenging department for the disposal of refuse shall be 2s. per ton as against 3s. 1d. originally charged (or 3s. 2d., as we find quoted in the municipal accounts for 1896-7) as the net cost per ton of barging refuse.

It may be noticed that the deficit of the dust destructor for the year was £3,651, but this is after deducting £2,373 received from the scavenging department at 2s. per ton. The total net cost of disposing of the refuse by the destructor was therefore £6,024. This reduced by £4,581, the net profit of the electricity department, is therefore £1,443—viz., the net cost of disposing of 23,729 tons of refuse by the combined works, electricity being looked upon as a by-product. By the old method of barging the refuse at 3s. 1d. the cost would have been £3,660, or £2,217 above the net cost by the combined works.

Islington Vestry Electric Supply Works.

We must offer to the staff at the Islington station our congratulations on their having brought the undertaking to a successful and self-supporting stage.

Excellent progress has marked the concern since supply commenced at the end of January, 1896. Last year the output exceeded that of the preceding year by 408,000 units sold, or 81 per cent., the maximum demand touching 800 kilowatts as compared with 585 in 1897.

Owing to reductions in the tariff, taking effect from Oct. 1, 1897, the revenue in 1898 shows a slight decrease compared with that of 1897.

We are glad to notice a material reduction in the total costs. The total, and the several items, of generating costs, except fuel, have dropped; and in spite of increases in the items of public lighting and distribution costs, the total works costs also show a diminished figure.

The actual working profit for the year was more than double that of 1897, and, after paying capital charges totalling 4·06 per cent. of the mean capital, there is a balance of £2,207 left as net profit. This result compares well with the £318 deficit which was the result of the working in 1897.

No doubt the fuel item would have shared the fate of the other items of works cost, had it not been for the Welsh coal strike of 1898.

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

Aberdeen (Municipal)	Jan. 6,	1899	
Ayr (Municipal)	Sept. 22,	,,	
Bedford (Municipal)	May 19,	,,	
Belfast (Municipal)	Sept. 15,	,,	
Birmingham (Company)	Sept. 15,	,,	
Blackpool (Municipal)	Sept. 29,	,,	
Bournemouth (Company)	April 28,	,,	
Bolton (Municipal)	Dec. 9,	1898	
Bradford (Municipal)	April 14,	1899	
Brighton (Municipal)	May 12,	,,	
Bristol (Municipal)	July 14,	,,	
Burnley (Municipal)	Aug. 25,	,,	
Burton-upon-Trent (Mun.)	April 21,	,,	
Bury (Municipal)	Sept. 22,	,,	
Cambridge (Company)	Mar. 10,	,,	
Cardiff (Municipal)	Jan. 6,	,,	
Charing Cross (Company)	Mar. 17,	,,	
Chelsea (Company)	Mar. 31,	,,	
Cheltenham (Municipal)	Oct. 7,	1898	
Chester (Municipal)	June 23,	1899	
City of London (Company)	May 12,	,,	
Clerkenwell (Company)	Aug. 18,	,,	
Derby (Municipal)	Dec. 9,	1898	
Dewsbury (Municipal)	Nov. 25,	,,	
Dover (Company)	June 2,	1899	
Dundee (Municipal)	Nov. 4,	1898	
Eastbourne (Company)	July 22,	,,	
Edinburgh (Municipal)	Oct. 14,	,,	
Exeter (Municipal)	Aug. 5,	,,	
Glasgow (Municipal)	Sept. 1,	1899	
Guildford (Company)	May 5,	,,	
Halifax (Municipal)	July 21,	,,	
Hammersmith (Vestry)	May 26,	,,	
Hampstead (Vestry)	Aug. 25,	,,	
Hanley (Municipal)	April 28,	,,	
Harrogate (Municipal)	Oct. 20,	,,	
Harrow (Company)	June 16,	,,	
Hast'gs & St. Leonards (Co.)	April 29,	1898	
H'use-to-H'useCo.(K'ns'gt'n)	Mar. 31,	1899	
Hove (Company)	Mar. 10,	,,	
Huddersfield (Municipal)	Oct. 6,	,,	
Islington (Vestry)	June 24,	1898	
Kensi'gton & Knightsbr' (Co.)	Mar. 8,	1899	
Kingston-upon-Hull (Mun.)	June 9,	1899	
Kingston-on-Thames (Mun.)	April 21,	,,	
Lancaster (Municipal)	Oct. 21,	1898	
Leeds (Company)	Mar. 8,	1899	
Leicester (Municipal)	Jan. 20,	,,	
Leyton (Municipal)	Sept. 8,	,,	
Liverpool (Municipal)	June 9,	,,	
Manchester (Municipal)	Aug. 11,	,,	
Newcastle and District (Co.)	Oct. 6,	,,	
Newcastle-upon-Tyne (Co.)	April 14,	,,	
Northampton (Company)	Oct. 20,	,,	
Norwich (Company)	Dec. 2,	1898	
Notting Hill (Company)	Mar. 17,	1899	
Nottingham (Municipal)	July 21,	,,	
Oldham (Municipal)	Nov. 18,	1898	
Oxford (Company)	May 19,	1899	
Pontypool (Company)	May 5,	,,	
Portsmouth (Municipal)	July 14,	,,	
Preston (Company)	Sept. 29,	,,	
Reading (Company)	Oct. 13,	,,	
Richmond (Company)	Oct. 13,	,,	
Scarborough (Company)	April 1,	1898	
St. James' & Pall Mall (Co.)	Feb. 24,	1899	
St. Pancras (Vestry)	May 26,	,,	
Sheffield (Company)	Dec. 16,	1898	
Shoreditch (Vestry)	May 27,	,,	
Southampton (Municipal)	June 8,	,,	
Southport (Municipal)	July 7,	1899	
South Shields (Municipal)	July 7,	,,	
Stafford (Municipal)	Oct. 21,	1898	
Sunderland (Municipal)	July 28,	1899	
Taunton (Municipal)	June 16,	,,	
Tunbridge Wells (Mun.)	Sept. 1,	,,	
Walsall (Municipal)	June 23,	,,	
Wandsworth (Company)	Aug. 18,	,,	
Westminster (Company)	Feb. 24,	,,	
Whitehaven (Municipal)	July 28,	,,	
Windsor (Company)	Dec. 30,	1898	
Wolverhampton (Municipal)	June 30,	1899	
Woolwich (Company)	Jan. 18,	,,	
Worcester (Municipal)	April 7,	,,	
Yarmouth (Municipal)	June 17,	1898	

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	SHOREDITCH.		ISLINGTON.	
Undertaking Worked by	Shoreditch Vestry.		Islington Vestry.	
Date of Commencement of Supply	June 28, 1897.	[trans. in sub-stations.	1896.	[street transformers
System of Supply	Con.-curr., low-press., with high-press. motor		Alternate-current transformer substations and	
Chief Engineer	C. Newton Russell.		Albert Gay.	
YEAR ENDED	MAR. 25, **1898.**[a]	MAR. 25, **1899.**	DEC. 31, **1897.**	DEC. 31, **1898.**
QUANTITIES—				
Units generated	491,107[a]	1,276,322	—	—
„ SOLD (TOTAL)	284,295[a]	1,031,348	503 572	911,571
„ sold to consumers	203,504	892,753	310,093	508,559
„ sold for public lighting, &c.	80,791	138,595	193,479	403,012
„ used on works	156,725	59,666	—	—
UNITS SOLD PER 8 C.P. LAMP CAPACITY	12·9	46·9	20·1	19·4
Maximum supply demanded	408 kilowatts	720 kilowatts	585	800
Number of public lamps	57 arc, 114 (32 c.p.) glow	151 arc, 302 (32 c.p.) glow	186	216
Number of consumers	127	333[b]	250	341
Connections to mains in 8-c.p. lamps	13,000	40,000[b]	20,327	27,782[e]
CAPACITY OF PLANT IN 8-C.P. LAMPS	22,000	22,000	25,000	46,900
CAPACITY OF PLANT IN KILOWATTS	705	705	800	1,500
CAPITAL—	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.
AUTHORISED (TOTAL)	£71,032 / £101	£85,934 / £122	£150,850 / £188	£191,300 / £128
Share	— / —	— / —	— / —	— / —
Loan (including Debenture charges)	71,032 / 101	85,934 / 122	150,850 / 188	191,300 / 128
RECEIVED (TOTAL)	71,265[c] / 101	93,075[c] / 132	150,850 / 188	191,300 / 128
Share	— / —	— / —	— / —	— / —
Loan (including Debenture charges)	71,032 / 101	92,842 / 132	150,850 / 188	191,300 / 128
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	nil / —	nil / —	nil / —	nil / —
Share (unissued)	— / —	— / —	— / —	— / —
Share (uncalled)	— / —	— / —	— / —	— / —
Loan (including Debentures)	— / —	— / —	— / —	— / —
REPAID (TOTAL)	1,035 / 1·47	1,737 / 2·46	— / —	— / —
RESERVE OR SINKING FUND	— / —	— / —	— / —	1,940 / 1·29
DEPRECIATION FUND	— / —	— / —	— / —	— / —
EXPENDED (TOTAL)	87,802 / 125	116,032[f] / 165	144,226 / 180	188,518 / 126
Lands and buildings	28,596 / 40·6	35,699 / 50·6	55,163 / 69	60,387 / 40·2
Plant	30,249 / 42·9	40,169 / 57·0	47,623 / 59·6	68,133[f] / 45·4
Mains	26,068 / 37·0	36,483 / 51·8	40,586 / 50·7	59,145 / 39·4
Miscellaneous	2,889 / 4·10	3,677 / 5·22	854 / 1·07	854 / 0·57
BALANCE OF CAPITAL ACCOUNT	−16,538[d] / −23·5	−22,958[d] / −32·6	+6,624 / 8·28	+2,782 / 1·85
REVENUE—	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.
TOTAL	£6,231 / 5·260d.	£13,769 / 3·206d.	£12,197 / 5·82d.	£21,217 / 5·590d.
Revenue from supply	3,745[e] / 3·163d.	10,938[e] / 2·547d.	7,770 / 3·70d.	12,274 / 3·230d.
„ meters, &c.	— / —	25 / 0·006d.	180 / 0·086d.	296 / 0·078d.
„ public lighting	2,374 / 2·005d.	2,489 / 0·579d.	4,031 / 1·92d.	8,396 / 2·210d.
„ sale of lamps, &c.	— / —	239 / 0·056d.	— / —	— / —
„ miscellaneous sources	113[f] / 0·096d.	78[n] / 0·018d.	216[a] / 0·103d.	250 / 0·066d.
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	£2,334 / 1·971d.	£6,152 / 1·432d.	£7,765 / 3·70d.	£12,252 / 3·226d.
WORKS COSTS	1,709 / 1·444d.	4,921 / 1·146d.	5,717 / 2·72d.	9,901 / 2·607d.
Generation of electricity	*1,707[g] / 1·442d.*	*4,030 / 0·938d.*	*5,389 / 2·57d.*	*8,682 / 2·286d.*
Fuel (including cartage, &c.)	279 / 0·236d.	1,376 / 0·320d.	2,393 / 1·14d.	4,614 / 1·215d.
Oil, waste, water, stores	247 / 0·209d.	465 / 0·108d.	783 / 0·373d.	901 / 0·237d.
Wages at station	774 / 0·654d.	1,438 / 0·335d.	1,726 / 0·823d.	2,317 / 0·610d.
Repairs and maintenance at station	277 / 0·234d.	751 / 0·175d.	487 / 0·232d.	850 / 0·224d.
Distribution of electricity	*2 / 0·002d.*	*505 / 0·118d.*	*54 / 0·026d.*	*255 / 0·067d.*
Wages, &c.	2 / 0·002d.	186 / 0·043d.	5 / 0·002d.	165 / 0·043d.
Repairs, renewals of mains, &c.		319 / 0·074d.	49 / 0·023d.	90 / 0·024d.
Public lighting	— / —	*386 / 0·090d.*	274 / 0·131d.	964 / 0·254d.
Attendance	— / —	382 / 0·089d.	250 / 0·119d.	496 / 0·131d.
Renewals	— / —	4 / 0·001d.	24 / 0·011d.	468 / 0·123d.
MANAGEMENT AND PROPERTY CHARGES	625 / 0·528d.	1,231 / 0·287d.	2,018 / 0·976d.	2,351 / 0·619d.
Royalties	— / —	— / —	— / —	— / —
Rent, rates, taxes	*20 / 0·017d.*	*76 / 0·018d.*	*477 / 0·227d.*	*665 / 0·175d.*
Management	*605[h] / 0·511d.*	*1,155 / 0·269d.*	*1,571 / 0·749d.*	*1,686 / 0·444d.*
Salaries	239[i] / 0·202d.	596[o] / 0·139d.	916 / 0·436d.	1,043 / 0·275d.
Stationery, &c.	79 / 0·067d.	105 / 0·024d.	150 / 0·072d.	168 / 0·044d.
Establishment charges	94 / 0·079d.	194 / 0·045d.	169 / 0·081d.	170 / 0·045d.
Law charges, &c.	130[j] / 0·110d.	260[p] / 0·061d.	336[b] / 0·160d.	305[q] / 0·080d.
FINANCIAL RESULTS—	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded
WORKING PROFIT FOR YEAR	£3,935[k] / 4·54%	£7,619 / 7·47%	£4,432 / 3·60%	£8,965 / 5·39%
Sum carried to Depreciation Fund	— / —	— / —	— / —	— / —
Sum carried to Reserve or Sinking Fund	834 / 0·95%	916 / 0·893%	1,055 / 0·856%	1,952 / 1·17%
Net interest on loans (incl. Debenture charges)	2,089 / 2·38%	2,147 / 2·11%	3,621 / 2·94%	4,806 / 2·89%
BALANCE FROM LAST ACCOUNT	−27 / 0·03%	+1,883[l] / 1·85%	— / —	— / —
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	1,045 / 1·19%	6,464[q] / 6·34%	— / —	2,207 / 1·33%
Deficit	— / —	— / —	— / —	— / —
ORDINARY DIVIDEND PAID	— / —	— / —	318[c] / 0·258%	— / —
PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE	37·5%	44·7%	63·6%	57·8%
Expenditure per kilowatt capacity	£3. 6s. 3d.	£8. 14s. 7d.	£9. 14s. 2d.	£8. 3s. 5d.
REVENUE PER KILOWATT CAPACITY	£8. 16s. 10d.	£19. 10s. 10d.	£15. 5s. 0d.	£14. 2s. 10d.
Expenditure per 8-c. lamp capacity	2s. 1½d.	5s. 7d.	6s. 2½d.	5s. 2½d.
REVENUE PER 8-C.P. LAMP CAPACITY	5s. 8d.	12s. 6½d.	9s. 9d.	9s. 0½d.
REVENUE PER 8-C.P. LAMP CONNECTED	9s. 7d.	6s. 10½d.	12s. 0½d.	15s. 3½d.
Price charged for lighting, per unit	6d. to 2d.[m]	5d. to 2d.[r]	7d. to 3½d.[d]	7d. to 3½d.[d]
Price charged for power, per unit	2d.	2d.	5d. per unit.	5d. per unit (inclusive)
Price charged for public lighting	5d. per unit.	—		

SHOREDITCH.—REMARKS.—*a* The accounts dealt with are those for the year ending March 25, 1898; the working and output date from June 28, 1897. *b* At December, 1898. *c* Includes £233 miscellaneous receipts. *d* Over-expended. *e* Includes arrears to March 25, 1898, £3,144. *f* Includes £99 for rents. *g* Includes £130, items of which are not given. *h* Includes £161, items not given. *i* Includes chief engineer's salary from June 25, 1897, £188 less £83 charged to dust destructor. *j* Includes £128 for insurance. *k* After deducting £167 in respect of wiring and fitting work and £140 in respect of sundry expenses to March 25, 1898, not allowed as capital charges, and after adding £405 from dust destructor for current up to March 25, 1898. *l* After *adding* £665 interest on, and £172 principal of, capital expenditure in respect of central station site for three years to March 25, 1898, received from dust destructor. *m* On "Wright" system. *n* Includes £33 balance of stores account. *o* Includes chief engineer's salary £280 less £93 charged to dust destructor. *p* Includes £74 net cost of souvenirs, £170 insurance, £8 testing meters and £7 compensation for accident. *q* After *adding* £25 from sale of building materials. *r* "Wright" system on 2-hour scale. *s* Includes £548 from dust destructor for current supplied for

ISLINGTON.—REMARKS.—*a* Includes £179 rents of property, less taxes, &c. *b* Includes £200 to insurance. *c* After *adding* £74 "written off as irrecoverable." *d* Max. demand system, 7d. per unit for daily average of one hour, 6d. for second hour and 4d. per unit remainder; the daylight supply for any purpose is at 3½d. per unit net. *e* Assuming the equivalent of 4,050 8-c.p. lamps as representing the 216 arc lamps, the incandescent lamp connections [illegible] the equivalent of 24,732 8-c.p. lamps.

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The Oldest Electrical Journal (established as a weekly Journal 1861—1878)

Published every Friday, Price Sixpence; Post Free, Sixpence-Halfpenny
Editorial, Publishing and Printing Offices,

I, 2 & 3, SALISBURY COURT, FLEET ST., LONDON,

Telephone: 949 Holborn. *Telegrams:* "ELECTRICIAN NEWSPAPER LONDON."

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THE INVASION OF FOREIGN MACHINERY.

While our army is engaged in the repulse of a military invasion of British dominion in South Africa, an industrial invasion of our own country, equally threatening to its prestige, is making rapid inroads, with little opposition, and even with some encouragement from within. We refer to the importation of foreign-made machinery and plant into a country which has until recently occupied unchallenged the premier position in the engineering world. Confining ourselves to the consideration of the equipment of electrical generating stations and tramways, hardly a week passes without the news of a contract, often of considerable magnitude and importance, being awarded to an American or Continental firm of manufacturers or its agents. As for the Colonial market, if the present tendency is not soon reversed, British machinery will in a very few years occupy the position filled by German machinery a quarter of a century ago, while the amount of machinery we send over to the Continent of Europe threatens to become small compared with that imported into our own country. Just as American machine tools and labour-saving devices have obtained a firm foothold in Great Britain, so are now American, German, Austrian, and Swiss dynamos and motors beginning to oust British-made goods. Recent contracts have shown that American engines may occasionally, with advantage, drive American dynamos, that the building containing these may in a certain instance be constructed with American steel at a far cheaper rate than with British metal, that foreign tramway trucks will run on foreign rails, and last—but by no means least—that a firm of American cable manufacturers can out bid a number of English firms tendering for some £150,000 worth of underground electric cable to be delivered to the Glasgow Corporation.

Besides endeavouring to shift the responsibility for this state of affairs on to other shoulders, our manufacturers and their apologists have run through a whole gamut of excuses. The great strike in the engineering trade, terminated in February, 1898, has been blamed in the first instance. As

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things settled down again, and manufacturers, overburdened with orders, were unable to meet their engagements with regard to time of delivery, contracts continued to be given out of the country; and, instead of enlarging their works and preparing to increase their output, the majority of our firms were so lacking in enterprise as to plead that the "boom" in electrical work was merely a passing phase. At this period consulting engineers were, and are still, liable to a share of the blame by their practice of specifying that only those firms need tender who have had actual experience in making the particular class of machines required, supplied for precisely the same work to which they were to be devoted in each instance. This of a necessity limited the list of tenderers to the very firms whose workshops were already overcrowded, and prevented any new firms from competing. It is frequently contended, and with some justification, that these consultants engaged by municipal authorities have no right to advise their principals to spend money on an untried make of machine; but although a comparison with the progress of electric lighting and traction in the United States and Canada shows that this country has been seriously hampered by the craze of municipalisation, it cannot seriously be urged that this alone is responsible for the condition of affairs to which we are calling attention. Then comes the cry for standardisation—an excellent thing, certainly, when not carried to excess, but hardly a sovereign remedy for all manufacturers' ills. Then the suggestion has been put forward that, so long as there was uncertainty as to the value of what are claimed to be the fundamental patents for polyphase systems, English manufacturers are doing well to avoid them. But surely the matter could have been tested in the law courts, and the expense divided among those interested; and then, if the decision upheld the validity of the patents, compulsory licences for manufacture in this country might have been obtained, if licences were refused under other conditions. It is pleaded that wages are unduly high in this country, and that employers have to submit to tyrannisation by trade unions; but these conditions obtain to an equal if not to a greater extent in America, where trade unionism has not suffered as it has in this country by the great engineering strike.

We should be the last to deny that all these excuses have not some basis of fact, but yet they are to a large extent mere excuses made in order to avoid looking the true cause of the loss of our manufacturing ascendancy full in the face. It is the manufacturers themselves who must bear the greater part of the blame. Instead of being encouraged by a large influx of orders, they have assumed a condition of indifference. Contented with the reflection that their works are as busy as they can be, they give no thought for the future. Their provision for an increase in output, if made at all, is insufficient; and even if some are accepting more orders than they can execute with punctuality, and in a manner creditable to first-class engineering firms, a large number of important contracts are allowed to be awarded outside the country. The foreign and Colonial markets are left alone almost entirely, and, so long as sufficiently high dividends are earned, British manufacturing firms are happy in their own short-sightedness and supine to the industrial future of their country. And it is not only certain classes of machinery and plant that are disregarded by our home manufacturers—not only polyphase alternators and electric traction equipments that are being manufactured abroad for the British market—but also such things as continuous-current machinery for electric lighting purposes and cables, in which the price of labour bears but a small proportion to the cost of material. It is no longer a question of quick delivery, for over and over again our makers have been beaten in price. Electric supply works are paying in many cases thousands of pounds less for machinery and plant than they would be if they had ordered it in this country. We should be the last to disparage British products. British works have and can still make the best machinery in the world. But if the present apathy continues we shall literally merit the reproach cast on us by Napoleon I. of being a mere "nation of shopkeepers."

REVIEWS.

(Copies of any of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price.)

History of Wireless Telegraphy, 1838-1899. By J. J. Fahie. (Edinburgh and London: Blackwood and Sons, 1898.) Price 6s.

The author breaks up the historical treatment of his subject into three periods, which he calls "The Possible," "The Practicable," and "The Practical;" and to the latter, five appendices are added. The book contains a good frontispiece, made up of twelve portraits of leading men in natural philosophy, mathematics, and engineering. These the author calls the archbuilders of wireless telegraphy: they are representative of electrical science in Denmark, France, America, Germany, Italy, and England. The saying attributed to Clerk Maxwell—that every student of science should be an antiquarian in his subject, has evidently been Mr. Fahie's motto. With great care he presents the reader with information on each branch of his subject, with due reference to quotation of authority and date, and many most obscure experiments bearing on the matter have been rescued from the gloom of almost-forgotten shelves.

In the first period, the author gives a careful description of the many experiments made between 1838—1872. In this section the methods used by Morse in 1842, in America, and subsequently by Lindsay, of Dundee, and the air wire experiments of Loomis, are the most interesting. In Morse's method a river was used as the conductor, and signals were made across the Susquehanna River, at Havre-de Grace, with complete success, the distance being nearly one mile.

The experiments of Lindsay were conducted in almost exactly the same manner as those of Morse. In the system of Loomis the point of interest lies in the fact that he proposed to use (and apparently did use) sky-wires to effect his signalling from point to point. His idea was that an alteration of potential of the air strata would be propagated to great distances, and affect a similar sky-wire far off in such a way as to be detected by a suitable receiver. The importance of a sky-wire is now fully recognised, and upon its use signalling by means of the Hertz wave is said to depend. It is worthy of note that, by means of electrostatic charges, signals were transmitted, in the last century, by a Frenchman, by name Lomond: his experiment is described in Young's "Travels in France," Vol. I., p. 65, 1792.

In the second period—"The Practicable"—the author gives a lucid and detailed account of the progress of signalling without wires through conductors such as the earth and water, due to the introduction of the telephone of Bell. He writes thus: "The introduction of the telephone, in 1876, placed in the hands of the electrician an instrument of marvellous delicacy, compared with which the most sensitive apparatus hitherto employed was as the eye to the eye aided by the microscope." In the early days of the telephone many remarkable and curious sounds were heard through its agency, and a search for their cause led to successful systems of signalling without wires, by induction, devised by Trowbridge, Bell, Dolbear, Rathenau, and others.

Coming to the third period—"The Practical"—we find that excellent work was done by Mr. (now Sir) William Preece, and a considerable distance was signalled across by his system; for example, when a buzzer, a Morse key, and 30

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Leclanché cells were used at Southampton, signals were heard and received at Newport, and *vice versâ*. The author devotes 25 pages to the description of many other experiments due to Sir William Preece, which were carried out on a large scale, and are therefore of much value to future workers in the same direction. Much care has been taken to make the nature of the experiments clear to the reader, diagrams having been introduced when required. At page 177 the history of the wireless telegraphy of Marconi begins. In it we see how the different parts of the structure were brought together, the various sources from whence they were taken, and the final result. In the description given of the detector or coherer, the action of the electric wave is thus spoken of: "They, *i.e.*, the filings, touch each other in a chaotic manner; but when electric waves fall upon them, they are polarised—order is installed—they are marshalled in serried ranks and press on each other—in a word, they cohere." This description should be accepted with caution. A close microscopic examination of fine filings, when cohering and not cohering, does not reveal a change in their mutual disposition; but it is possible that some other optical method might indicate the nature of the change. Probably at the present time it would be safer to say that we do not understand precisely how the electrical condition of the coherer is changed by the electromagnetic wave.

The Appendix D, p. 289, contains some remarkable evidence respecting certain experiments of Prof. D. E. Hughes, of microphonic fame. It had not escaped his notice that a loose contact was sensitive to the effects produced by an electric spark, and it is much to be regretted that Hughes was so much discouraged by the opinion of Prof. Stokes (who did not at that time accept his views) that, in spite of experiments which indicated the existence and action of electric oscillations, the results arrived at by Hughes were not published at the early date, 1879-80, when his research was made. Appendix D is well worth careful perusal.

The book closes with a reproduction of Marconi's patent specifications.

Both the scientific and general reader will find Mr. Fahie's "History of Wireless Telegraphy" a very excellent book on a most interesting subject. F. J. J.-S.

Geschichte der Physikalischen Experimentirkunst. By Dr. E. GERLAND and Dr. F. TRAUMÜLLER. (Leipzig: Engelmann.) Price 14 marks unbound, 17 marks bound.

To the ancients, Nature was a deity to be venerated and feared. In modern times, Nature is more of a witness, to be subjected to rigid cross-examination. Hence the different spirit which at different times of the world's history animated experimental research. Archimedes and the Alexandrian school seem to have acquired something of the true experimental turn, but experiment was not in their hands a means of deciding questions of theory, but of solving problems of practical utility.

The book before us brings out this fact pretty clearly. The Babylonian unit of weight was a cube of water whose side was the unit of length. This ancient metric system was at one time general throughout what was then the civilised world. The illustrations which the authors have collected, 425 in number, give a vivid picture of the development of science from the oldest times. Egyptian gold-workers are seen at work with bellows and crucibles. Glass-blowing and distilling are depicted by Egyptian hands, and the syphon and the balance are shown in active use. Among the Greeks experimental activity had its origin in the colonies. Thales was the first to predict an eclipse of the sun, and Pythagoras designed the oldest instrument of research still in use, the monochord. The atomic theory was first enunciated by Empedocles, and Democritos supported it, as he thought, by pouring water into a vessel full of ashes and showing that no increase of volume resulted. Aristotle was of small account from the experimental point of view, but his mighty intellect attempted to cope with all the problems of the universe with the slender aid of the knowledge accumulated up to his time.

After the fall of the Roman Empire the little scientific work that was done in the Middle Ages fell to the Byzantines and the Arabs, and it is only with the birth of Galileo in 1564 that modern science takes its origin. Specific gravity, the laws of falling bodies, the telescope, the microscope, and the thermometer are so many stages in the period of rapid advance covered by Galileo's life. And after his death the Florentine *Accademia del Cimento* continued the Master's work with rare sagacity and in that moderate and far-seeing spirit which we now consider the first essential of true research. Gilbert, Keppler, Descartes, Guericke, and Boyle mark the spread of experimental activity over Western Europe; and with Huygens, Leibniz, and Papin the field of conquest broadens out until it embraces most of those subjects which we know to-day, though the vast field of electrical research was hardly suspected as yet. Newton was one of the last of the "natural philosophers" whose attention was not absorbed by the growing possibilities hidden in the electric spark and the magnetic needle, and it is not surprising to find that the last quarter of the book is entirely devoted to electrical work. After Napoleon had, in 1809, surprised and beaten the Austrians with the aid of his optical telegraph, it was natural for him to pooh-pooh Sömmering's electrolytic telegraph as "*une idée germanique.*" The development of electric telegraphy forms one of the best-written and most enticing chapters of this interesting work. It finishes with Daniell and his constant cell, for with him we enter modern and recent times, whose adequate chronicling would require another work of the same dimensions.

Fortschritte der Elektrotechnik. Edited by Dr. KARL KAHLE. (Berlin: Julius Springer.)

While still maintaining its excellence as a catalogue of all the articles which have appeared in the leading German, English, American, and French technical journals, with abstracts of the more important items, this quarterly is again beginning to get behindhand in its publication. We have only recently received the first number for the year 1899. The thorough manner in which the arduous work of compilation is done may possibly account for the delay in the appearance of each number, but the editor and publisher should realise that a work of this sort loses more than half its value by being issued so late. It would be preferable to sacrifice to some extent the completeness of the references, if by so doing each number could be published, say, within a few weeks of the end of the quarter to which it refers.

SOUNDS EMITTED BY THE ELECTRIC ARC.

BY F. J. JERVIS-SMITH, M.A., F.R.S.

The sensitiveness of the electric arc to electrical changes in a supply system is probably well known to all persons who use arc lamps. While making certain experiments with the electrolytic break, I thought that it would be interesting to find out how far the break when working would affect an electric arc when burning steadily. An electric lamp by Serrin was fed from the company's mains through a resistance sufficient to reduce the current to about five amperes. The current was continuous at a pressure of 100 volts. In a room about 60ft. distant from the lamp an electrolytic break was used in connection with a coil of wire in length about 50ft., furnished with a small core, and also supplied from the company's mains. At each closing of the break circuit the arc gave out a loud clear note of the same pitch as that of the break. I found that the best condition was obtained by making the arc long and quiet-burning by an old method of mine—viz., by introducing a little powdered glass into the core hole of the positive carbon. The note then produced was unpleasantly loud to a person standing at a distance of 4ft. from the lamp. My next experiment was to remove the electrolytic break to a point about a mile distant from the lamp. When the circuit of the break was closed the same effect was produced, but in a less degree, but enough sound was given out to receive a Morse code message at a distance of 10 to 12 feet from the lamp. In this latter case the electrolytic break was driven off the company's mains.

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A SIMPLE FORM OF INFLUENCE MACHINE FOR X-RAY WORK.*

BY WILLIAM COTTON, M.A., M.D., ED.

To get X-rays out of a suitable vacuum tube, it needs to be excited by an electric discharge at a tension of hundreds of thousands of volts. Such a discharge is furnished by the induction coil and by the static induction or "influence" machine, associated in its most elegant and effective form with the name of Mr. Wimshurst. In spite of the obvious advantages of the latter type of machine over the former, very little systematic X-ray work with the influence machine has appeared; and the greater number of the text books of radiography pass the matter over with a general statement that the Holtz or the Wimshurst machine from the steadiness and continuity of its discharge is specially fitted for work with the screen. It is possible, however, with a very simple form of influence machine to get good X-ray negatives.

This Paper has been written in collaboration with Mr. Thomas Clark, of Horfield, Bristol. He is almost entirely responsible for the electrical part of it. Some time ago he experimented successfully for X-rays with a sectored Wimshurst of his own construction, and was led to devise and construct the sectorless modification described below.

The essential part consists of two parallel circular discs of ordinary window glass, 22in. in diameter, about $\frac{1}{8}$th of an inch thick, and $\frac{1}{4}$ of an inch apart, varnished with shellac. Being mounted centrally on independent wooden bosses, they can be rotated in opposite directions on a horizontal metallic spindle or axle, which pierces them and is supported at each end by a wooden upright springing vertically from a stout rectangular mahogany base. The lower parts of the two uprights support another horizontal axle, parallel to the main one, turned by a handle, with two wooden wheels on it, which by a crossed and an open strap act respectively on the bosses of the glass discs and thus supply the necessary motive power. The glass employed is of the gauge of 22oz. per square foot. It must be of the highest dielectric quality; green glass and plate glass are found unsuitable, and of white glass of similar commercial standard some specimens are found on trial much fitter than others. Ebonite discs do very well, but exposure to vicissitudes of temperature causes them to bend and buckle, and in time the atmosphere affects them chemically on the surface and so deteriorates their insulating property.

At each end of the main axle where it projects through the supporting upright is metallically connected a movable brass rod, known as the neutralising rod. This rod is bent round at each end towards the surface of the adjacent glass disc, and has jointed to it at each end a straight piece about 4in. long, radially disposed as regards the glass disc, parallel to its surface and just within the outer margin thereof. Each straight piece has attached to it at equal distances so as lightly to trail upon the surface of the glass three fine wire brushes. Thus we have two neutralising rods, a near one and a far one, each with two straight pieces, and each straight piece has three brushes, *i.e.*, there are 12 neutralising brushes in all.

Besides the wooden uprights, there are situated upon the rectangular base of the apparatus and towards its extremities three other pairs of structures. At the inside or far side of the base are two insulating cups or holders for a pair of Leyden jars, should it be thought advisable to join them up in the circuit. In front of each holder and opposite the right and left lateral rims of the glass discs are two stout vertical rods of ebonite or other insulating material, supporting a polished brass sphere about three inches in diameter—the prime conductors. From the metallic neck of each prime conductor there runs in horizontally for about four inches and exactly in the line of the horizontal diameter of the glass discs a pair of brass collecting rods—one rod in front of the near disc, the other behind the farther one. Each collecting rod has on it at equal distances eight trailing brushes similar to those on the neutralising rods. Thus we have two prime conductors—a right one and a left one—each with two collecting rods, and each collecting rod has eight brushes, *i.e.*, there are 32 collecting brushes in all. In front of the insulating supports of the prime conductors is a pair of more slender insulating rods to support the metallic stems of two approximately hemispherical knobs, somewhat smaller than the spherical heads of the prime conductors, which may be called the secondary conductors. The metallic stem is bent to a right angle. The supporting insulating rods can be rotated round the vertical axis and fixed at any point by a small set screw, so that the gap—the spark gap—between the prime and secondary conductor of each side is an adjustable one. It is on the management of these spark gaps, in series with the vacuum tube, that success or failure in the emission of X-rays from the tube mainly depends in the case of the influence machine.

The remainder of the apparatus, as ordinarily joined up, consists of two well-insulated thick copper wires or "leads," coiled *secundum artem*, running over from the brass stem of each secondary conductor to the external wire terminal of the indispensable Jackson focus tube in the same side. The stem of the tube is held by a specially-designed well-insulated stand, with well-insulated ebonite rods to support the wire leads and to take the strain of them from off the external wire terminals of the tube. It is useful in some cases to have some arrangement for a second spark gap in series on each side of the tube; and it is always of importance to have the leads connected with the respective external wire terminals of the tube under cover of small hollow tunnelled brass spheres to minimise leakage of electricity from sharp points by brush discharge outside the tube. The internal resistance of the focus tube best suited for this machine is so great, that the distance apart of the external wire terminals of the electrodes into the tube should be greater than the spark length of the machine in air with tube away, with the same view of preventing brush discharge. To avoid the risk of puncture of the tube by sparking, the tube should have its external wire terminals at least 8in. or 10in. apart.

With the machine described, a pair of Leyden jars may be used in two ways. First: The secondary conductors being disconnected from the tube and connected one to another by a thick copper wire between the brass stems, the spark gap between prime and secondary conductor on each side is left open, and the inside of each Leyden jar is put in direct communication with the adjacent conductor. Each jar is on its insulating cup, and has its outside coating connected by a thick copper lead to an external terminal of the tube. When the accumulated unlike internal charges of the Leyden jars recombine across the spark gaps and the wire uniting the secondary conductors, we have the reverse charges in the outer coatings recombining across the tube. As a result we have one or two explosive discharges per second, with deafening noise and an almost blinding yellow fluorescence of the tube; the screen lights up most brilliantly, but only for a moment. Owing probably to the higher quantity (amperage) of the electrical discharge, this method is dangerous to operator and patient, and very detrimental to the tube: it is only to be used with great caution in radiographing the thickest parts of the body. Second: When the apparatus is joined up in the ordinary way, a well-insulated Leyden jar (with the knob from its interior in contact with the adjacent prime conductor), at each side, having its outer coating removed, promises to be of great use. When this arrangement is made the discharge across the spark gaps is white instead of violet, and is continuous. In this case the jars act as condensers or reservoirs of electricity.

The machine described, like other influence machines which have no metallic sectors, plates, buttons, or knobs upon the discs, is not (except under the most unusual climatic conditions) self-exciting. Once excited, it will not require re-excitement for a whole evening though revolved very slowly, or even allowed to be at rest for a little while. The most convenient method is to have a miniature influence machine as exciter. For exciting purposes, only one prime conductor is needed on it; the other is superfluous.

In practice the sectorless Wimshurst is to be preferred to a sectored one of the same size for five reasons:—(1) It is easier to construct and keep in order—it is simpler; (2) it never reverses polarity during running—the other does so occasionally; (3) it has a greater output of electrical energy—the tube lights up better with the same amount of mechanical energy expended on the handle; (4) in a sectored Wimshurst, where there is a great resistance in the tube, the inner ends of the sectors leak towards the boss, as shown by a visible brush discharge; (5) After prolonged use the friction of the brushes on the sectors as they pass leads to the formation of rings of metallic deposit, which break down the insulation.

On the other hand, except under exceptional circumstances, the sectorless Wimshurst is not, and the sectored Wimshurst is, self-exciting.

The sectorless Wimshurst having been carefully dusted, has a charge communicated by spark or contact from the exciter, and the discs are revolved. One soon learns which is the proper prime conductor to charge, according as the cathode or anode is left or right in circuit. The most effective output is got when the winch is rotated 80 times a minute, giving 200 revolutions in the same time to each glass disc in opposite directions. The spark gaps are opened gradually from contact till the tube fluoresces brilliantly, which it never fails to do; unless there is actually damp deposited on the outside of the tube, the spirit lamp is entirely unnecessary. The focus tube to be preferred is one adapted for a nominally 10in. spark induction coil: the sectorless Wimshurst gives with Leyden jars a maximum spark of 10½in.; without the jars, in favourable conditions of atmospheric dryness, a continuous brush discharge of 9½in. in length between terminals when the tube is removed. All the brass work of the conductors should be of the highest finish, to avoid the formation of any pointed parts and consequent brush discharge owing to local increase of electric density; and for the same reason care must be taken that if any silk fastenings are made at the external terminals of the tube the knotted ends be cut short. Otherwise we shall get a large part of the discharge streaming away visibly. Bedclothes in the neighbourhood of the circuit should be put out of the way, for if they are heaped up towards the tube, the moisture in them streams

* Abstract from the *Bristol Medico-Chirurgical Journal*.

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up and locally breaks down the atmospheric insulation. The apparatus, joined up in the ordinary way, is free from noisiness—there is only a low-pitched hissing sound. The odour associated with the presence of ozone is very perceptible. It is found that the best results are obtained when the upper end of the nearer neutralising rod is situated 30deg. to the left of the vertical, and that of the farther one the same distance to the right (the "five minutes to five" position).

The results obtained by means of the sectorless Wimshurst described may be given under two heads:—

I. *With the Screen.*—I was able to see the shadow of a watch through the trunk of a thick-set man; the heart, with the pericardial bag, was quite distinctly seen in outline suspended in the thorax of a boy of ten viewed from the back; in a young lady of twelve, the waves of contraction of the heart muscle on its left border were seen quite deliberately passing downwards in regular succession, viewed from the front of the chest; it was always possible with the Leyden jars joined up to get the fluorescent glow on the screen through the adult trunk. Every detail of the bones, even the fissure of a fracture, if caught in its plane, could be seen in the hand, wrist, elbow, and ankle of the adult, and the shoulder and thorax of a young boy. In all these parts we get indications of soft tissues. The bones of the phalanges and metacarpus could be distinguished 5ft. from the tube through a wooden door; and at the same distance the screen lit up through a brick partition. It is an interesting point to note that the fluorescent screen glows with a light that has very little actinic power. Photographs with an ordinary camera of objects shadowed on the screen have been taken successfully, but I have never seen any, and have failed again and again to obtain a negative at different distances and with different kinds of plates, even after an exposure of 10 minutes On the other hand, it is easy to obtain a good photograph of a fluorescing focus tube with an exposure of a quarter of a minute; while everyone knows the electric spark under the same conditions photographs itself instantaneously. To employ a screen to the best advantage the room must be darkened, and the eyes prepared by being kept in a dimly lighted room for 10 or 15 minutes. Daylight should always be religiously excluded.

II. *With the Photographic Plate.*—The duration of exposure is somewhat long; about half the time would be sufficient where the detection of the presence only of a metallic foreign body is needed. We get pictures with detail and sharpness and quite a perspective effect, not mere shadowgraphs. To do justice to the negative, I always use gelatino-chloride paper, slightly undertone, and squeegee on polished glass. Shortness of exposure for its own sake is not much of an object when using the Wimshurst apparatus, as the patient keeps placid, and the operator is not obsessed by the haunting idea of impending collapse to one or more parts of a long train of complicated and costly apparatus. To give examples of the degree of detail, the sesamoid bones of the hand and foot (including that in the tendon of the peroneus longus as it crosses the sole of the foot) came out sharply, and we get details of all the bones of wrist, elbow, ankle and knee, especially in the adult—the fibrous structure of the os calcis and astragalus is quite distinctly shown. Time of exposure: *Adult*: Fingers, 2 minutes; hand, 8—10 minutes; forearm 10 minutes; elbow, 10 minutes; shaft of humerus, 10 minutes; shoulder (with clavicle, ribs and scapula), 45 minutes; foot and ankle, 16—20 minutes; knee and leg, 20 minutes. *Aged 12*: Hip-joint, showing pelvic brim, 20 minutes. *Aged 6*: Femur shaft, 18—20 minutes. *Fœtus, 6—7 months*: 15 minutes.

The advantages of an influence machine in X-ray work may now be considered, taking as a standard of comparison an 8in. or 10in. spark induction coil, with special reference to the sectorless Wimshurst described.

1. The primary inducing current of the coil and its appurtenances are abolished. There is no primary battery or accumulator, no interrupter, no primary coil, and consequently none of the uncertainties, annoyances, or risks of breakdown associated with the use of these pieces of mechanism. Further, the absence of Fizeau's condenser (a necessary part of the primary circuit to render the discharge of the secondary coil unipolar and to minimise the sparking at the platinum contacts of the interrupter) removes one source of "fault" development (and breakdown by sparking penetration of an insulating partition) somewhere over its 40 or 50 sq. ft. of area—a fault that is difficult to locate, reach, or repair. A similar remark applies to the secondary coil of the induction coil proper, with its six or eight miles of fine insulated wire, which at any point, from over-heating or mechanical injury or sparking perforation due to over-driving, may likewise develop a "fault." In place are substituted two glass discs in the open, easily removed and replaced if broken.

2. Owing to the small amount of electricity, though at a high tension, passing continuously and regularly, the life of the tube as regards useful work is a prolonged one. There is none of the heating of the internal terminals of the tube under the heavy, interrupted, and it may be irregular discharges of the induction coil. The tube, not a very soft one to begin with, used for the last year with the sectorless Wimshurst has been under continuous discharge for a total of over 160 hours, and has only recently shown signs of "hardening." This hardening over its first condition is probably due to the use of the Leyden jars, for a few hours in the aggregate, by means of their outer coatings, in the manner described. When joined up in the ordinary way the tube never appears to heat and has never failed to respond promptly to the excitation of the discharge. The only difference to be noted is that the spark gaps have to be a little wider than they were a year ago. The tube has never turned sulky or needed to be coaxed with the spirit lamp or by any other of the empirical methods resorted to by the practical worker with the coil. It is probable that, with the coil, no tube after the first dozen hours of exposure to actual discharge but is perceptibly hardened, especially if the capacity of the apparatus is forced to its utmost. The sharpness of the Wimshurst negative is probably due in part to the quiet continuous discharge, the small emitting area not shifting, nor the original fine adjustment of the cathode and anti-cathode altered by irregular or extreme heatings under greatly varying discharges. To put the matter in a nutshell, it is hardly to be expected that any induction coil set, worked at a strain to perform some *tour de force*, however successful at the time, will repeat the performance, while a static induction machine may be almost surely relied on to do again what it has once done.

3. It is generally acknowledged that the continuous non-flickering, uniform discharge, varying only with the rate of rotation of the discs up to a maximum, of the influence machine renders it more suitable than the induction coil for work with the fluorescent screen. But, further, it is peculiarly fitted, especially if driven by a well-regulated electric or other motor, for delicate and prolonged experimentation, *e.g.*, for photometric observation of the intensity of the fluorescence under different conditions; for examining into the influence of X-rays on bacteria in the animal body or in cultures; for testing the action of the rays on growing plants or germinating seeds. All such experiments when made with a coil labour under the fallacy that nothing certain is known quantitatively about the agent employed, except that it is on the whole after a short time irregularly diminishing in energy. The Wimshurst apparatus is the only one at present known in X-ray work that is adapted for the standardising of X-ray electrical, fluorescent and other physico-chemical effects.

4. When joined up in the ordinary way without Leyden jars the static induction machine gives a discharge which is absolutely harmless to operator or patient, even if the live wires be purposely handled. A pricking sensation, hardly amounting to pain, and a fading of fluorescence in the tube is the sole result. There are none of the dangerous shocks to be apprehended from accidentally touching the circuit of the induction coil, on account of the small amperage associated with the continuous discharge of the former apparatus. No cases of eczema have been reported with the influence machine as yet; it would be very interesting to test the matter by exposing to X-rays from a tube excited by an influence machine individuals who are known to be susceptible to X-rays and to have previously suffered from exposure to a tube excited by a coil. In demonstrating his fluorescent screen, the demonstrator has had to be exposed to the rays of the tube with his trunk in close neighbourhood thereto for 4½ hours without any inconvenience.

5. In regard to portability, an important question as regards cases that have to be X-rayed in their own bedrooms, it may be mentioned that the sectorless Wimshurst weighs 28lb., the Leyden jars 3lb each, the focus tube and stand 7lb., and the exciter 7lb.—in all, 45lb.—just a little over the weight of a six-celled charged lithanode accumulator; the jars are not indispensable, and in this case the apparatus weighs rather less. The whole apparatus can be packed in a box 39 × 19 × 14in., which can be used as a pedestal.

6. The cost of an apparatus is about half or a third of a coil set giving the same length of spark; and there is no cost for maintenance or repairs, there being no accumulators to re-charge or parts to wear out.

The objection most urged against the influence machine is that it is liable to be much affected by damp and dust. Most certainly it is not more so than other electrical apparatus, and with ordinary care there is no great difficulty in keeping it in working order. Mr. Wimshurst says his machines work in the damp; he keeps them in glass cases permanently, to avoid dust and handling by the inexperienced. The sectorless Holtz is more susceptible to damp, and requires to be kept permanently in a case with a bowl of chloride of calcium, changed every six months, to keep the air dry. The sectorless Wimshurst described is kept in an ordinary room without any casing, and taken without packing in a cab to the patient's house; and if the night be damp, a little warming at a fire and dusting with a silk handkerchief is all that is required. On only one occasion I have seen it make a failure, and then it was on a very damp night in a long damp vault of a schoolroom, set up for use on a platform that had just been brought in from lying in the drizzle. Even under these circumstances we got a fair negative of metallic objects, and could see the bones of a man's fingers on the screen.

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CORRESPONDENCE.

LOW-VOLTAGE DYNAMOS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have been much interested in reading the article on "Low-Voltage Dynamos," by Mr E. Kilburn Scott, on p. 904 of your issue of yesterday's date, as we are using such dynamos in Bradford for an electrical process of removing wool from skins.

The dynamo gives 1,000 amperes at 8 volts, and is driven by a motor from the Corporation mains; and we have found it absolutely necessary, in order to be certain of the constant excitation of the fields of the dynamo, to separately excite it from the Corporation mains at 230 volts. This arrangement will not, however, always be possible, and I have decided to have a machine with a separate exciter directly coupled on the same bed-plate, exciting the shunt at 50 volts, with the compounding on the dynamo to keep the voltage constant from one-tenth load to full load.

I have found the same difficulty as regards the collection of these heavy currents as mentioned in the article, and therefore I think that the speed of these machines should not exceed 400 revolutions per minute, and that the temperature rise in any part of the machine, after six hours' run at full load, should not exceed 50 degrees Fahrenheit above the atmosphere. Such conditions make the machine an expensive one, and therefore it would be of considerable interest to me, and possibly to others, to know if there is any better form of low-voltage heavy-current dynamos which will run perfectly on a constantly varying load without the possibility of losing the excitation and its consequent trouble.—Yours, &c.,

Bradford, Oct. 21. ALFRED H. GIBBINGS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of October 20th Mr. E. Kilburn Scott, under the above title, urges the use of multipolar machines with internal field-magnets for electrolytic purposes. The advantages of multipolar machines, for this work, have long been recognised, but it is difficult to see in what respects the particular type described is so eminently suitable. It is true that the necessary brush area is easily obtained; but, on the other hand, it must not be forgotten that the peripheral speed of the commutator will be extremely high, and that with large currents (especially if carbon brushes are employed, as Mr. Scott suggests) this means an excessive friction loss. This need not, however, in itself be an insuperable defect.

Probably the most serious objection to the adoption of this type of generator for electro-chemical work is to be found in its unmechanical construction. Much has been made—perhaps too much—of the serious stresses which have to be allowed for in dynamos intended for traction. Great as these undoubtedly are, they are small compared with those met with in metallurgical work, and under these circumstances I hardly think the overhanging armature recommended by Mr. Scott will commend itself to engineers.

It must be conceded, however, that the centrifugal force on the armature is opposed by the pull due to the field magnets, and that, further, this same centrifugal force tends to hold the inner conductors in place, which would otherwise be a matter of considerable difficulty. In the machine of Messrs. Siemens and Halske, in common with almost all Continental machines, solid conductors are used. With the stranded conductors, however, which Mr. Scott suggests, there would, I fear, be some difficulty in keeping them in place, unless some such arrangement as the brass plates alluded to by him were adopted.

It is doubtful, however, whether it is good policy to introduce a thin piece of brass on edge between each of the conductors, as, however well they may fit into the holes at first, there is a tendency for the tubes to shake loose; and if this occurs, the insulation will sooner or later be cut, to say nothing of the strain thrown on the soldered joints. Any device for holding armature conductors in place should have a certain amount of *flexibility* about it.

Mr. Scott assumes that "there is very little magnetic leakage" with outward pointing poles, though upon what he bases this statement does not appear. It may, I think, be said that it is entirely opposed to general experience, and with a given pole pitch it is clear that the leakage in this type must be greater than in the other. With the "claw" magnet the leakage is even more pronounced; and it is on account of this defect, probably rather than of the "fly-wheel action" suggested by Mr. Scott, that it is rapidly giving way, on the Continent, to what may be called the consequent pole type.

In the hands of Messrs. Siemens and Halske the "Innenpol" machine has done excellent work during the last eight or nine years, but I venture to think that, if employed to any extent in the future, it will be rather in the solution of the problem of designing dynamos to give normal voltages at low speeds (*e.g.*, direct coupled exciters), than those to give low voltages at normal speeds.

In conclusion, it can hardly be said that the design of electro-chemical generators presents a very "special problem" (except in so far that sudden overloads must be allowed for), as voltages of 50 to 150 are now the rule rather than the exception.—Yours, &c., KENELM EDGCUMBE.

London, Oct. 21.

THE HASTINGS BREAKDOWN.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have read with much interest your article, as also Mr. Arnold Phillips' letter of the 16th hereon. I heartily concur in Mr. Phillips' suggestion to the effect that the excitation of generators should be accomplished by batteries—or that the battery should be the agent responsible for this important duty. We have but two high-tension systems, calling for exciters, in operation on the Midland. For the past two years it has been our practice to join a set of small accumulator batteries in parallel with the exciting machine. No safety fuse is employed, and all connections are made as rigid as possible, so as to avoid any possibility of an open circuit, whether by intention or otherwise.—Yours, &c.,

Derby, Oct. 24, 1899. W. LANGDON.

SELECTOR SYSTEMS OF WIRELESS TELEGRAPHY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In reply to Mr. Brown's letter in your last week's issue, we have referred to his patent No. 28,955, and find that his system is worked on an entirely different principle to ours. We cannot see, therefore, how Mr. Brown's remarks affect us. As at present our patent is in the provisional stage, we are unable to publish details.—Yours, &c., BERTRAM S. COHEN.

London, W., Oct. 24, 1899. PHILIP H. COLE.

THE TELEGRAPH ACT, 1899.

In the *London Gazette* for October 24th is set out an Order of the Postmaster-General under Section 3, sub-section (5), of the Telegraph Act, 1899. This sub-section enacts that if the licence of an existing company [referred to in this Order as "the company"] is extended in respect of any exchange area for a period of not less than eight years, the company shall, at the request of any licensee of the Postmaster-General providing public telephonic communication in the whole or any part of the exchange area [called in the Order "the new licensee"], and under such circumstances and on such terms and conditions as within six months from the passing of this Act may be prescribed by an Order of the Postmaster-General, afford all proper facilities for the transmission of telephonic messages between persons using the system of the company (either in the whole or in part of the exchange area, as the Postmaster-General may prescribe) and persons using the system of such other licensee, provided that the licensee so requiring intercommunication shall in any such case afford similar facilities.

The Postmaster-General therefore orders as follows:—

1. When the subscribers of the new licensee at the date when intercommunication is requested equal or exceed in number one-fourth of those of the company at that date, in the area specified in the new licence, or number 500, whichever first happens, but not before, mutual intercommunication shall be afforded by the company and the new licensee between their respective subscribers and other persons using their respective systems in the area specified in the new licence only. [Such intercommunication is referred to in this Order as "restricted intercommunication."]

2. In any case in which the company's exchange area, as defined by agreement with the Postmaster-General, exceeds in extent the area speci-

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fied in the new licence, then, when the subscribers of the new licensee at the date when intercommunication is requested equal or exceed in number one-fourth of those of the company throughout the whole exchange area of the company, at that date, but not before, mutual intercommunication shall be afforded by the company and the new licensee between their respective subscribers and other persons using their respective systems throughout the whole exchange area of the company. [Such intercommunication as here indicated is referred to in this Order as "unrestricted intercommunication."]

3. The fact that restricted intercommunication exists with reference to the system of any new licensee shall not prejudice that licensee in requesting unrestricted intercommunication, and the two kinds of intercommunication may exist side by side on different terms.

4. The company and the new licensee may make terminal charges (*per call*) not exceeding the following:—

In the case of restricted intercommunication—

(*a*) When the subscribers of the new licensee at the date when intercommunication is requested number 500, but are less than one-fourth in number of the company's subscribers at that date in the area specified in the new licence .....1½d.

(*b*) When the subscribers of the new licensee equal or exceed in number one-fourth (but do not equal in number one-half) of the company's subscribers for the time being in the area specified in the new licence...1d.

(*c*) When the subscribers of the new licensee equal or exceed in number one-half of the company's subscribers for the time being in the area specified in the new licence.....Nil.

In the case of unrestricted intercommunication—

(*a*) When the subscribers of the new licensee at the date when intercommunication is requested equal or exceed in number one-fourth (but do not equal in number one-half) of those of the company at that date in the whole of the company's exchange are—in respect of intercommunication with the subscribers of the company and other persons using the system of the company in the portion of the company's exchange area which is not included in the area specified in the new licence .....1d.

(*b*) When the subscribers of the new licensee equal or exceed in number one-half of those of the company for the time being in the whole exchange area—in respect of such intercommunication as last aforesaid... .....Nil.

5. Any new licensee requesting facilities for intercommunication shall satisfy the Postmaster-General that such licensee possesses the required number of *bonâ fide* subscribers actually working.

6. When the intercommunication has once been established—

(*a*) It shall be maintained, notwithstanding that the number (actual or relative) of the subscribers to one or other of the intercommunicating systems may subsequently fall below the number which would entitle a new licensee to request intercommunication, and

(*b*) no terminal charge shall be increased because the number (actual or relative) of the subscribers to one or other of the intercommunicating systems may fall below the number which first justified such charge, and

(*c*) if terminal charges have ceased, they shall not under any circumstances be reimposed.

7. The term "subscriber" means any person with whom the company, or the new licensee, has entered into an agreement for at least one year, for the purpose of enabling such person to communicate from time to time with other persons through the medium of an exchange, and does not include persons using call offices on an exchange.

8. This Order may be cited as the Telegraph (Telephonic Intercommunication) Order, 1899.

PARLIAMENTARY INTELLIGENCE.

COMMUNICATION ON TRAINS.

In answer to a question as to whether the committee of railway general managers had yet decided on the most suitable appliance to be fixed on passenger trains as a means of communication between railway passengers and guards, the President of the Board of Trade (Mr. Ritchie) stated in the House of Commons, on Monday, that he understood there was a preponderance of opinion in favour of what is known as the brake system of communication, and that most of the larger companies were taking steps to apply it.

ELECTRIC TRACTION ON THE UNDERGROUND.

In the House of Commons on Monday, in answer to a question whether the experiments made between Earl's Court and High-street, Kensington, with the object of introducing electric traction on the Metropolitan underground railways, had proved satisfactory, and whether there was any prospect of electric traction being introduced on those railways at an early date, Mr. Ritchie said that the necessary plant had been constructed, and he understood that an experimental train would be run during the early part of November. He could not state when electric traction would be introduced generally; that would depend, of course, upon the result of the experiments.

TELEPHONE RATES.

In the House of Commons last night (Thursday), in answer to Mr. Provand, the Secretary to the Treasury (Mr. R. W. Hanbury) said the Postmaster-General hopes to be able very shortly to publish the revised rates for telephone subscribers both for London and provincial exchanges.

LEGAL INTELLIGENCE.

Brougham v. Bateman.

In the Westminster (London) County Court the Hon. Reginald Brougham, electrical engineer, sued Messrs. John Bateman and Co., mechanicians and model makers, for the return of a deposit of £10 and damages for the non-completion of an order. The plaintiff's case was that he visited defendants' premises and submitted plans and models of automatic couplings for railways which he had designed and provisionally patented. He told defendants he wanted working drawings within a week, as a Parliamentary committee was sitting on the subject and he was desirous of getting the matter through quickly. Defendants agreed to do the work, and he sent £10 deposit at their request. He said there were hundreds of electrical engineers devising schemes for automatic couplings. A number of frivolous excuses were, he contended, made for delaying the whole matter, and eventually plaintiff asked for his money back, countermanding the order. He could not get his money back, and he had been put to a great deal of trouble. The defence was that the drawing was supplied in the time specified, but was returned by plaintiff for alteration, and an employé of the defendants took it away. A prosecution followed, and that delayed the order. Two model trucks were now produced, minus couplings, and their value was said to be £6. 10s. The time spent on the order was worth £3 or £4 in addition. The order would have been completed if plaintiff had not stopped defendants in their work.

Judge LUMLEY SMITH said there had been delay owing to disagreements between defendants and their employés, but that was a risk they took, and customers were entitled to have their work in the ordinary way. To have made the trucks before the couplings was premature, and he thought the plaintiff was entitled to recover for the return of the deposit, less £1 for the plan, which would be a judgment for plaintiff for £9 and costs.

FORTHCOMING LEGAL ACTIONS.

The following cases having an electrical interest have been entered for trial at the Royal Courts of Justice during the Michaelmas sittings:—

SUPREME COURT OF JUDICATURE.

COURT OF APPEAL.—CHANCERY DIVISION.—*General List.*

Alexander v. *Automatic Telephone Co.* (*Limited*).—(Appeal of plaintiff from order of Mr. Justice Cozens-Hardy of May 12, 1899.)

National Co. for Distribution of Electricity, &c. (*Limited*) v. *Gibbs.*—(Appeal of defendant H. O. Ruelle from order of Mr. Justice Cozens-Hardy of April 28, 1899.)

Before Mr. Justice North. Actions with witnesses—

Fox v. *National Telephone Co.* (*Ltd.*) (action and counter-claim).

Stelges v. *The Exchange Telegraph Co.* (*Ltd.*) (action).

Actions without witnesses—

In re The Companies Acts, 1862 to 1898. In re The Automatic Telephone Co. (*Ltd.*) (motion to rectify register).

Before Mr. Justice Kekewich. Actions with witnesses—

Rucker v. *London Electric Supply Corporation* (*Ltd.*).

Chamberlain and Hookham (*Ltd.*) v. *Mayor, &c., of Bradford*

Before Mr. Justice Wright companies' winding-up and petitions.—

Madras Electric Tramways Co. (*Limited*) (petition of *Electric Construction Co.*).

Before Mr. Justice Cozens-Hardy. Actions with witnesses—

Electric Construction Co. (*Limited*) v. *Imperial Tramways* (*British Thomson-Houston Co.* (*Limited*), third parties (not before Nov. 2).

Chadburn's (*Ship*) *Telegraph Co.* (*Limited*) v. *Robinson* (Liverpool District Registry).

QUEEN'S BENCH DIVISION (Non-Juries).

Electric Welding Co. v. *Armitage* (calls).

Walcott and another v. *Electrical Inventions and Manufacturing Co.* (*Limited*) *and others* (patent).

Electric Welding Co. (*Limited*) v. *Lady Bouch* (calls).

Electrical Welding Co. v. *Wilson* (calls).

COMMERCIAL LIST.

Electrical Copper Co. (*Limited*) v. *Commercial Bank of Scotland.*

In the Chancery Division of the High Court of Justice, at Dublin, before the Vice-Chancellor:—

British Insulated Wire Co. v. *Dublin United Tramways Co. and the National Conduit Co.* (*of New York.*)—This is an action charging infringement of certain patents for the manufacture of electric cables, and is down for hearing on Wednesday, Nov. 8. (Some particulars will be found in *The Electrician* for Sept. 23, 1898, p. 725.)

BOOKS RECEIVED.

(Copies of any of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price.)

"The Principles and Practice of the Valuation of Gas, Electricity, and Water Works for Assessment Purposes." By T. and W. Newbigging. Second edition. (London: Walter King.) 5s.

"The Official Gazette of the United States Patent Office." Nos. 1 and 2, Vol. LXXXIX. Published by authority of Congress. (Washington: Government Printing Office.)

Map of Southern Africa, including the Cape Colony, Natal, South African Republic, Orange Free State, &c. Presented with Part. I., price 7d., of "Battles of the Nineteenth Century." (London: Cassell and Co.)

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TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

NOW READY.

"The Electrician" Electrical Trades' Directory and Handbook for 1899.—The *Second Edition* of the "Big Blue Book" for 1899 is now ready. The volume contains the large Sheet Tables of Electricity Supply Stations and Electric Railways and Tramways. The price of the Directory and Handbook is now reduced to 6s, post free 6s 9d. ; abroad, post free, 7s. 6d. (United States 8s. 6d.).

TENDERS INVITED.

The *Maidstone* Corporation invite tenders for the supply, delivery, and erection of (*a*) steam dynamos, balancers, and boosters, (*b*) boilers and economiser, (*c*) surface condenser and feed pumps, (*d*) main switchboard and instruments, (*e*) storage battery, (*f*) travelling crane, (*g*) underground mains, (*h*) arc lamps and posts, (*i*) electricity meters. Further particulars are given in an advertisement, and specifications, &c., can be obtained on and after the 24th inst. from the engineers (Messrs. Stevens and Barker), St. Peter-street, Maidstone. Tenders are to be delivered at the offices of the town clerk (Mr. Herbert Monckton), on or before Monday, Nov. 6.

The *Middlesbrough* Electric Lighting committee invite tenders for condensing plant and pipework, further particulars of which are given in an advertisement. Specifications, &c., may be obtained at the offices of the consulting engineer (Mr. Robert Hammond), 64, Victoria-street, London, S.W., after 27th inst. Tenders must be delivered at the offices of the town clerk (Mr. George Bainbridge), Municipal Buildings, Middlesbrough, not later than 4 p.m., Nov. 22.

The Guardians of the *Croydon* Union invite tenders for electric light wiring and fitting work for their workhouse, infirmary, and union offices. The specifications, &c., can be obtained of Mr. A. W. Sclatter, 182, Oxford-street, London, W., on and after 26th inst., and tenders must be sent to the Croydon Union Offices, Mayday-road, Thornton Heath, Surrey, before 5 p.m., on Monday, Nov. 13. Mr. Harry List is clerk to the Guardians. An advertisement gives further particulars.

The Governors of *Felsted* School, Essex, invite tenders for the supply and erection of electric lighting plant, particulars of which are given in an advertisement. Specifications, &c., may be obtained (after Nov. 7) at the offices of the consulting engineers (Messrs. O'Gorman and Cozens-Hardy), 66, Victoria-street, London, S.W., and tenders must be in by Nov. 27.

The *Bradford* Corporation invite tenders for the supply and delivery of electrical equipments for 25 tramcars, 25 tramcar bodies, and trucks and trollies for 25 tramcars. Specifications and forms of tender may be obtained of the tramway manager (Mr. C. J. Spencer), Horton Bank depot, and tenders must be sent in to the town clerk (Mr. F. Stevens), Town Hall, Bradford, on or before Thursday, Nov 9. Further particulars are given in advertisements elsewhere.

The *Newcastle-upon-Tyne* Electric Tramways committee invite tenders for two 1,000-H.P. generators. Further particulars are given in an advertisement, and specifications, &c., may be obtained on and after 6th prox. from the consulting engineer (Mr. Charles Hopkinson), 29, Princess-street, Manchester, or 26, Victoria-street, London, S.W. Tenders (addressed to the committee) must be left at the office of the town clerk (Mr. Hill Motum), Town Hall, Newcastle-upon-Tyne, not later than noon of Nov. 30.

The *Hoylake and West Kirby* District Council invite tenders for the supply, delivery and erection of—(1) Lancashire boilers, superheaters and Green economiser ; (2) quick-revolution steam engines, alternators, motor alternator, feed pumps, piping, tanks, crane, wiring electricity supply works, &c. ; (3) high and low-tension switchboards and connections ; (4) secondary batteries and accessories ; (5) transformers and accessories ; and (6) high and low-tension mains, &c. Tenders to Mr. Roderick Williams, Town Hall, Hoylake, by noon of Nov. 15.

The *Morecambe* District Council require—(*a*) boiler, (*b*) steam dynamos, (*c*) switchboard, (*d*) transformers, (*e*) mains, (*f*) pumps and condensers, and (*g*) storage batteries in connection with their electric lighting extension scheme. Particulars from the electrical engineer, (Mr. C. F. Parkinson, M.I.E.E.), Wood Hill-lane, Morecambe.

The *Llandudno* District Council invite tenders for the supply and delivery of three 150-kilowatt high-speed engines and dynamos, and motor and boosters. Tenders to Mr. A. Conolly, Council Offices, Llandudno, by noon, Nov 6.

The Vestry of *St. Pancras* (London) are prepared to receive offers for temporary generating plant at their Regent's Park electricity supply station. Particulars from Mr. C. H. F. Barrett, Vestry Hall, Pancras-road, London, N.W.

The Electricity department of the *Glasgow* Corporation invite offers for ten miles of 2in. cast-iron pipes. Tenders to Sir J. D. Marwick, City-chambers, Glasgow, on or before Nov. 20.

The *Glasgow* Corporation also invite tenders for the supply and erection of two 800-H.P. compound vertical auxiliary engines for Port Dundas station. Tenders to Sir J. D. Marwick by 5 p.m., Nov. 14.

The *Wrexham* Town Council invite tenders for the supply and erection of (*a*) boilers, economiser, fittings, &c. ; (*b*) steam dynamos, condensers, pumps, steam and exhaust pipes, &c. ; (*c*) switchboards, &c. ; (*d*) underground mains, lamp posts, &c. ; (*e*) accumulators ; (*f*) meters ; (*g*) cranes, &c. ; (*h*) buildings. Tenders to Mr. Thomas Bury, Town Hall, Wrexham, before 3 p.m. of Nov. 8.

The *Birkenhead* Corporation invite tenders for 13 single-deck and 31 double-deck electric motor cars. Tenders by 4 p.m., Nov. 14. Also for boilers, economisers and mechanical stokers, steam dynamos and booster, and storage batteries.

The *French* Post and Telegraph Administration invite tenders until Nov. 14 for supplying 10,000 metres of pipes (18mm. diameter) for pneumatic dispatch tubes. Tenders to le Sous-Secretariat d'Etat des Postes et des Télégraphes, 103, Rue de Grenelle, Paris.

TENDERS RECEIVED AND ACCEPTED.

The Battersea (London) Vestry have accepted the tender of Messrs. H. Young and Co. (amounting to £3,797) for steel girders, joists, &c., required in connection with the erection of the electric light station, and that of Messrs. J. G. Jones and Co. for the cast-iron stanchions, columns, &c., for £860.

The Liverpool Corporation have accepted the tender of the Leeds Steel Works Co. for the supply of 6,000 tons of rails at £8. 10s. per ton, and that of Francis Morton and Co. for the iron roof of the Carisbrooke-road tramcar shed at £4,053.

The Hampstead (London) Vestry have accepted the tender of Messrs. Patman and Fotheringham for extending the electricity supply station building at £28,551. The tender of the Wigan Coal and Iron Co. for the supply of 4,500 tons of coal to the works for the next six months has also been accepted.

The Glasgow Corporation on Thursday last accepted, on the recommendation of their Tramways committee, the tender of the Riter-Conley Manufacturing Co. (Pittsburg (U.S.A.) for the supply of the constructional steel work, bunkers, &c., for the new power station at Port Dundas, at £25,000.

The Poplar (London) Guardians have accepted the tender of the Thames Ironworks Engineering and Shipbuilding Co. for the supply of a steam dynamo at £827, and that of the Fuller-Wenström Electrical Manufacturing Co. for the supply of electric motors at £419.

The Colwyn Bay District Council have accepted the tender of Mr. T. Brown, Chester, for the erection of electricity supply buildings for £1,910.

The West Hartlepool Corporation have accepted the tender of Messrs. J. and A. Laws, Glasgow, for the supply of 33 arc lamp posts at £9 each.

APPOINTMENTS VACANT.

The Tynemouth Corporation invite applications for the position of clerk of works to superintend (under the direction of the consulting engineers) the erection of electrical plant, &c., at the borough electricity works. An advertisement contains further particulars, and applications must be sent in to the town clerk (Mr. John P. Smillie) not later than Nov. 7.

The Wigan Electric Light and Tramway committee require a chief assistant electrical engineer and a foreman jointer. An advertisement contains additional particulars, and application must be sent to the borough electrical engineer (Mr. H. Collings Bishop) not later than Saturday, Nov. 4.

Two officers are required to act as electrical engineers and mechanics on the training ship "Shaftesbury." Further particulars are given in an advertisement, and applications must be made to the clerk to the managers (Mr. A. E. Garland), School Board Office, Victoria Embankment, London, W.C., by Nov. 1.

A shift engineer is required for the electricity department of the Leyton District Council. Further particulars are given in an advertisement, and applications must be sent to the engineer and manager (Mr. F. Harman Lewis), Electric Light Works, Cathall-road, Leytonstone, by Nov. 7.

A physical science master is required for the City of London School. Salary £300, increasing to £450 per annum. Applications to the secretary, Victoria Embankment, E.C., by Nov. 31.

The Manchester Tramways committee require a competent electrical engineer to assist the city electrical engineer in the erection of overhead equipment for the Corporation tramways. Applications to Mr. Wm. Henry Talbot, Town Hall, Manchester, on or before 30th inst.

The Hastings Corporation require an assistant electrical engineer. Applications to Mr. Leonard Andrews, Earl-street works, Hastings.

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The Manchester Electricity committee require the services of three assistant engineers (steam and mechanical assistants, and a mains engineer). Applications (addressed Chairman Electricity committee, Town Hall, Manchester) by Nov. 1.

The Coventry Corporation require an assistant engineer for their electricity works. Applications to Mr. Gilbert S. Ram.

A meter inspector is required at the Lancaster electricity works. Application to the borough electrical engineer (Mr. W. A. Fraser).

Mr. James Brown, late assistant to Messrs. Walter Dixon and Co., of Glasgow, has been appointed resident electrical engineer by the Govan Town Council.

Mr. Harry England has been appointed traffic manager of the Bolton Corporation tramways department.

Mr. A. M. Withers and Mr. P. Yapp have been appointed assistant engineers at the Watford electricity works.

BUSINESS NOTICE.

The address of the Northern Society of Electrical Engineers (to which all future communications should be addressed) is "Fernholme," Barrington-road, Altrincham. Mr. Samuel Joyce is hon. sec.

BANKRUPTCIES, LIQUIDATIONS, &c.

A petition presented by J. Trenam for the winding-up of the Portable Electric Battery Syndicate (Limited) will be heard in the High Court on 1st prox.

A meeting of Dutton and Co., Limited (old company), will be held at the Great Western Hotel, Shrubb Hill-road, Worcester, on Nov. 22, to receive an account of the winding-up. Mr. G. H. Bull is liquidator.

Creditors of Elmore's Foreign and Colonial Depositing Co. (Ltd.), must send particulars of their claims to the liquidator (Mr. J. Shurmer), Greek-street-chambers, Park-row, Leeds, by Dec. 9.

Claims against J. E. Stott, electrician, 10, Wood-street, Byrom Arcade, and 9, Westfield-road, Huddersfield, are to be in by Nov. 3. Mr. T. H. Kaye, 8, Princess-street, Huddersfield, is trustee.

Sale by Tender.—There is advertised on another page for sale by tender, in one or in separate lots, a large quantity of nearly new high-class machine tools and loose plant, at the Nelson Cycle Works, Beeston, Notts., on Nov. 2. Full particulars and tender forms can be had of Messrs. McKenna and Co., 17 and 18, Basinghall-street, and of Messrs. Ogden, Palmer and Langton, 6A, Austin-friars, E.C., London.

Plant for Sale.—The London School Board invite offers for the purchase of two 35-kw. dynamos (coupled direct to two Parsons steam turbines), with circulating oil pumps, spare armature, &c. Offers by noon of 30th inst.

The Newport (Mon.) Corporation have for sale a 100-kw. steam alternator. See advertisement.

Factory for Sale.—In an advertisement elsewhere it is announced that a leasehold factory, suitable for electric or light engineering works, motor-car factory, &c., is for sale. The plant comprises automatic and plain lathes, milling, drilling, and profiling machines, a Dowson gas plant, three gas engines, &c., and is in first-class order.

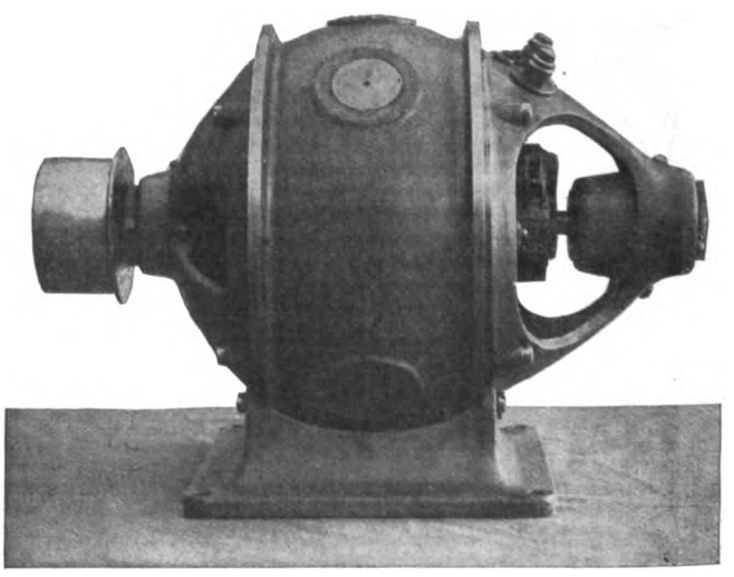
Personal.—We are informed that Mr. Wilfred L. Spence, Assoc. M.Inst.C.E., M.Inst.M.E., who has for some time past been with the Electric Construction Co., of Wolverhampton, has been appointed managing director of a new company which is being formed in Scotland to undertake the supply of electricity in bulk. Mr. Spence's headquarters will be in Glasgow.

Wire-bound Hose.—Users of water hose for various purposes are increasing in number in all branches of industry, and in engineering work the supply for a make of hose which will stand rough wear and tear has long been a desideratum. To the solution of this problem Messrs. Willcox and Co., the well-known engineers' furnishers, of 23-36, Southwark-street, London, S.E., have brought to bear a lengthy experience, and last season introduced a make of patent wire-bound hose, which they have termed their "Special Traction Engine" quality. This is constructed to meet the demands made upon water-lifter hose, and the success which has attended its introduction is shown by the demand, which has more than verified expectations. There is no rubber used in the composition of this hose: it is made with wire on the inside, and wire-bound externally in such a manner as to effectually prevent kinking. It is generally regarded as suitable in every way to supersede the ordinary rubber hose for all purposes to which this every-day article is put.

Exhibition Plant.—The Electric Lighting committee of the 1901 Glasgow Exhibition have decided to accept combined engines and dynamos from the following firms:—Edison and Swan Co.; Alley and MacLellan; E. Scott and Mountain; Mavor and Coulson; D. Bruce Peebles and Co.; Wm. Sisson and Co.; Robey and Co., and Ruston, Proctor and Co.

Electrical Accessories List.—Messrs. Gent and Co. have just issued their 1899-1900 price list of electric bells, indicators, batteries, alarms, medical and surgical apparatus, switches, and other electrical accessories.

"Universal" Motors.—We learn that Messrs. Salmony and Co. (Limited), of 118-120, Charing Cross-road, London, W.C., have taken over the agency in this country for the "Universal" continuous-current motor manufactured by the Jenney Electric Manufacturing Co., of Indianapolis (U.S.A.). These motors are at present made from ⅛ H.P. to 5 H.P., and are of the multipolar type. It is stated that the Jenney Co. have the patterns in hand for the manufacture of this motor up to 50 H.P. It is claimed that "Universal" motors have been tested to from 50 to 100 per cent. overload without sparking. The frame of the "Universal" is spherical, and consists of a single casting, and the bearings are supported by heads made to conform with the spherical shape of the frame. The field cores are circular in section, of annealed wrought iron, and the armatures are of the slotted core type. The supporting foot of the motor is made independent of the frame, and so drilled that it can be attached to any part of the motor frame, enabling the machines to be fastened to the ceiling, side wall and right or left-hand, or at any desired angle. The motor is provided with reducing gear, which can be attached anywhere round the frame. The machines are made either wholly or semi-enclosed, to suit varying conditions of work, and are furnished



with automatic release starters. Messrs. Salmony and Co. inform us that they have ready for prompt delivery a large stock of enclosed arc lamps, electric measuring instruments, rheostats, switches of all kinds, and plant and material for electric railway and tramway work.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Oct. 18, to Oct. 24, with the ports of destination:—

Africa—Alexandria, £159; Cape Town, £387; Durban, £4,425 (including £4,168 telegraph material); East London, £172; Port Elizabeth, £341 (including £317 telegraph wire). *Argentina*—Buenos Ayres, £3,976 (including £579 telegraph material). *Australasia*—Albany, £277; Christchurch, £75; Fremantle, £52; Melbourne, £1,032 (telegraph material); Otago, £75; Perth, £137; Sydney, £1,414 (including £204 telegraph wire); Wellington, £528. *Canada*—Montreal, £77. *Ceylon*—Colombo, £228. *Colombia*—Santos, £324 (including £194 telegraph material). *Denmark*—Copenhagen, £85 (telegraph cable). *Germany*—Hamburg, £200 (telegraph material). *Holland*—Amsterdam, £50; Rotterdam, £29 (telegraph wire). *Hong Kong*—£700. *India*—Bombay, £206 (including £59 telegraph material); Calcutta, £438. *Italy*—Venice, £500. *Japan*—Nagasaki, £13; Yokohama, £766 (including £566 telegraph cable).—*Mexico*—Santa Cruz, £35. *Siam*—Bangkok, £49. *Sweden*—Gothenburg, £29 (including £17 telegraph material); Stockholm, £156 (telegraph wire). *West Indies*—Trinidad, £26. Total £16,961, against 16,331 in the corresponding week last year (Oct. 19 to 25).

MUNICIPAL, FOREIGN, AND GENERAL NOTES.

Aberdeen.—A report from the Tramways committee will be considered by the Corporation this (Friday) afternoon, in which they are recommended to construct and electrically equip four additional lengths of tramways, at a total estimated cost of about £125,602.

Arbroath.—A special committee is inquiring into and reporting upon the advisability of obtaining electric lighting powers.

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Barnsley.—The salary of the borough electrical engineer (Mr. S. E. Bastow) has been increased to £200 per annum. A special meeting of the Council has been called for the purpose of authorising the promotion of an electric tramway bill.

Barking.—The expenditure of the electricity department for the first quarter's working amounted to £385 (including £139 for interest and sinking fund), and the income to £294.

Battersea.—A report from the solicitor on the interim injunction obtained by the County of London Co., restraining the Vestry from interfering with the electric light mains laid by the company in Trinity-road, was considered on Wednesday, and it was decided to apply for a writ of mandamus to compel the company to remove the mains.

Bermondsey (London).—The Vestry have decided to acquire property in Neckinger and Limasol-streets as a site for electricity supply and refuse destructor works at a cost of £16,500.

Bexhill.—A further loan of £5,000 is to be applied for, in order to carry out extensions of the electric light cables and mains.

Birkenhead.—The Corporation have decided to advertise for tenders for 13 single-deck and 31 double-deck electric tramcars.

Birmingham.—The Corporation has formed an Electric Supply committee for the purpose of arranging for the transfer of the undertaking of the Birmingham Electric Supply Co. and for managing the works when transferred.

Bootle.—It has been resolved to apply for a provisional order for the construction of four additional lengths of electric tramway.

Brazil.—A Foreign Office report suggests an opening for British trade and industry at Rio de Janeiro, in the supply of electric plant and material for traction and lighting purposes, and at Santos for the supply of telegraph and telephone appliances.

Brighouse.—Extensions are to be made to the electricity works. The price of current has been increased from 5d. to 6d., a previous resolution increasing the price to 7d. having been rescinded.

Brighton.—The Brighton Corporation have decided to include in their tramway bill provision for the compulsory purchase of land at Southwick (outside the borough) for the site of an electricity generating station.

Burnley.—Powers to construct and equip electric tramways, involving a total capital expenditure of £91,000, are to be applied for next session by the Corporation.

Cheltenham.—The Council have resolved to apply for a provisional order to extend their electric lighting area so as to embrace the parishes of Charlton Kings, Leckhampton, Prestbury, Bishops Cleave, Southam, Woodmancote, and Brockhampton.

Croydon.—Acting upon the advice of their consulting engineer (Mr. E. W. Monkhouse), the Corporation have decided to adopt the overhead trolley system throughout the whole of the recently-acquired tramways. Mr. Monkhouse reported that, although there was no engineering difficulty in laying down underground conduit for a short length in the centre of the town, such a dual system would necessitate an increased expenditure, and the service would not be so satisfactory as a continuous overhead service. He also reported in favour of the proposal to lease the lines to the British Electric Traction Co., subject to the contract price with the British Thomson-Houston Co. for equipment being satisfactory. The Tramways committee endorsed this view, and stated that they were still of the opinion expressed in their report of May 26 last—viz, that the best practical way of dealing with the tramways after acquisition was to lease them for 30 years, subject to power of determination at periods of five years. The Corporation approved this proposal.

Dewsbury.—The Town Council are applying for electric tramway powers.

Douglas (Isle of Man).—Prof. J. A. Fleming has presented to the Douglas Corporation a further report on the subject of electric lighting. The question submitted to Prof. Fleming was as to the advisability of the establishment of municipal electric supply or the acceptance of an offer from the Isle of Man Electric Tramways and Power Co. to supply current in bulk. Prof. Fleming recommends the Corporation to lay down its own plant and this recommendation receives the approval of the Lighting Committee who will advise the Council to adopt the report as now presented.

Edinburgh.—The new M'Donald-road electricity station was formally opened by Mrs. Mitchell Thomson, wife of the Lord Provost on Monday. The Lord Provost said that of all the matters with which he had had to do during the 10 years he had been on the council there was none he would look back upon with greater pleasure than in taking the leading part to induce the city itself to undertake the work of supplying electric light. From the first it had been a success, and the cost of production was lower than that of any other electricity station in the kingdom, whether worked by a company or a municipality. The new station had been designed so that when completed it would contain machinery developing 30,000 H.P. The number of lamps on the Corporation's system was now 250,000, and was increasing at the rate of 1,000 a week. The convener of the Electric Light committee (Bailie Mackenzie), replying to the toast of "Success to the Electric Lighting Undertaking," said, some £500,000 was being spent for electric light and half a million for gas, but they would not stop there. He was sure that within the next five years the expenditure on electric light would amount to a round million of money. It had been a more pronounced success than any similar undertaking in the country.

Electricity in the East End.—A deputation from the East London Vestries waited upon Sir Courtenay Boyle on Tuesday, to urge upon the Board the advisability of revoking the provisional orders granted to the County of London Co., on the ground that they had failed to comply with the terms of the orders. Mr. H. H. Marks, M.P., introduced the deputation, and pointed out that though the terms of the orders (two years) had expired, nothing had been done for the lighting of Limehouse, Mile End, and St. George's East, while Whitechapel had started an electric lighting scheme of its own, upon which £100,000 had already been spent. Complications would be caused if, when Limehouse, Mile End, and St. George's were united with Whitechapel as one municipality, as one part of the new area was lighted by municipal and the rest by private enterprise. Sir Courtenay Boyle undertook to bring the matter before Mr. Ritchie, with a view to seeing how far the views of the East London authorities could be met.

Electric Railways in Berlin.—A practical issue is anticipated from the negotiations which have now extended over several years as to the construction of a system of high level and underground electric railways in Berlin and district. It is estimated that the railway (partly underground and partly high level) will cost £131,578 per mile, or 25,000,000 marks for the 9½ miles of railway. It is pointed out that the terms upon which the concessions are granted are more onerous than those under which the underground electric lines in London have been constructed and equipped. The German company will construct their line through the districts of Berlin, Schöneberg and Charlottenberg, and the Government concession is for a period of 90 years, but at the expiration of 30 years, and at succeeding intervals of 10 years, the municipalities of the districts mentioned have the right of purchasing the undertaking. The company has to pay an annual percentage of its gross receipts to each of these three municipalities during the working of the railway; the percentage rising on a sliding scale according to the increase in the company's receipts. It is anticipated that the line will be in operation at the beginning of 1901. These electric railway concessions were originally acquired by the Siemens and Halske Co., which, in conjunction with a combination of German banking houses, has formed the Gesellschaft für Elektrische Hoch und Untergrundbahn. This company is, at the present time, issuing Four per Cent. stock to the extent of 12,500,000 marks, corresponding in amount to the ordinary capital of the company.

Electric Tramways in South Staffordshire.—The British Electric Traction Co. have issued a pamphlet giving particulars of their lines of electric tramways in South Staffordshire and adjacent counties, accompanied by several interesting maps.

Exeter.—The accounts of the Electric Light committee for the past year show a surplus of £548, and £450 of this amount has been carried to reserve, which now totals £1,200. The balance has been arried for ward.

Glasgow.—The Electricity committee unanimously recommend the Council to authorise the supply of electric current to places of worship at 3d. per unit—half the ordinary rate.

Ham.—The Kingston Council is willing to apply for a provisional order for this district, provided the district council sanction the application. Ham council is considering the matter.

Hampstead.—A recommendation by the Lighting committee that a main be laid for the supply of electric current to private consumers in Oakland-terrace, Cricklewood (subject to the consent of the Hendon Council), was discussed at the meeting of the Vestry last week. Objection was made that the Vestry could not legally do what the committee recommended, and the vestry clerk (Mr. Johnson) said that undoubtedly the order only gave them power to supply current in Hampstead parish, but if the mains were laid with the consent of the Hendon Council there was no one to object. Eventually the recommendation was rejected.

Harrow.—The provisional order of the Harrow Electric Light Co. only embraces the area of the old local board, and as the company are precluded from applying for an extension order in consequence of omission to give formal notice to the local authority in July, the latter has decided to apply for and transfer the order, on condition that the company pay all expenses attached to the application.

Lanark.—Owing to dissatisfaction with the gas lighting the Burgh Commissioners have decided to establish electricity supply.

Leeds.—The Headingley to Chapeltown electric tramway route was inspected by the Board of Trade inspector (Mr. A. P. Trotter) on 19th inst.

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Leek.—The Council have decided to apply for a provisional order.

Leicester.—The Corporation were on Wednesday recommended by the Gas and Electric Lighting committee to apply for sanction to a further loan of £100,000 for electric lighting extensions. The chairman of the committee (Ald. Lennard) gave particulars of the progress of the undertaking. There was the equivalent of nearly 37,000 8-c.p. lamps connected, against 28,188 in 1898; in 1899 the revenue was £5,040, compared with £3,559 in the previous year. The capacity of their present plant was 1,600 kilowatts, and they now proposed to put up buildings capable of accommodating machinery of 4,000 kilowatts capacity. They proposed to put in half the machinery first, so as to increase from 1,600 to 3,600 kilowatts, but the buildings for the whole plant would be at once erected. They were perfectly satisfied with the character of the plant proposed to be used and with the system of generation and the type of machinery. As current became cheaper he was quite sure the Council would have to sanction further extensions. They had been twitted about variation of pressure. The pressure at their works varied very little indeed, not more than about 3 per cent., and there had never been a serious breakdown. With regard to the new works, they felt it imperative they should be ready by next winter. The plant they proposed to put down now (two 1,000 kw. machines) would last them until the winter of 1903. After that they would put down two more machines, which would probably last them another two or three years; and that would use up the entire amount of £100,000. In the balance-sheet of the last half-year they showed an earning power of 5¾ per cent. on the entire capital outlay after paying all expenses.

Lewisham (London).—A special committee has been appointed by the District Board of Works to report on the advisability of putting the Lewisham provisional order in force.

Light Railways.—An inquiry was held on Monday into the application of Railway Developments (Ltd.) for the construction of a light railway between Highbridge, Wedmore and Cheddar, and the Commissioners have granted the application.

Objections to the proposed light (electric) railway between Derby and Ashbourne were considered by the Board of Trade on Tuesday. The main point was as to the mode of construction, which the Board of Trade inspectors considered unsatisfactory and dangerous; and in order to meet these objections the promoters offered to lay guard rails and to make the roadway level with the rails, in the country by ballast and in the town by means of tarred macadam, the wheels cutting their own groove. Sir Courtenay Boyle said the inspecting officers adhered to their objections, and he could not pass the clause. He would not reject it, however, because he understood the Light Railway Commissioners wished to confer with the Board upon the subject. He therefore postponed the consideration of the clause.

The Bourne Vale light railway scheme was sanctioned by the Light Railway Commissioners on Thursday last.

An inquiry was held into the Bridgwater-Langport-Glastonbury light railway scheme on Tuesday, and after hearing evidence the Earl of Jersey decided that it was a case of competition with the Great Western Railway. The application was therefore rejected.

The Light Railway Commissioners have refused the application for powers to construct a light (electric) railway from Ryde to Seaview, Isle of Wight.

The East Ham District Council give notice of intention to apply or powers to construct electric tramways in East Ham, Little Ilford, and West Ham.

An influential committee has been formed for the purpose of furthering the proposal to construct a light railway from Duns to Cornhill-on-Tweed, N.B.

Limehouse (London).—The District Board of Works have unanimously resolved to apply for a provisional order. The County of London Co. obtained an order for the district in 1897.

Liverpool.—In reviewing the work of the tramways department during the past year, Mr. C. Petrie stated, at the meeting of the Tramways committee last week, that they were constructing and equipping for electric traction about four miles of tramway a month. Of the 78½ miles of tramways in the city, 28 miles were already converted to electric traction, consequently he hoped that by next year all the main lines into the city would be completed.

London County Council.—At Tuesday's meeting the Highways committee reported that Prof. Kennedy had expressed the opinion that the whole of the Council's tramways on the south side of the Thames, and also the additional tramways and light railways which it was seeking powers to construct, could be worked by means of one generating station, which could be constructed on the site of the Council's tramway depot at Camberwell, and further suggested that, as eventually this generating station, if erected, would be an extremely important one, it was very desirable that compulsory powers should be obtained for the acquisition of the freehold of the portion of that depot now held on lease, and also of certain houses abutting upon the north-east corner of the depot and the property on the east between the depot and Camberwell New-road. The committee recommended that the suggestion should be adopted, and that the property should be scheduled as to be acquired under the powers to be sought by the Electric Traction Bill. The estimated cost is £90,100. The recommendation was ordered to stand over.

The Highways committee further recommended that the Council rescind the resolution of July 25 to apply for powers to construct a tramway for Rushey Green, via Catford-road, Perry Hill, Bell Green, Sydenham-road and West Hill, to the Crystal Palace. This was carried.

A scheme for the construction of electric tramways or light (electric) railways in the southern and south-western suburbs of London, and in the northern part of the county of Surrey, will be submitted to the Council by the Highways committee on Nov. 14, when a recommendation will be proposed that application be made to the Light Railway Commissioners to obtain the necessary powers. The scheme, which comprises the construction of over 29 miles of line, is only the first part of a larger scheme for the whole county which will be hereafter elaborated. It includes lines connecting Hammersmith Bridge with Barnes, Mortlake, and Richmond; a line from the London county boundary at Wimbledon Common, passing over Kingston Hill to Kingston; lines connecting Tooting Junction with Mitcham, Carshalton, and Sutton, approaching Croydon urban boundaries at several places; and an extension from these lines by two routes to Raynes Park, through Wimbledon and through Merton. From Raynes Park the line will pass across country to New Malden, thence onward to Kingston and Richmond as far as Ham Common, and from Kingston through Surbiton, with several subsidiary routes, to Ditton. The local authorities in several of the places affected have proposals of their own already in hand, and it is probable that the London County Council's project will meet with considerable opposition.

Norway.—The Norwegian Ministry have decided to bring before the Storthing a bill for raising at 3½ per cent. a 30,000,000 kroner loan, to be devoted to railway construction and the development of telegraphs and telephones in the country.

Paignton (Devon).—The Council have refused to approve a proposed application by a company for a provisional order.

Post Office Telephone Facilities.—The Battersea Vestry is about to try conclusions with the Postmaster-General in its refusal to allow pipes to be laid for telephone cables. The Vestry has apparently overlooked the numerous decisions which have been given by the High Court in connection with this subject.

Provisional Order Application.—The Heston and Isleworth Council give official notice of their intention to apply for a provisional order.

Provisional Order Transfer.—The Kingswinford District Council give notice of intention to transfer their provisional electric lighting order to the Midland Electric Corporation for Power Distribution. A supply of electric current is to be available in 12 months, and "in case the company, in the opinion of a Board of Trade arbitrator, make default in the performance of its obligations, the company may be required to sell the undertaking to the Council on such terms as the arbitrator may determine."

Railway Station Lighting.—Last night the President of the Board of Trade stated in the House of Commons that he understood orders had been given for Ludgate Hill (London) station to be lighted throughout by electricity—a much-needed improvement.

Ramsgate-Margate Light Railway.—The work of constructing the permanent way, which was suspended during the season, has been resumed.

Redruth.—In consequence of an adverse vote at a recent ratepayers' meeting, the Council have reopened negotiations with Edmundson's Electricity Corporation, with a view to obtaining terms for establishing electricity supply in the district.

Romford.—The Council's consulting engineer (Mr. W. C. C. Hawtayne) has been instructed to prepare estimates of the cost of establishing electricity supply.

Saltburn.—The electricity works of the Cleveland and South Durham Assets Co were formally opened on Monday. At present the equivalent of 1,200 8-c.p. lamps is connected to the mains, and several private houses are being wired. The Council is also negotiating for the lighting of the Promenade by means of arc lamps of 2,000 c.p. each.

Sheffield.—The new tramway routes, powers for the construction of which are to be applied for next session, were decided upon at Wednesday's meeting of the Corporation.

Stalybridge.—At the conference of representatives from the Stalybridge, Hyde, Dukinfield and Mossley Councils on Tuesday it was decided to formulate a joint electric lighting and tramway scheme for the four districts.

Supply Interruption at Ealing.—On Tuesday last week a short-circuit on one of the cables necessitated the station being shut down from 7.30 to 8.45 p.m.

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Swindon and Pendlebury.—The consulting engineer to the Council (Mr. C. Hopkinson) has presented his report on the electric lighting question, and this will shortly come before the Council for consideration.

Telegrams to South and East Africa.—Telegrams in code or cypher are not accepted for Zanzibar, the Seychelles, Mauritius, or any place in British East Africa, Mozambique, Delagoa Bay, Rhodesia, British Central Africa, Orange Free State, Transvaal, Cape Colony, or Natal, and telegrams in plain language are only accepted at forwarding offices (including the post offices) at senders' risk.

Telephone Municipalisation.—The borough electrical engineer of Huddersfield (Mr. A. B. Mountain) has been instructed to prepare a scheme for the establishment of a municipal telephone exchange.

The Telephone in the Manchester District.—By a circular issued on behalf of the Mutual Telephone Co. members of the Manchester City Council are informed that the company is in a position to establish competitive telephone communication in Manchester and district, much more expeditiously and economically than can 20 different authorities acting independently, and the company is willing to accept and work a telephone licence subject to the transfer of the company's property to the Corporation at any time. It will be remembered that in times past the company has, more or less successfully, coquetted with the Corporation, which body has, in a way, granted the company the benefit of its sympathy and support. The special Telephone committee of the Corporation, which met last week to consider the company's application, resolved in favour of a licence being granted by the Postmaster-General, and the Council was on Wednesday asked to confirm this recommendation, but decided not to support the proposed application of the company for a telephone licence. The committee have, on the contrary, been instructed to report upon the advisability of obtaining a licence for establishing a municipal telephone service.

The Gorton Council have approved of the application of the Mutual Telephone Co. to the Postmaster-General for a licence to establish a telephone exchange in Gorton.

Thirsk (Yorks.).—A joint electric lighting scheme for Thirsk, Sowerby and Charlton Miniott districts has been proposed, and the Thirsk Council have conditionally expressed their approval.

Twickenham.—Negotiations have been re-opened with Edmundson's Electricity Corporation in connection with their proposed application for a provisional order. The Company offer to establish works in the district and to supply electric current in Twickenham and Teddington at 7d. per unit for the first hour, 4d. per unit for the second, and 2d. per unit for the thirds' consumption.

Ventnor.—Sixteen arc lamps are to be erected in the principal thoroughfares, to which current will be supplied by the Ventnor Electric Light Co.

Whaley Thorns (Bolsover).—This district is to be lighted electrically. Current will be supplied by the Sheepbridge Co., and the lamp-posts, &c., will be supplied and erected by the Bolsover Council.

Worcester.—The Corporation are recommended to purchase and electrically equip the local tramways.

Workhouse Lighting.—The Middlesbrough Guardians are considering the question of adopting electric lighting at their workhouse, and the Corporation have been invited to state the terms upon which they will supply current.

The Wandsworth and Clapham (London) Guardians have appointed a sub-committee to report upon the subject of lighting their Tooting home electrically.

The Stoke-on-Trent Guardians have decided to put down plant for the electric lighting of the workhouse buildings, cottage homes, nurses' home, &c., and sanction for the borrowing of the necessary money has been applied for. The consulting engineer is Mr. G. R. Peers.

Wrexham.—An inquiry was held here, on Friday last, into the application of the council to borrow £22,100 for electric lighting and refuse destructor works. The town clerk (Mr. Thomas Bury) appeared in support of the application, and gave particulars of the rateable value and existing loans of the borough, together with a history of the movement in favour of the introduction of electric lighting. He asked that the loan should be spread over a period of 30 years, but the inspector could not hold out any hope of this. The consulting engineer (Mr. W. H. Trentham) submitted plans and gave technical details: 27 arc lamps would be erected for street lighting, and from a canvass of the ratepayers there was every reason to anticipate that the undertaking would be a financial success from the first year. There was no opposition.

Yeadon.—Mr. J. E. Enright has been appointed consulting electrical engineer to the Council.

Smoking Concert.—This (Friday) evening a smoking concert of the Electro-Harmonic Society will be held in the International Hall, Café Monico, Piccadilly-circus, London, W., at eight o'clock.

PATENT RECORD.

The following list of Applications for Patents and Specifications published has been compiled for this journal by Messrs. J. C. CHAPMAN and Co., *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs, and Trade Marks may be obtained.*

SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1898.

15,792. LAVAVASSEUR. Electric motors.
19,337. RUDD. Electric apparatus for regulating clocks.
19,348. GIBBINGS and KAY. Contact devices for sectional cables or conductors for electrically-driven vehicles.
19,445. BLUMENBERG. Electric batteries.
19,636. BLACKBURN and SPENCE. Distribution of electricity on the three-wire direct-current system.
19,778. CROWDUS. Motor driven road vehicles and electric motors therefor.
20,393. HOLMES. Electrical motor transformers.
20,394. HOLMES. Controlling of electrical circuits.
21,155. JUVENET (de Siblas). Electrically propelled road vehicles.
21,941. BEAUMONT. Electricity meter for registering the amount of current consumed on direct or on alternating current circuits.
22,768. SHORT. Methods of, and apparatus for, increasing the volume of sounds from telephonic or phonographic instruments, and transmitting such sounds to distances.
23,143. BUCK. Electrical warming pans and like articles.
23,497. MERRIMAN. Electric tramways on a road-contact system.
23,510. LAKE (Spencer). Insulators for incandescence electric lamps.
23,659. ROBERTSON. Electrical propulsion of tramway cars, railway carriages, and the like, by a road contact system.
24,115. SCHMIDLIN. Electricity meter.
24,125. NEUMANN. Electrical railway signalling apparatus.
24,164. BRADLEY. Electric incandescent lamp shade holders and the like, and a device for use in connection therewith.
24,265. HIRST. Forming filaments, or the like, for incandescence or glow electric lamps.
24,308. HADDON (Columbus Electrizitäts-Gesellschaft m. b. H.). Electric batteries.
24,466. W. N. STEWART and H. H. WELLS. Electric arc lamps.
24,487. STEINER. Collectors for electric street railways with overhead conductors.
24,550. SCHNEIDER. Electro-therapeutical and massage apparatus.
24,532. MILLS (Soc. Francaise des Câbles Electriques, Système Berthoud, Borel and Cie). Electric cables for high-tension currents.
24,965. HANCHETT and SAGE. Electrical resistance measuring instrument.
25,314. ABEL (Soc. Anonyme pour la Transmission de la Force par l'Electricité). Apparatus for transforming alternating into continuous electrical currents, and conversely.
26,310. CLARK, MCAULAY and MCLAREN. Junction boxes, switches, wall plugs and distribution boards for use in electric wiring.
26,494. WATSON. Electrical switches.
26,738. TAYLOR. Conduit inspection fittings for electric wiring.
27,320. HEEBNER. Electric motors and method of, and controlling same.

1899.

2,218. SCHMIDT. Electric switch.
5,200. HOLLAND and LAURIE. Manufacture of porous diaphragms for electrolytic apparatus.
6,038. HUTCHISON. Controlling switches and apparatus for electric motors.
9,349. OSTMANN. Electromagnetic tooth-stopping hammer.
11,717. HODGSON. Electric batteries.
11,776. DOLTER. Means for supplying current to electrically-propelled vehicles.
13,826. TOBIANSKY. Elastic and permeable electrodes for storage batteries.
14,547. DAVIS. Electrical signalling systems. (Date applied for under International Convention, Dec. 16, 1898.)
14,774. HALL and BURDICK. Submarine electric arc lamps.
14,789. JELFS. Electric locking apparatus for railway signals.
14,794. HEEBNER. Storage batteries.
15,147. SIEMENS BROS. AND CO. (LIMITED) (Siemens and Halske Aktien Gesellschaft). Electrical apparatus for indicating the names of stations in railway and tramway vehicles.
15,148. SIEMENS BROS. AND CO. (LIMITED) (Siemens and Halske Aktien Gesellschaft). Junction boxes for underground electric conductors.
15,189. DANIELS. Rail bonds for electric railways. (Date applied for under International Convention, April 25, 1899.)
15,203. BRUNO and OTTESEN. Electric elevated railway.
15,426. TREBELHORN. Electric battery and process for constructing the electrodes for the same.
15,460. GARDNER. Tap-switch for electric incandescence lamps.
16,005. SWAN. Method of and apparatus for manufacturing incandescent electric lamps.
16,387. SHORT. Brush holders for electric machines.
16,439. DYMOND (Toerring). Arc lamps.
16,555. GOOCH. Reduction of aluminium by electrolysis.
16,627. LESTHEVENON. Electric arc lamps.
18,489. SIEMENS BROS. AND CO. (LIMITED) (Siemens and Halske Aktien Gesellschaft). Apparatus for the electrical working of railway points and signals.

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COMPANIES' MEETINGS AND REPORTS.

Western and Brazilian Telegraph Co. (Limited).

The thirty-eighth ordinary general meeting of this Company was held on Tuesday, at Winchester House, Old Broad-street, under the presidency of Mr. W. S. ANDREWS.

The SECRETARY (Mr. E. Steer Hodson) read the notice calling the meeting, and the minutes of the last general meeting, which were confirmed.

The CHAIRMAN then said: I do not propose to go into our business at any length to-day, because this meeting really partakes of the nature of a funeral ceremony. We are met to-day for the purpose of beginning the interment of the Western and Brazilian Co., in order that it may come to fresh life and go on again prosperously with the Brazilian Submarine Co. as a united undertaking. As regards the accounts, we generally deal a little with them, although I do not think it is necessary to do so on this occasion. The income for the half-year ended June 30th last amounted to £66,494, and for the corresponding period of last year it was £72,692, showing a decrease of £6,198. Of course, these figures look a little unfavourable, but I may tell you that things have changed already, and that this half-year the traffic is going on much better. We may trace the cause of the falling off shown in the accounts now before you to the stagnation of commercial affairs in Brazil. Fortunately that is mending, and we are looking to the future with more satisfaction. The working expenses for the half-year were £45,730, as against £43,179 for the preceding six months. There were decreases in the working expenses amounting under five heads to £3,043, and there were certain increases amounting to £1,388, chiefly on maintenance account, in addition to which an outlay of £887 was incurred in bringing about the closer working union between the two companies. Then the value of cable used for repairs—and here we come to see the whole cause of the increase in the working expenses—was £7,158, which was all charged to revenue. In consequence of this expenditure on cables, instead of our showing, as we otherwise should have done, a considerable saving in working expenses, we come out with an increase of £2,551 under this heading. We cannot, however, control the quantity of cable that has to be used through accidents and other circumstances, and really I think that the outcome is very satisfactory. Deducting expenses and income-tax from the receipts, we have a balance of £20,073, to which is added the balance from December, 1898, of £1,608, and the dividend from the Platino Co. of £8,320, making a total of £30,001. After providing for the fixed charges for debenture interest and redemption fund, £9,100, there remains £20,901. That enables us to recommend a dividend of 4s. a share, corresponding with that paid for the last half-year, and leaves a balance of £1,422 to be carried forward. I now move—

"*That the report and accounts to 30th June, 1899, now submitted, be and the same are hereby approved and adopted, and that an interim dividend of 4s. per Ordinary share, free of income tax, be and the same is hereby declared payable to-day.*"

Mr. D. H. GOODSALL seconded the resolution, which was carried unanimously.

An extraordinary general meeting was held subsequently.

The SECRETARY having read the notice convening it,

The CHAIRMAN said: Gentlemen, there is not very much to be said upon the business before you. In fact, owing to the very unanimous approval by the shareholders of the arrangement made with the Brazilian Submarine Co., they have rather forced our hands. They have shown that the shareholders evidently thought well of the arrangement between the two companies, and that the closer the working methods adopted by them were, the better for all classes of shareholders. To the extent of 95 per cent. the shareholders of the Western and Brazilian Co. have become shareholders of the Brazilian Submarine Co. There is therefore a very small residue, which, moreover, keeps becoming "beautifully less," because from time to time people who have been absent, or who from other causes have not expressed their views, are still coming in, so the percentage is constantly diminishing. Under these circumstances we thought that it was scarcely advisable to keep alive an organisation which might be merged in that of one concern with considerable advantage. That will increase the excellence of the arrangements already existing; and altogether we have thought that it would be advisable to have only one concern. We have obtained all the necessary authority for carrying out this purpose, and we now come before you to ask your approval of a matter about which there is no difficulty with Governments or anyone else. The proposal, in fact, has been approved by everyone except the shareholders in general meeting, and we now ask for your authority to sanction the winding up of the Western Co. and the merging of the whole concern with the Brazilian Submarine Co. The shareholders outstanding will be properly dealt with. I now propose the following resolutions:—

1. "*That the conditional agreement made between this Company of the one part, and the Brazilian Submarine Telegraph Co., Limited, of the other part, and dated the 13th day of October, 1899, submitted to this meeting, be and the same is hereby approved, and that the liquidator hereinafter mentioned be and he is hereby authorised to adopt the said agreement, and carry the same into effect with such, if any, modification therein as the said liquidator may think expedient.*"

2. "*That this Company be wound up voluntarily, and that William Henry Axworthy be and he is hereby appointed the liquidator for the purpose of such winding up.*"

Mr. GOODSALL seconded the resolutions.

Mr. G. ENNIS asked that a *résumé* of the agreement might be given for the information of the shareholders.

The CHAIRMAN thought it would be better if the solicitor gave the required explanation.

The SOLICITOR stated that the first clause provided that the agreement was conditional upon its being sanctioned by a general meeting, and the special resolutions for winding up being passed by December 31, 1899. The second clause provided that the Western Co. and its liquidator should sell to the Brazilian Co. the whole of their undertaking, and also that the Western Co. should be entitled to retain out of its assets a sum equal to 4s. a share, so as to provide a dividend up to December 31st next on the outstanding shares. As part of the consideration the Brazilian Co. was to undertake to pay and satisfy all outstanding debts of the Western Co., and to deal with its liabilities, including the Debentures amounting to about £397,000. The next clause was the usual one—that was, that the Brazilian Co. took over all the liabilities and indemnified the Western Co. against them. As the residue of the consideration for the transfer the Brazilian Co. was to pay to the liquidator of the Western Co. £61,706. 5s., and possession of the property was to be given as on January 1, 1900. Up to that date the Western Co. would work the business as trustee for the Brazilian Co. The Western Co. and its liquidator were to have a lien on the property for any money expended up to that time. The ninth clause was to the effect that the Brazilian Co. authorised and requested the liquidator or liquidators of the Western Co. to distribute the cash, distributable under clause 5, among the shareholders who at this date had not come in. The agreement was really for a sale of that portion of the undertaking which had not already been acquired by the Brazilian Submarine Co. Anyone who wished to see the agreement, which was not a long one, could do so.

Mr. DRYSDALE inquired what was to become of the reserve fund of the Western Co.

The CHAIRMAN: The whole of the assets of the Western Co. were purchased when the exchange of shares was made; the whole of those assets would now, of course, be transferred to the Brazilian Submarine Co., who would become possessed of all the property of the Western Co. In regard to the question of the reserve, that did not represent profits.

Mr. DRYSDALE said he took it that the Brazilian Co. purchased all the assets of the Western Co., including the reserve fund.

The CHAIRMAN: Yes.

Mr. ENNIS stated that the solicitor had mentioned the essential features of the agreement, and he (the speaker) quite saw that amalgamation was the proper thing. Perhaps, however, the shareholders might be informed what amount per share the agreement would give.

The SOLICITOR: £12. 10s. per Ordinary share. Any shareholder who cared to come in and exchange his shares for Brazilian Submarine shares could do so up to the next meeting—the confirmatory meeting.

The CHAIRMAN: It will be only after the confirmatory meeting that the other question—the question of purchase—will be applied. You are still free to exchange your shares up to the next meeting.

A SHAREHOLDER said that as £12. 10s. a share would be paid for the Ordinary shares, he would like to know what would be given for each of the Preferred and Deferred shares. Did they each stand in for £6. 5s., or how was the money divided, because they ranked at present equally for capital?

Sir A. J. L. CAPPEL, K.C.I.E., remarked that in a liquidation that would undoubtedly be the case. The safeguard was to come in before the next meeting.

Mr. J. DENISON-PENDER observed that there were two sides to that question.

The CHAIRMAN: We must leave it to the discretion of the shareholders, who, I have no doubt, will know how to act in their own interests.

The resolution was carried unanimously, and the proceedings terminated with a vote of thanks to the Chairman.

Brazilian Submarine Telegraph Co. Limited.

The fifty-second ordinary general meeting of this Company was held on Wednesday, at Winchester House, Old Broad-street, under the presidency of Mr. W. S. ANDREWS.

The SECRETARY (Mr. E. Steer Hodson) read the notice convening the meeting, and the report of the Directors was taken as read.

The CHAIRMAN then said: Gentlemen, the income for the half-year ended June 30 last, including the dividends from the Western Co. and other telegraph companies in which the Brazilian Submarine Co. has investments, amounted to £119,360, as compared with £133,371 for the previous half-year, showing a decrease of £14,011. There were, however, increases in dividends from other telegraph companies of £2,771, and of £159 from interest, rent, transfer fees, &c., making together £2,930. But for these increases we should have had to tell you there was a loss of £16,941. The falling off in the traffic receipts, on being analysed, is far less discouraging than these figures would lead us to conclude. As a fact, the falling off has nearly all taken place in Brazil, where practically, as you are aware, there is no competition with other lines. Consequently, it is not a question of loss of traffic through competition, but it really represents in a sense, I am particularly sorry to say, the stagnation of trade existing in Brazil at the present time—well, perhaps not so much at the present time, because I am pleased to say that since these accounts were closed for the half-year to June last the accounts for the current period are more encouraging, and I hope, therefore, that we shall not have to present to you such an unsatisfactory statement at our next meeting. The traffic with Argentina has also undergone some diminution. Although there was a falling off in the Press work, we do not have a falling off in the number of words of the ordinary private messages; in fact, we show that, from some source or other, we are getting more words—commercial words—from Buenos Ayres, which is very satisfactory, because in Buenos Ayres there is rather severe competition. Of Chili there is nothing much to say, except that bad trade exists there, which adversely affects our receipts; in fact, as far as we can trace trade and traffic, it seems to be not the traffic so much being affected by causes which were preventable

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as by trade. It is trade alone that has taken off the number of our messages. Turning to the expenses side of the account, the total expenditure was £21,999 for the half-year, while that for the previous year was £22,253, or a decrease of £254. It is really hardly worth enlarging upon that at all, but, as a fact, there was a decrease in the London expenses of £294, and an increase at the stations of £191, the net decrease being £250. There are certain special items, but they do not affect the position at all. The outcome of these figures is that, after paying £3,200 for Debenture interest and sinking fund, and providing for the payment of income tax, there is a credit balance on the half-year's business of £92,435. To this is added £15,801, the balance brought forward from December 31st last, making a total of £108,236, from which £635 for further expenses in connection with the closer working union of the companies and the interim dividend for the March quarter, amounting to £30,899, have to be deducted, leaving a balance of £76,702. After transferring £20,000 to the reserve fund, the Directors recommend the payment of a final dividend of 3s. per share, making with the interim dividend 6 per cent. for the year, and also the payment of a bonus of 2s. a share, both free of income tax, which together will amount to £51,639. 10s., leaving a balance of £5,062. 16s. 3d. to be carried forward. That is our usual dividend, and I think we may congratulate ourselves that in face of somewhat adverse circumstances—although I do not wish to make too much of them—we maintain our dividend and our reserves, and we go on in the same prosperous way that we have hitherto done. You were told that the Lisbon-Madeira No. 1 cable was faulty, but it has continued to work satisfactorily, notwithstanding the fault that there is in it; and as we always with these cables like to let sleeping dogs lie, we have not interfered with it. You were also told that the Madeira-St. Vincent No. 2 cable was in a faulty condition. We adopted the same policy with that cable, only it did not turn out quite satisfactorily, because the cable gave out altogether. We therefore had to avail ourselves of a ship which was pretty near to the spot, and she effected the restoration almost immediately. But the cable was again interrupted, and again it was restored almost immediately, and that not at any great expense and with the smallest delay that could very well occur. The ship, as I have said, was very near the spot—it was one of the Eastern Company's ships—and she certainly did this work most satisfactorily. The proportion of the charges to June 30th appears in the present accounts, and the balance will appear in those of the current half-year. Gentlemen, a rather important state of things has been brought about in consequence of the arrangements for consolidation, that have been carried out successfully up to the present time, of our interests and those of the Western and Brazilian Telegraph Co. These arrangements for a closer working have resulted very satisfactorily indeed, and the shareholders of the Western and Brazilian Co. have exchanged their shares for shares in the Brazilian Submarine Co. to the extent of about 95 per cent. When this arrangement was first brought upon the tapis, we were, of course, very careful not to offend in any way whatever the susceptibilities of the Governments that might conceive themselves affected by it, and therefore we had to proceed prudently, and to do nothing in the shape of a complete consolidation of the two companies Well, our proceedings thus far have been received with very considerable. approval, and we have now seen for some little time that the period was approaching when we might venture to carry out a complete arrangement for a consolidation of the companies instead of the more or less incomplete one which we embodied in the working arrangement. You will therefore, no doubt, have seen that notice has been given for the winding up of the Western and Brazilian Co., and also for the acquirement of the remaining properties of that company by the Brazilian Submarine Co. Of course, this is a big thing. We obtain the collecting ground of the Western and Brazilian Co., which was hitherto not in our possession; but it is a circumstance that adds greatly to our strength that we should be enabled to include this collecting ground in our possession. We are therefore not merely consolidating, but are also greatly improving and strengthening our position. We have always felt that it ought to be one company, extending to Europe and embracing Brazil and Uruguay and the Argentine, and that it should be worked as one concern, possessing all the advantages appertaining to the territory itself. Of course, to bring this about we were obliged to conciliate the Governments, but our preliminary measures, in the way we dealt with them, had so satisfied them that the objections which formerly existed, and which had been expressed, appear to have disappeared, and we were able to show the Government, like the public and the general senders of messages, such advantageous arrangements for developing their trade and for encouraging the commerce of the country, that consents fortunately were obtained. Now, in obtaining those consents you quite understand that the old expression of "nothing for nothing" applies. The Government desired that we should do certain things. Well, singularly, we had already been thinking on our own behalf that it was very advisable to do those things for the encouragement of the trade and for the strengthening of the concern, and therefore we readily complied; and the consequence was that we succeeded in obtaining the valuable concession that the Western and Brazilian Companies might effect a complete union of their interests. You will therefore now be in this position—that you will be yourselves masters of the whole of the sources of traffic from which you have been benefiting all these years, and from which we hope and believe increased benefits will be derived by you. This will, of course, entail encroachments on the reserve—that goes without saying; but we are of opinion that the vastly improved communications and the development of the valuable sources of traffic which the new cable will enable us to develop fully will more than compensate for the extra expenditure. In fact, this is a thing which, if the companies had not been divided, as they have been hitherto, would no doubt have been carried out some years ago. I cannot help congratulating the shareholders on this important development of their property, and on their being now in the position we have secured for them of developing and protecting their future interests. I do not know that I need touch on the reserve fund, because you see that, although we do add to that fund, we shall now have to deplete it a good deal in carrying out all these new arrangements. I do not know that there is anything else with which at this particular moment I need trouble you. I may, however, say that I have received a letter from a gentleman who asks us to state to the meeting—he cannot attend himself—whether it is likely that wireless telegraphy will in any way affect the future of our company. Well, I do not think it will. Wireless telegraphy is a very wonderful invention, and within certain limited areas is likely to prove of very great utility; but it is not an instrument which works very large distances, and the areas in which it works cannot have a lot of things working at the same time. It is a small thing for shipping purposes and lightships and that sort of thing, but nothing more. I have nothing else to lay before this meeting, and therefore I will now move the resolution, which is:—

"*That the report of the Directors and the accounts to June 30, 1899, now submitted, be approved and adopted, and that a dividend be now declared of 3s. per share, making with the interim dividends already paid, a total dividend of 6 per cent. for the year, and also a bonus of 2s. per share, making in the aggregate a distribution of 7 per cent. in respect of the profits for the year ended June 30, 1899, the said dividend and bonus to be respectively free of income tax.*"

Mr. FREDERICK YOULE: I have much pleasure in seconding that.

A brief discussion followed, and, in answer to questions,

The CHAIRMAN stated that the board had not yet obtained the report as to the depth of water in which the repairs to the No. 2 cable were completed. The repair was at a distance of about 20 miles from St. Vincent. He did not think that the Company were likely to have a worse half-year than that under review. Practically the whole of the Western and Brazilian Co.'s capital was incorporated in that of the Brazilian Submarine Co., for, as he had already stated, about 95 per cent. of the Western and Brazilian Co.'s shares had already been exchanged for shares in this Company. On this 95 per cent. of the Western Co.'s capital the Brazilian Submarine Co. were already paying a dividend, and the Directors believed that the measures which they were taking, or going to take, would give a return for the outlay. The money forming the staff endowment assurance, superannuation, and pension funds was in the hands of trustees; it was paid separately to trustees, who administered the fund, and the item therefore did not appear in the balance-sheet. These trustees acted for several other companies, who all joined together in order to average their risks and give a greater security to the staff and less cost to themselves. He then put the resolution, which was carried unanimously.

The retiring auditors, Messrs. Deloitte, Dever, Griffiths and Co., and Messrs. Gane, Jackson, Jefferys and Wells were re-elected.

An extraordinary general meeting was held in connection with the conditional agreement which had been made between the Company and the Western and Brazilian Co.

The SECRETARY having read the notice convening the meeting,

The CHAIRMAN stated that he had already pointed out that the object in view was to effect the consolidation of the two companies.

The SOLICITOR (Mr. Dawes) pointed out the salient features of the scheme, recapitulating the statement made by him at the meeting held on the previous day of the Western and Brazilian Co., which is set out in the report of the proceedings of that company in another column (p. 26).

The CHAIRMAN then proposed the adoption of a conditional agreement between the Western and Brazilian and Brazilian Submarine Companies, and authorising the Directors to carry the same into effect.

This was carried unanimously, as was also a resolution authorising the issue and allotment of so many of the 120,000 new Ordinary shares created by the special resolutions passed at the meetings of the Company in July and August last as might be required.

On a resolution authorising the substitution of a new Article 110 in the Articles of Association affecting the annual remuneration of the Directors,

The CHAIRMAN said: Gentlemen, this resolution raises several questions. For instance, we are going now to do away with Article 110. Under that article it was in the power of the Directors, by paying certain extra dividends, to become the happy possessors of increased stipends. The board, however, never took advantage of this clause; so far from their taking advantage of it, indeed, I believe it has almost been a source of complaint with the shareholders that the Directors did not declare sufficiently high dividends. They have always insisted on declaring what they believed to be good dividends, and dividends within the resources of the Company and providing for the Company's backbone (for it is really that)—namely, a sufficient and adequate reserve against breakages, or any other circumstances, or as against (as it is in the present case) demands that might be made for the extension and development of the Company's undertaking. Therefore, you see, you are in pretty safe hands with respect to the future. As regards the Western Co., there was a similar clause in the articles of that company, but in like manner, the Directors of the Western Co. have never taken advantage of those stipulations, which now disappear. But as the Western Co. is being wound up, there also disappears, on account of that circumstance, the provision of any fees whatever by that company. We have consequently been obliged to incorporate in these articles a something which should make up that provision again; and I may say that, with respect to the labour and responsibility in administering fitly and thoughtfully the large interests which are now involved, and in working the consolidated concern, there will be a good deal more labour and probably more work than there has been hitherto. We have also had in view that it might be advisable—although it is only fair to say that we do not see any immediate prospect of it—to strengthen the board by the appointment

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of some gentleman having considerable influence and weight, who might be some benefit to our counsels and also assist in securing and maintaining what you all want and what we have been fortunate in ensuring for you up to the present time—the permanent value of your property. I do not think as respects this particular resolution that I need say any more, but I hope it will commend itself to you, like the other resolutions.

Mr. YOULE seconded the motion.

The CHAIRMAN, in answer to a question, stated that the projected operations were not all completed yet, and he could not go into them in detail at present. It might happen that the amount which the Directors would receive under the resolution now before the meeting might be less eventually than they were at present receiving—not materially less, but something.

Major COTTON supported the resolution. He believed that the Directors of the Brazilian Submarine Co. had £2,500 a year and that the board of the Western Co. received £1,500, or £4,000 a year together. The Directors had waived the additional remuneration which they might have received under the article referred to, and in place of that it was now proposed that the board should have another £1,000 a year, making £5,000 a year in all. He thought that the shareholders were very much indebted to the Directors for their large-mindedness in having brought the two companies together.

The motion was then carried unanimously.

The CHAIRMAN proposed the alteration of the name of the Company to "The Western Telegraph Company, Limited."

The resolution was carried unanimously.

A hearty vote of thanks to the Chairman and Directors for their successful conduct of the Company's affairs terminated the proceedings.

Cuba Submarine Telegraph Co. (Limited).

The fifty-sixth ordinary general meeting of this Company was held on Wednesday, at the offices, 58, Old Broad-street, E.C., Mr. CHARLES W. PARISH (Chairman of the Board of Directors) presiding.

The SECRETARY (Mr. James Scott) read the notice calling the meeting.

The CHAIRMAN said: We are again able to lay before you very satisfactory results. Our receipts for the half-year to June 30 amount, with interest on investments, to £25,027, while for the same period in 1898 they amounted to £33,504; but then I explained to you that such an abnormal increase was mainly due to the traffic arising from the continuance of the insurrection, followed by the Spanish-American war. If we go back to the first half of 1897, we find the receipts amounted to £25,623, or very nearly the same amount as we are now dealing with, although the earnings from traffic were a little larger and the interest from investments somewhat smaller. On the debit side of the account before us you will notice working expenses amount to £7,257: in 1898 they were £8,091, and in 1897 they were £7,005. The net result of the past half year's working is a profit of £17,769, of which we have placed £8,000 to reserve fund, the Preference dividend amounts to £3,000, and the balance enables us to propose a dividend on the Ordinary shares at the rate of 6 per cent. per annum, and an additional 1 per cent. for the half-year in the form of a bonus, which I think we may consider as highly satisfactory. The amount of our investments has been increased, and now totals up to the respectable figure of £117,059. The last item on the credit side of the balance-sheet is "Repairs to cables, &c., damaged during Spanish-American war, £8,084," and which for the present we are keeping in the form of a suspense account. As mentioned in the report, we are communicating with the Foreign Office as to our claim for compensation for this damage, and the matter is being laid before the United States Government. The question of our concessions being formally recognised by the United States Government is still unsettled, and I think a good deal must depend upon what the American policy with regard to Cuba will be. You probably have heard reports that the Americans have no desire to remain in the island any longer than is absolutely necessary, while others refer to a prolonged occupation. When I had the pleasure of addressing you in April last I said: "I would like to put on record that we are of opinion that the Spanish Government have treated us very fairly, and I have every expectation that we shall eventually receive the amount at present outstanding, but until it is actually encashed we prefer to leave it out of the receipts, although we have now practically agreed the amount with the Government"; and now, gentlemen, I have the satisfaction of telling you that my forecast was not misplaced. The accounts extended over several months of the war period, and it was unfortunate that the Spanish authorities had to leave Cuba before they were settled; but copies were sent to us here, and we thought it advisable that Mr. Keith and Mr. Scott should go to Madrid and explain the whole matter to the Government officials. They were kindly received, and in a few days the account was settled; and the present half-year's receipts will benefit by some £5,000 or £6,000, which they encashed. I have frequently warned you that our receipts must be seriously affected by the lower rates we have had to bring into force, and by the competition subsidised by the English and French Governments, with which we are unfortunately surrounded; and you will notice that under the table giving the comparative statement of monthly traffic we have only estimated the May and June receipts, which are generally small months, at £2,000 each. I hope this estimate may prove on the safe side, and that the actual traffics will be rather larger, but such figures bring home very seriously the heavy loss that lower rates must cause; and I would also have you recollect that our receipts for some time past have been swollen by large Government accounts, which have now practically ceased. During the half-year we are dealing with the cables worked well, and we were free from accidents, but in July last the Cienfuegos-Cape Cruz cable broke down, and in September the Cape Cruz-Manzanillo cable gave way. They are now being repaired, and our latest news reports that the fault has been located in the Cape Cruz-Manzanillo cable, and I expect the repair will soon be effected. I now move—

"*That the report and accounts for the half-year ended June 30th last, now submitted, be received and adopted.*"

Mr. GEORGE KEITH: I have great pleasure in seconding that.

Mr. COCHRAN observed that they had two sets of reserve funds, and asked for some explanation regarding them. The item of "sundry creditors, including reserve for liabilities" (£18,520), was a heavy sum, in addition to the reserve against loss on deposits (£6,600), and he would like to know what the contingent liabilities were. Was the amount of damage to cable, carried to suspense fund, included?

The CHAIRMAN: So far as our investments go, they stand on their own legs, so to say. The reserve against loss on deposits is £6,600, and that is by itself; but I may mention that I hope that we shall not be called on to use it all up. The other sum of £18,520 does not include any reserve against the repairs of cable of £8,000, as suggested by Mr. Cochran.

The resolution was then agreed to unanimously.

The dividends set out in the report were then approved, Mr. R. Kaye Gray was re-elected a Director, the auditors were re-appointed, and a cordial vote of thanks to the Chairman and Directors and the Company's staff terminated the proceedings.

Monte Video Telephone Co. (Limited).

The annual general meeting of this Company was held yesterday, at Winchester House, Old Broad-street, E.C., Mr. FRANK W. JONES (Managing Director) presiding.

The SECRETARY (Mr. E. M. Reiss) read the notice calling the meeting.

The CHAIRMAN said: Gentlemen, we are able to report continued improvement in the Company's business at Monte Video. The effect of this is given in the amount to credit of our profit and loss account for subscriptions, rentals, &c., of £18,308, which is nearly £2,000, or 12 per cent. more than last year. While this result is satisfactory in itself, it is a further satisfaction to find that working expenses for the year are heavier by only £240, in which fact is reflected the success attending the efforts of our manager in Monte Video to keep down working expenses. Taking the principal items in our balance-sheet, the capital issued is rather more than last year, the further issue being the Preference and Ordinary shares given in exchange for the Company's promissory notes, as provided for under the scheme for reduction of capital. Turning to the credit side of the balance-sheet, it will be seen that the capital outlay for the year has amounted to £2,248, some £600 more than last year, a less amount than might have been expected, considering the greater increase in the number of subscribers. Stock of material at Monte Video, and in transit, £1,540 is £188 less than last year. Sundry debtors, £2,110, mainly comprising the outstanding subscriptions, remain at about the same figure. The remaining items call for no comment. I think you will agree that these figures go to prove that our undertaking is in sound condition and that the business is progressive. Without wishing to under-estimate the position, I desire to put before you the fact which has been explained before from this chair—that the natural growth of a telephone business like ours entails continued capital expenditure. With this patent truth always before them, the board considered it only judicious to place to reserve a sum fully covering the moneys expended out of revenue and charged to capital, and they accordingly decided to carry £2,500 to reserve fund, as shown in accounts. This course we are confident you will approve. They recommend the payment of 5 per cent. on the Preference shares and a dividend of 2½ per cent. on the Ordinary shares, absorbing together £6,072, leaving £2,258 to be carried forward. I think, gentlemen, we may congratulate ourselves on the satisfactory result of the year's business.

During the past winter I had occasion to make a visit to the River Plate, and took the opportunity to spend some time in Monte Video, in order to look into the affairs of the Company there. I was gratified to find that the general conduct of the business under the administration of Mr. A. B. Powers, who has been our manager in Monte Video from the first, was highly to be commended; and I am sure you will agree with me that Mr. Powers, by his careful and untiring exertions through less prosperous times and up to the present, has merited our warmest thanks. My report to the board on returning was to the effect that the business was well managed, and only needed reasonable provision for capital expenditure to insure its position and increase its value. While in Monte Video I was able to confirm opinions which I had before brought to the attention of the board, and to some extent had referred to in remarks at our company meetings—viz., as to the advisability of keeping in mind certain extensions and improvements which the circumstances of our business would not admit of being indefinitely postponed. These extensions and improvements are:—1st. The ownership or control of the Camp lines—lines connecting Monte Video with important towns and properties within a radius of 100 miles, and some important connections even beyond this limit. 2nd. Metallic circuits for our Monte Video subscribers. 3rd. Improvement of our central office building for our own uses and to obtain additional revenue from letting such portion as is not required for our uses. These improvements and others which will naturally be demanded from time to time make it imperative to provide the capital required to carry them out. The amounts which from year to year we necessarily have been taking from revenue for the ordinary extensions of the business will be found insufficient for the purposes indicated. Your Directors are therefore considering the practicability of making use of their powers under the Company's articles of association to raise the necessary funds. I now move the adoption of the report and accounts.

This was seconded by Mr. CHARLES LOCK, and carried unanimously.

The dividends mentioned by the Chairman were then approved, the auditors were re-appointed, and a cordial vote of thanks to the Chairman brought the proceedings to a close.

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NEW COMPANIES, STATUTORY RETURNS, &c.

BLAST FURNACE POWER SYNDICATE (LTD.).—This company was registered on Oct. 17, with a capital of £100,000 in £1 shares, to acquire and exploit any inventions or processes for the production, distribution, or utilisation of chemical, electrical, mechanical, and other power. The first directors are F. L. Gardner, J. J. Cooper, C. Critchett, and Benjamin H. Thwaite.

MANCHESTER AND LIVERPOOL ELECTRIC RAILWAY SYNDICATE (LTD.).—This company was registered on Oct. 18, with a capital of £40,000 in £100 shares, to construct, equip, and maintain railways, on the mono-rail system or otherwise, between Manchester and Liverpool or any other places, and to work the same by means of electricity or other power. The subscribers are J. K. Macmillan, E. T. Broadhurst, B. Armitage, J. B. Brooks, G. H. Gaddum, A. Wilson, J. D. Crosfield, W. Oulton, and W. H. Vaudrey.

ROYCE (LTD.).—This company was registered on Oct. 17, with a capital of £110,000 in £1 shares, to acquire the business now carried on under the style of F. H. Royce and Co. (Ltd.), and to carry on the business of manufacturing electricians, engineers, manufacturers of electrical and other apparatus and machinery, &c. The subscribers are F. H. Royce, electrical engineer; E. A. Claremont, electrical engineer; A. W. Claremont, J. C. Whitehead, engineer; R. D. Hully, engineer; J. de Looze, and J. H. Watkins, electrical engineer. The first directors are F. H. Royce and E. A. Claremont (permanent managing) and J. P. Whitehead.

CITY NOTES.

MEMORANDA.—Bank rate 5 per cent. (since Oct. 5, 1899). Price of silver 26⅝d. per oz. (Oct. 26). Consols (2¾ per cent.) 103¾—104 for money, 103¾—104 for account; 2½ per cent. 100⅝–101¼ (Oct. 26). Stock Exchange Settling Days: Consols, Nov. 3; Stocks and Shares Continuation Day, Nov. 13; Ticket Day, Nov. 14; Pay Days, Oct. 27 and Nov. 15; Mining Share Carry over Days, Nov. 11 and 27.

BARCELONA TRAMWAYS CO. (LTD).—Letters of allotment for the Debenture stock and Preference shares recently issued by this company have been posted.

CASTNER KELLNER ALKALI CO. (LTD.).—An interim dividend at the rate of 8 per cent. per annum (payable 1st prox.) has been declared on the Ordinary shares for the six months ended Sept. 30.

HONG KONG ELECTRIC CO. (LTD.).—It has been decided to double the capital of the company (from $300,000 to $600,000).

CHELSEA ELECTRICITY SUPPLY CO. (LTD.)—Subscriptions are invited until 4 p.m. to-day (Friday) for an issue of £50,000 4½ per cent. Debenture stock of this Company, issued at £107, and redeemable after 1910, at the company's option at £110. The funds raised by this issue are required for the further development of the company's business and in particular under the powers of the Chelsea Co.'s act of 1898. Applications from existing shareholders and Debenture stock holders will receive prior consideration.

ORIENTAL TELEPHONE AND ELECTRIC CO. (LTD.).—The directors of this company have declared an interim dividend of 4d. per share, free of tax. Dividend warrants will be posted 31st inst.

STOCK EXCHANGE NOTICE.—Application has been made to the Stock Exchange Committee to appoint a special settling day in, and to grant a quotation to, the further issue of 20,000 6 per Cent. Cumulative Preference £5 shares of the *New General Traction Co. (Ltd.)*, and 16,639 £5 (£3 10s. paid) 5 per Cent. Cumulative Preference shares (Nos. 1 to 16,639) of the *United River Plate Telephone Co. (Ltd.)*.

WEST INDIA AND PANAMA TELEGRAPH CO. (LTD.).—Subject to final audit the directors recommend a dividend, for the six months ended June 30, of 6s. per share on the first and second Preference shares, and 6d. per share on the ordinary shares, free of tax, carrying forward £380.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	1899	£	£		£	£
*Birmingham Tramways.	Oct. 21	4,247	+ 269	16	66,611	+ 7,353
Blackpool Corporation...	„ 19	234	+ 32	29	19,187	+ 4,287
Blackpool and Fleetwood	„ 21	325	+ 83	16	18,633	+ 5,952
Bradford Corporation ...	„ 22	349	+ £4	62	20,536	...
Brisbane Trams	Sept. 6	1,477	+ 564	49	63,379	+18,375
*Bristol Trams & Carriage	Oct. 20	3,061	+ 495	16	50,160	+ 4,773
*Buenos Ayres & Belgrano	Sept.24	2,444	+1,350	38	81,727	+38,430
City & South London Ry.	Oct. 22	1,019	- 5	17	16,233	- 42
Dover Corporation	„ 21	187	+ 3	29	6,617	...
Dublin United	„ 20	2,301	+1,988	...	...	...
Dublin Southern Dist....	„ 20	727	+ 111	...	...	...
*Glasgow Corporation ...	„ 21	9,377	+ 977	...	...	...
*Liverpool Corporation...	„ 14	7,161	+1,348	41	281,677	+31,893
Liverpool Overhead Rly.	„ 22	1,571	+ 195	17	27,636	+ 250
*Sheffield Tramways	„ 22	1,058	+ 770	42	58,413	+16,178
*South Staffs. Trams... .	„ 20	662	+ 23	42	28,033	+ 1,474

* Partly electrical.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Oct. 18.		Price Wednesday, Oct. 25.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Oct. 25. Highest	Lowest
			TELEGRAPHS.					£ s. d.			
£110,800	100	4%	*African Direct Telegraph 4% Mort. Deb. (red.)	100	104	100	104	3 16 11	January and July	...	...
25,000	10	..	Amazon Telegraph	3	4	3	4	...	June and December	...	...
£125,000	100	5%	Do. 5 per Cent. Debentures	85	90	85	90	5 11 1	...	...	...
£875,520	Stock	15/0	Anglo-American	61	64	64	67	4 9 7	Feb., May, Aug., Nov.	65½	64½
£3,062,240	Stock	30/0	Do. Preferred	112½	113½	114⅛	115⅛	5 3 11	„ „	115	113½
£3,062,240	Stock	18/0	Do. Deferred	14½	14¾	16	16⅛	5 9 1	...	16⅜	14⅜
205,993	10	3/0	Brazilian Submarine	14¾	15¼	15	15⅛	4 10 4	Mar., June, Oct., Dec.	15⅜	15 1/16
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1900)	107	111	107	110	4 10 11	June and December	...	...
10,000,000	$100	$1¼	Commercial Cable Capital Stock	185	190	190	190	4 4 3	Jan., Apr., July, Oct.	...	...
£1,385,141	Stock	4%	* Do. 4 per Cent. Debenture Stock	102	104	102	104	3 16 11	„ „	103¾	102¾
16,000	10	8/0	Cuba Submarine Ordinary	9	10	9	10	8 0 0	February and August	...	...
6,000	10	10/0	Do. Preference 10 per Cent.	18½	19½	19	20	5 0 0	„ „	...	...
12,931	5	2/0	Direct Spanish Ordinary	4	5	4	5	4 0 0	April and October	...	...
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference	9	10	9	10	5 0 0	„ „	...	...
£30,000	50	4½%	Do. 4½ per Cent. Debentures	103%	107%	103%	107%	4 4 1	January and July	...	...
60,710	20	3 0	Direct United States Cable	11½	12	11½	12½	5 14 3	Jan., Apr., July, Oct.	12½	11 1/16
£120,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red.)	100	103	101	104	4 7 10	June and December	...	...
£4,000,000	Stock	5%	Eastern Ordinary	145	150	152	157	4 9 2	Jan., Apr., July, Oct.	155	150½
£1,795,000	Stock	3½%	Do. 3½ per Cent. Preference Stock	99	102	99	102	3 8 8	„ „	100	99½
£1,432,288	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.)	118	123	118	123	3 6 0	May and November	121	...
250,000	10	2/8	Eastern Extension	14	14½	14	14½	4 16 7	Jan., Apr., July, Oct.	14⅜	14⅜
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	117	123	117	122	3 6 0	February and August	120	...
£16,200	100	5%	* Do. 5% (Austln. Gov. Sub.) Deb., 1900 (reg.)	99	103	99	103	4 17 4	January and July	...	...
£64,400	100	5%	Do. (Bearer)	100	103	100	103	4 17 1	„ „	...	...
£17,400	100	5%	*Eastern and S. African 5% Mort. Deb., 1900 (reg.)	99	103	99	103	4 17 1	„ „	...	...
£24,500	100	5%	Do. (Bearer)	100	103	100	103	4 17 1	„ „	...	...
£300,000	100	4%	* Do. 4 per Cent. Mortgage Debentures, 1909	101	104	101	104	3 16 11	February and August	...	...
£200,000	25	4%	Do. 4 per Cent. Mauritius Sub. Debs. (red.)	102%	105%	102%	105%	3 15 2	May and November	...	...
180,227	10	4/8	Globe Telegraph and Trust	10½	11½	11	11½	4 11 4	Jan., Apr., July, Oct.	11½	10 5/8
180,042	10	3/0	Do. 6 per Cent. Preference	15	15½	15½	15⅝	3 16 2	„ „	15⅝	15½
150,000	10	5/0	Great Northern of Copenhagen	30	32	29	31	4 0 10	January and July	...	...
£89,500	100	4½%	Halifax & Bermuda Cable 4½ 1st Mort. Deb. red.	100	103	100	103	4 7 5	...	...	...
17,000	25	37/6	Indo-European	48	52	49	53	4 14 4	May and November	...	...
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904	106	109	106	109	5 10 1	March and September	...	...
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.	103	106	103	106	3 15 6	June and December	...	...
11,839	8	4/0	Reuter's	7	8	7	8	5 0 0	April and October	...	...
3,381	£100 Cert.	6%	Submarine Cables Trust	130	135	128	133	4 10 3	„ „	...	...
15,609	10	...	West African Telegraph	2½	3½	2½	3½	4 9 3	December and July	...	...
£200,000	100	5%	* Do. 5 per Cent. Debentures (red.)	99	102	99	102	4 18 0	March and September	...	...
30,008	2½	...	West Coast of America	½	1	½	1	..	...	...	...
£150,000	100	4%	* Do. 4 per Cent. Debentures	102	105	102	105	3 16 8	January and July	...	...
88,321	10	2/8	West India and Panama	1½	1½	1⅜	1⅝	...	May and November	...	...
34,563	10	6/0	Do. 6 per Cent. 1st Preference	10½	10½	10½	10⅝	5 11 6	„ „	...	...
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	8½	9½	8½	9½	6 6 3	„ „	...	...
£80,000	100	5%	* Do. 5 per Cent. Debentures	104	107	104	107	4 14 1	January and July	...	...
£389,731	Stock	4%	Western & Brazilian 4 per Cent. Debenture Stock	104	107	104	107	3 15 0	June and December	...	...
£158,100	100	6%	*Western Union 6 per Cent. Sterling Bonds (red.)	98	103	98	103	5 16 6	March and September	...	...

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Oct. 18.	Price Wednesday, Oct. 25.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Oct. 25. Highest	Lowest
			TELEPHONES.			£ s. d.			
44,000	£5	3/0	Chili Telephone (fully paid)	2½ 3	2 3	6 13 4	August	...	...
224,850	10s.	0/1½	Consolidated Telephone Const. & Manufacturing	⅜ ½	⅜ ½	4 15 3	July	...	...
71,000	1	...	Monte Video Telephone Ordinary	⅛ ⅜	⅛ ⅜	...	October	...	...
84,000	1	...	Do. 5 per Cent. Preference	¾ 1	¾ 1	...	...	...	...
490,000	5	3/0	National	5 5½	5 5½	5 14 3	February and August	5 5/16	5
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Preference	13 14	13 14	4 5 9	,, ,,	...	...
15,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference	13 14	13 14	4 5 9	,, ,,	...	...
250,000	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref.	5⅛ 5⅜	5⅛ 5⅜	4 13 0	,, ,,	5 1/16	...
1,329,471	Stock	3⅛%	* Do. Debenture Stock 3½ per Cent. (red.)	99 102	99 102	3 8 8	June and December	100	...
171,504	1	0/8	Oriental	¾ 1	¾ 1	5 0 0	April and October	...	...
58,000	5	6/0	United River Plate	4⅜ 5⅛	4⅜ 5⅛	5 14 3	July	...	...
£179,947	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	104 107	105 108	4 13 9	June and December	...	...
			ELECTRICITY SUPPLY COMPANIES.						
160,000	1	...	Bl'ckh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (15s. pd.)	¾ 1	¾ 1	...	...	...	...
6,000	10	7/9⅜	Bournemouth and Poole Electricity Supply Ord.	13 13½	13 13½	2 18 5	...	...	...
6,000	10	4/6	Do. 4½ per Cent. Cumulative Preference	10 11	10 11	4 1 10	...	...	...
19,661	5	2/6	Brompton & Kensington Electricity Supply Ord.	7⅛ 8	7⅛ 8⅛	3 10 7	...	...	...
12,000	5	3/6	Do. 7 per Cent. Preference	9 10	9 10	3 10 0	March and September	...	...
20,000	5	...	Calcutta Elec. Supply Ordinary (£4 paid)	5⅜ 6¼	5⅜ 6¼	...	...	6 1/16	...
30,000	5	4/0	Charing Cross & Strand Electricity Supply Corp.	10 11	9½ 10⅛	4 5 9	February & August	10⅛	9½
20,001	5	...	Do. (Nos. 3,001 to 50,000)	...	9½ 10⅛	...	...	9½	...
20,000	5	2/3	Do. 4½ per Cent. Preference	6 6½	6 6½	3 9 3	,, ,,	...	...
£34,000	5	2/6	Chelsea Electricity Supply Ordinary	7⅛ 8⅛	7⅛ 8⅛	3 10 7	March	...	...
£100,000	Stock	4½%	* Do. 4½ per Cent. Debenture Stock (red.)	110 112	110 112	4 1 1	June and December	...	...
$1,200,000	$1,000	5%	Chicago Edison 1st Mort. 5% 30 year Gold Bonds (red.)	100 110	100 110	4 10 11	April and October	...	...
60,000	10	7/0	City of London Electric Lighting Ordinary	11 12	11 12	5 0 0	February and August	11⅛	11
40,000	10	6%	Do. 6 per Cent. Cumulative Preference	12½ 13⅛	12⅜ 13⅛	4 8 11	January and July	13	...
£400,000	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	125 130	125 130	3 17 5	June and December	...	...
40,000	10	...	County of London and Brush Prov. Ordinary	10½ 11½	10½ 11	...	...	...	...
20,000	10	6/0	Do. 6 per Cent. Cumulative Preference	13 14	13 14	4 5 9	March and September	13	...
£200,000	Stock	7/8	Do. 4½% Deb. Stock Certs. (30% to be pd.) (red.)	80 84	81 84	...	...	82½	...
15,000	5	10%	Kensington and Knightsbridge Ordinary	12½ 13½	12½ 13½	4 1 5	...	...	...
10,000	5	6%	Do. 6 per Cent. 1st Preference	7½ 7¾	7½ 7¾	3 17 5	January and July	...	...
110,000	3	...	London Electric Supply Ordinary	3⅜ 4	3⅜ 4	...	...	3⅜	3⅜
48,050	5	3/0	Do. 6 per Cent. Preference	6¼ 6¾	6¼ 6¾	4 8 11	...	6⅜	...
100,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures	105 107	104 106	3 16 4	Mar., June, Sept., Dec.	105	104½
62,500	10	5/0	Metropolitan Elec. Supply Ord. (Nos. 1 to 62,500)	15 16	15 16	3 2 6	April and October	15⅜	15⅜
22,500	10	3/7½	Do. (Nos. 62,501 to 85,000)	14 15	14 15	3 5 10	...	...	...
£120,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage	117 119	117 119	3 15 7	June and December	...	...
6,452	10	6/0	Notting Hill Electric Ordinary	15 16	15 16	3 15 0	March	...	...
10,000	5	5/0	Oxford Electric Ordinary	6¾ 7¼	6¾ 7¼	3 9 0	,,	...	...
300,000	1	8%	Rand Electric	⅜ ½	⅜ ½	10 13 4	...	...	...
£130,070	Stock	5%	River Plate El. Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb.	85 90	85 90	5 11 1	...	...	...
150,000	$100	$2	Royal Electric Company of Montreal Shares	160 180	160 180	4 8 11	...	...	...
123,200	100	4½%	* Do 4½ per Cent. 1st Mortgage Debentures	103 105	103 105	4 5 9	April and October	...	...
31,980	5	5/0	St. James's and Pall Mall Electric Ordinary	16 17	14½ 15⅛	4 13 7	February and August	15⅜	15⅛
20,000	5	3/6	Do. 7 per Cent. Preference	9 10	9 9½	3 13 8	,, ,,	...	...
65,000	5	...	South London Electric Supply Ordinary (£4 paid)	3¾ 4¼	3⅜ 4	...	...	...	...
79,900	5	5/0	Westminster Electric Supply Ordinary	14 15½	14½ 15½	3 17 5	March and September	...	...
			ELECTRIC MANUFACTURING, &c., COMPANIES.						
125,000	1	...	Aron Electricity Meter 6 per Cent. Cum. Pref.	¾ ¾	⅞ 1⅛	...	...	...	...
40,000	5	5/0	British Insulated Wire Ordinary	11 12	11 12	4 3 4	...	...	...
27,500	5	3/0	Do. Preference	6½ 6¾	6½ 6¾	4 8 11	...	...	...
90,000	2	2/0	Brush Electrical Engineering	1⅞ 2	1⅞ 2	4 14 1	September	1 15/16	...
90,000	2	1/2⅞	Do. 6 per Cent. Pref. Non-Cumulative	2⅛ 2⅜	2⅛ 2⅜	5 1 1	,,	2⅜	2⅛
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Deb. Stock	109 113	109 113	3 19 10	February and August	...	...
£50,000	Stock	4½%	* Do. 2nd Debenture Stock (red.)	104 107	104 107	4 4 11	June and December	...	...
£20,000	5	10/0	Callender's Cable Construction Ordinary	13½ 14½	13½ 14½	5 3 5	,, ,,	14	...
20,000	5	...	Do. 5 per Cent. Cumulative Preference	5½ 6	5½ 6	...	...	...	...
£90,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb. (red.)	112 115	112 115	3 18 3	November and May	116	...
300,000	1	0/0½	Castner-Kellner Alkali Co. (fully paid)	1 1⅛	1⅛ 1⅜	5 16 5	...	1⅛	...
60,000	1	0/7½	Chadburn's Ship Telegraph Ordinary	1 1⅛	1 1⅛	...	...	...	...
60,000	1	0/7½	Do. 6 per Cent. Cumulative Preference	1 1⅛	1 1⅛	4 16 0	...	...	...
32,098	3	2/11½	Crompton and Co. (Nos. 1 to 32,098)	3⅛ 4	3⅛ 4	4 10 9	January and July	3⅜	...
£100,000	100	5%	* Do. 5 per Cent. First Mortgage Deb. (red.)	100 103	100 103	4 17 10	,, ,,	...	...
60,000	1	0/3	Davis and Timmins 6 per Cent. Cum. Pref.	¾ 1	¾ 1	...	...	...	...
99,261	5	1/9⅜	Edison and Swan United ("A" Shares) (£3 paid)	2 2⅛	2 2⅛	7 4 0	February and August	...	...
17,139	5	2/9⅜	Do. (£5 paid)	4 5	4 5	6 0 0	,, ,,	...	...
£350,000	Stock	4%	Do. 4 per Cent. Mortgage Deb. Stock (red.)	95 97	95 97	4 2 6	June and December	...	...
26,100	5	5/11⅛	Edmundson's Electric Corporation Ord. (fully pd.)	5 5⅛	5 5⅛	5 9 1	Half-yearly	...	...
112,100	2	1/2⅝	Electric Construction Co. (Limited)	2⅛ 2⅜	2⅛ 2⅜	4 16 10	January and July	...	...
25,000	2	2/9⅜	Do. 7 per Cent. Cumulative Preference	3 3⅛	3 3⅛	4 0 0	July	...	...
182,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	103 106	103 106	3 16 0	January and July	...	...
91,195	1	...	Elmore's Patent Copper Depositing	⅝ ⅝	¼ ½	...	...	...	...
15,000	10	8/0	Henley's Telegraph Works Ordinary	... ...	... ...	...	February and August	...	...
3,000	10	9/4	Do. 7 per Cent. Preference	... ...	... ...	...	,, ,,	...	...
£50,000	Stock	4½%	Do. 4½ per Cent. Mortgage Deb. Stock (red.)	110 113	111 114	3 19 6	,, ,,	...	...
50,000	10	5/0	India Rubber, Gutta Percha, &c., Works	21 22	21 22	4 8 11	,, ,,	21⅝	21 1/16
300,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	100 104	100 104	3 16 11	March and September	...	...
7,350	12	12/0	Telegraph Construction and Maintenance	37 41	37 41	4 8 3	March and July	39	37½
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909	103 106	103 106	3 15 6	...	...	...
£20,000	5	4/5⅜	Do. Manufacturing Ordinary	9⅛ 9⅜	9⅛ 9⅜	4 2 1	...	9⅜	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5⅛ 6	5⅛ 6	4 3 4	...	...	...
£30,000	5	5/0	Willans and Robinson Ordinary	10⅛ 11	10⅛ 11	4 1 10	April and October	...	...
£30,000	5	3/0	Do. 6 per Cent. Cumulative Preference	7 7⅛	7 7⅛	4 0 0	,, ,,	...	...
£100,000	Stock	4¼%	Do. 4¼ per Cent. 1st Mortgage Debentures	106 108	106 108	3 18 8	May and November	...	...
			ELECTRIC RAILWAYS, TRAMWAYS, &c.						
12,000	10	6/0	Blackpool and Fleetwood Tramways	19 21	19 21	3 16 2	...	...	...
167,900	100	5%	Brisbane Tramway 5 per Cent. Debentures	106 108	104 106	4 14 4	...	...	...
50,000	10	7%	† Bristol Tramways and Carriage Ordinary	23 24	23 24	2 17 2	February and August	...	...
25,000	10	...	† Do. Cumulative Preference (£4 paid)	4⅜ 4⅝	4⅜ 4⅝	...	...	...	...
£100,000	Stock	4%	† Do. 4 per Cent. Debentures	118 119	118 119	3 7 3	...	...	...
30,000	10	9/0	British Electric Traction Ordinary	17 18	16½ 17½	6 0 0	...	...	...
30,000	10	6/0	Do. 6% Cum. Pref. (Nos. 30,001 to 60,000)	13⅞ 14⅛	13⅞ 14	4 5 9	...	14 1/16	...
£200,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures	125 128	125 128	3 18 2	...	128	...
40,000	5	1/9	Buenos Ayres & Belgrano 6% "A" Cum. Pref.	4⅛ 5⅛	5⅛ 5⅛	5 9 1	...	5⅜	5 3/16
27,500	5	...	Do. "B"	5⅛ 5⅜	5⅛ 5⅜	...	...	5 1/16	5⅛
265,585	Stock	5%	Do. 5 per Cent. Debentures	108 111	108 111	4 10 1	...	...	...
£35,250	10	3/0	Central London Ordinary	10 10⅛	10 10½	2 17 4	June and December	10⅜	10 1/16
178,303	10	2/4 1/16	Do.	... ...	... ...	...	,, ,,	...	...
£630,000	Stock	2½%	City and South London Railway Con. Ordinary	63 66	63 66	3 4 6	January and July	63½	...
22,500	10	...	Do. Ordinary (Nos. 1 to 22,500) (fully paid)	6⅛ 6¾	6⅛ 6¾	...	...	...	...
37,000	10	...	Do. (Nos. 22,501 to 60,000) (£4. 10s. paid)	3⅛ 4⅛	3⅛ 4⅛	...	...	...	...
15,000	10	5%	Do. 5 per Cent. Perpetual Preference (1891)	14 15	14 15	3 6 8	January and July	...	...
20,000	10	5%	Do. (1896)	13⅛ 14⅛	13⅛ 14⅛	...	...	...	...
187,701	Stock	4%	Do. 4 per Cent. Perpetual Debenture	132 134	132 134	2 19 9	May and November	...	...
20,000	10	7⅛%	Imperial Tramways Ordinary	... ...	... ...	...	March and September	...	...
10,000	10	6%	Do. 6 per Cent. Preference	15½ 16	15⅛ 15⅝	3 13 10	,, ,,	15⅝	15½
£200,000	Stock	4½%	Do. 4½ per Cent. Debenture	114 115	114 115	3 18 6	January and July	...	...
37,500	10	2½%	Liverpool Overhead Railway Ordinary	8⅛ 8⅜	8⅜ 8⅝	3 12 9	February and August	...	...
10,000	10	5%	Do. 5 per Cent. Preference	13⅛ 13½	13⅜ 13¾	3 12 9	,, ,,	...	...
125,000	Stock	4%	Do. 4 per Cent. Debenture	104 106	104 106	3 16 4	January and July	...	...
24,000	5	...	New General Traction Ordinary	3⅝ 4⅛	3⅝ 4⅛	...	...	...	...
30,000	5	6/0	Do. 6 per Cent. Cumulative Preference	5 5⅛	5 5⅛	5 9 1	May	5⅛	...
13,334	10	...	Potteries Electric Traction Ordinary	13½ 14⅛	13 14	...	...	15⅜	...
20,000	10	5/10	Do. 5 per Cent. Cumulative Preference	10⅛ 11	10½ 11	4 10 11	...	...	...
540,000	Stock	3%	Waterloo and City Ordinary	100 103	101 104	2 18	June and December	101½	101

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

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THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,120. [No. 2. Vol. XLIV.] FRIDAY, NOVEMBER 3, 1899. PRICE SIXPENCE (by post, 6½d.), Abroad, 8d., or 15 cents, or 80 fr., or 70 pf.

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NOTES.

WHILE the Press was commenting upon the news of the first serious engagement in South Africa, the reading public experienced some natural misgiving as to whether its notification in so short a time was within the range of practical telegraphy. As a matter of fact, the telegrams had to be conveyed a distance of 10,000 miles, which comprises the more or less mountainous but always wild country between Glencoe and the base of the army. Thence the message followed the Government land lines to Durban Bay, where it was taken up by the cable and re-transmitted by way of Zanzibar, Aden, Egypt, and the Mediterranean to London. The first part of this distance was of course accomplished by the military field telegraph to Glencoe. Looking to the fact that the messages passed through so many hands and different systems of telegraphy, one is amazed at the regularity, accuracy, and precision of the transmission, especially when we remember that the earlier descriptions of the battle were being eagerly read and discussed in the City of London before its later stages had become part of the events of the day. In other words, the Government dispatch dated 8.40 a.m., and many later messages, were published in the London Press some hours earlier than 1:30 p.m., by which time the engagement was stated to have finished. It must be borne in mind, however, that part of this, to the uninitiated almost impossible feat, was due to the difference of time, which in the case of Ladysmith is between one and a half and two hours ahead of that of Greenwich, leaving that amount of margin in favour of England.

To reduce this to practical figures, it may be said that the first official news from the actual scene of hostilities occupied less than an hour in transit, and that the public interest in its later stages was fed steadily and unceasingly by later details which came through with equal expedition. It should be stated that military censors were placed at various intermediate points, to hold or forward, at their discretion, such news as it might appear desirable to them should be made public. If, therefore, occasional discrepancies have been observed in the times of dispatch and receipt of private or Press messages, it would be well for the public to form their judgment as to what the telegraph companies are capable of doing by the speed shown in the case of the earlier official telegrams, rather than by those which may have been detained in the way stated. To accomplish what has been done, it need hardly be said that the staff of the company has been occupied without cessation day and night, and that probably as many as 30,000 words in one day have been transmitted from the scene of action and delivered to various recipients in Europe. It is no matter for surprise that this enormous volume of traffic, which had to be transmitted over long submarine cables, necessarily resulted in some congestion, and that the interruption last Tuesday of the east coast cable compelled the placing of a limit to the length of Press messages over the west coast cable. The restoration of the east coast route by to-morrow is, however, confidently anticipated, as the repairing ship is almost on the spot, and then the demands of the public will no doubt be met with the customary promptitude.

THERE have been different interpretations of certain of the Board of Trade Regulations (under the Electric Lighting Acts of 1882 and 1888) for Securing the Safety of the Public and for Ensuring a Proper and Sufficient Supply of Electrical Energy. The two main points on which there has been difference of opinion were not of much moment at the time the regulations were framed, but now they have become of considerable importance, in view of the recent trend of electric supply practice. One of these is the question whether a "declared" pressure of 250 volts (variable to the extent of

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4 per cent. according to regulation B7) is permissible. We have no hesitation in asserting that the Board of Trade, when it fixed that "the pressure of the supply to any consumer shall not exceed 250 volts at any pair of terminals, except with the express approval of the Board of Trade," intended this figure to be literally the maximum, so that a supply station engineer who wishes to profit by the 4 per cent. margin should fix his "declared pressure" no higher than 240 volts. The Glasgow Corporation, we are aware, supplies at 250 volts; and we can only conclude that their electrical engineer either never allows the pressure within a consumer's premises to exceed this figure, or that he has obtained the express approval of the Board of Trade, or (as a third possibility) he is acting at his own risk should accident arise or his authority be questioned.

THE other question of interest is whether, with regard to the definition of high pressure as that exceeding 500 volts continuous or 250 volts alternating, a pressure not exceeding 250 volts alternating may be brought into a house from one side of an earthed three-wire system. Many engineers have considered that a 2×220 volts alternating-current three-wire system comes within the category of high-pressure supply. This is correct so far as the regulations concerning the mains and distribution network are concerned; but the distribution from two service cables, one connected to the outer and one to the middle wire, is low pressure so long as the other outer wire is not led into the house. If, however, the middle wire were not earthed, this would not be permissible, as then there would be a possible difference of potential of over 250 volts between one terminal and earth. Those who argue, therefore, that in this respect alternating current is placed at an unfair disadvantage by the Board of Trade regulations, interpret them wrongly.

THE offer of the Isle of Man Electric Tramways and Power Co. to supply electrical energy on a wholesale basis to the town of Douglas was referred to in our last issue. On the recommendation of Prof. FLEMING the Town Council refused the offer, and in another column will be found a digest of Prof. FLEMING'S report. On the main point, viz., that of cost, it would appear that Prof. FLEMING is right in saying that 3d. to 3½d. is too much to pay per Board of Trade unit of electrical energy when the cost of mains and distribution would fall on the municipality and not upon the company. The first part of Prof. FLEMING'S report, however, is likely to excite some adverse comment. Although subsequently characterising it as a not very serious objection, he devotes a whole paragraph of his report to explaining his objection to a declared pressure of 230 volts. He states that it is difficult, if not impossible, to obtain good lamps of a smaller size than 16 c.p. to work at that pressure, and that the small consumer would be largely prevented from using 5 and 8 c.p. lamps. We cannot think that this view is shared by many supply station engineers or consultants. Since the introduction of the higher pressure great progress has been made in lamp manufacture, and if it were impossible to obtain 200–240 volt 8 c.p. lamps which give satisfaction, we do not think that the gradual change from 110 to 220 volts throughout the country would continue. 230 volts happens to be the very pressure recommended by Prof. KENNEDY in his more recent stations, and similar voltages have been adopted in several provincial towns where there are possibly as many 8 c.p. as 16 c.p. lamps connected to the mains. We have recently seen several examples of 5 c.p. and 6 c.p. 200-volt lamps, although they may not yet be generally successful; and it might be interesting if not only supply station engineers, but also contractors and consumers, would place their recent experience with these lamps on record.

IT is taking the average householder a long time to realise that in replacing gas by electric light he has materially diminished the risk of fire on his property. No doubt the fire insurance offices, when they issued their pages of "rules and regulations" at the inception of electrical illumination, did it with a view to disabusing the minds of their policy-holders of the idea that the new illuminant was any safer than the old, for fear a reduction in premiums should be demanded. The writer of a letter to a local contemporary suggests that the vestries, or what will shortly be called the municipalities, of London should inaugurate a movement to compel fire insurance companies to reduce their premiums upon all kinds of property on which electric light has been installed. But surely the ratepayer has not already become so childishly helpless that he must needs call in the local authority to help him in his private business matters. We have consistently held that premiums should be reduced in the case of electrically lighted buildings which have been properly wired, and we believe that one fire office at least has already taken this step. If every owner of a building refused to take out a policy with an office who will not grant the relief in question, the insurance companies' recognition of the safety of electric light would soon take the desired form.

MR. RAWORTH'S Paper, read last Saturday before the Manchester Association of Engineers, was admirably suited to his audience. It did not give merely a list of the advantages of electric driving for workshops and the usual general statements in favour of its adoption, but, in addition, put everything clearly on the commercial basis of pounds, shillings, and pence. His hearers were probably to a large extent mechanical engineers and mill-owners, and could appreciate the practical way in which Mr. RAWORTH stated his case, whereas they might not have troubled to follow equally ingenious reasoning based on the units kilowatt and kilowatt-hour. The Paper might have been more interesting to electrical engineers had it dealt with the relative merits of three-phase and continuous-current distribution, considered more of the technical side of the question, and enumerated the effects of the power-factor, load-factor, and various other factors which have recently been suggested; but this would have been wasted on the majority of his audience, and would have made them less attentive to that part of the Paper whose significance they could grasp.

AFTER a stormy meeting, the Poplar District Board of Works recently decided by a majority of 23 votes to 16 that the electrical engineer should have complete control of his

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staff. That such a resolution should have been necessary at all is remarkable, that 16 men possessing a fair share of common sense should have voted against it is still more remarkable, but strangest of all is that the Electrical Committee, who recommended the resolution, only decided to do so by the casting vote of their chairman. The wording of the resolution was that "the electrical engineer have power to dismiss any member of his staff, and that all appointments thereto be made on that condition"; and according to the amendment which was thrown out, he was, so far as the salaried staff were concerned, to be allowed to suspend only and not to dismiss. Resident engineers have themselves to blame if they submit to such treatment. However anxious he may be to obtain an appointment, a resident engineer should only accept it on the understanding that he shall not be interfered with in the management of his staff. To take up such a position from the outset would distinctly raise his *prestige* for firmness and decision in the eyes of his prospective employers, and not only make it easier for him in the future, but increase rather than lessen his chance of obtaining the coveted berth.

It may occasion some little disappointment in the electrical world that the compliment was not paid to Lord Kelvin of electing him Rector of Glasgow University. Lord Kelvin's association with that seat of learning has been a long and distinguished one, and it is but natural that a large number of the students should desire to show him their gratitude by electing him to a post of honour. On the other hand, students are young, notoriously patriotic, and influenced more than their elders by excitement of the moment. It is no matter for wonder, therefore, that the bold way in which Lord Rosebery declared his imperialistic opinions, in the face of the contrary views held by his former associates, should have raised the student mind to such a pitch of enthusiasm that the majority of them were for the time oblivious of the fact that Lord Kelvin's views are probably as imperialistic as those of Lord Rosebery, and of his more lasting services not only to his university and to his country, but also to all humanity.

The Berlin Technical College.—The Royal "Technische Hochschule," of Berlin, celebrated the one hundredth anniversary of its foundation on the 18th to 21st of last month.

Institution of Electrical Engineers—Annual Dinner.—We learn from the secretary that the annual dinner of the Institution of Electrical Engineers will be held in the Grand Hall of the Hotel Cecil, on Wednesday, December 6th.

Wireless Telegraphy in South Africa.—With reference to the note in our last issue under this heading, the instruments and operators mentioned left Liverpool for Cape Town yesterday. In addition to the five assistants of the Wireless Telegraph and Signal Co., the Government also sent an engineer.

"Album Elettricisti."—We have received from the publishers of *Elettricità* of Milan an album issued in connection with the Volta centenary, and containing a number of photographs of distinguished men in the electrical world. Some of these photographs are exceedingly well and others less well reproduced.

Russian Government and the Telephone.—At present the telephone in St. Petersburg is being worked by the Bell Telephone Co. This company's concession will shortly expire, and the Russian Government has expressed its determination to take over the management of the telephone on the expiry of the concession.

Polyphase Motor Patents.—In the Eastern District Court of Pennsylvania the Tesla Electric Co. has been successful in an action brought against Messrs. Scott and Janney for infringing the Tesla patents Nos. 511,915 and 555,190, which are fundamental patents relating to polyphase motors, and are now owned by the Westinghouse Electric Co.

Cable Interruptions and Repairs:—

	Date of Interruption.	Date of Repair.
Latakia—Cyprus	June 21, 1899 ...	—
Cayenne—Pinhieros	Oct. 11, 1899 ...	—
Para—Maranham	Oct. 20, 1899 ...	Oct. 28, 1899
Zanzibar—Mombassa	Oct. 27, 1899 ...	—
Lorenzo Marques—Mozambique	Oct. 31, 1899 ...	—

War Telegrams on Sundays.—The Postmaster-General has undertaken, until further notice, to forward to every telegraph office in the country open for delivery of telegrams on Sunday mornings any important news from the seat of war which may be received from the War Office up till 1 a.m. on Sunday morning. The messages are to be exhibited in the window or in some other prominent position, so that the public may be kept informed of the progress of military operations.

The Manchester Society of Junior Electrical Engineers.—A general meeting of this society was held at the Deansgate Hotel, Manchester, on Tuesday evening last, under the presidency of Mr. W. W. Haldane Gee. A Paper was read by Mr. S. Payne on "Condensers and Condensing as applied to Electric Light Stations," and a discussion followed. The next meeting of the society will be held on Tuesday, November 28, when a Paper will be read by Mr. J. H. Henderson on "Aluminium: its Treatment and Use, as applied to Electrical Engineering."

Electric Traction on the Erie Canal.—It has been reported in New York that the executive committee of the Erie Canal Electric Traction Co. has adopted the storage battery system for use as its motive power, subject to the approval of the Superintendent of Public Works. We read in the *Electrical Review* that the method of operation will be as follows:—"An electric traction engine will run along the towpath of the canal. It will tow a canal boat filled with storage batteries of sufficient capacity to furnish current for the traction engine and for a reasonable number of canal boats with cargoes towed behind the battery boat."

The Metropolitan Electric Supply Co.'s New Station.—Trial runs of the engines at the new station at Willesden took place last week, and the only trouble experienced was hot bearings. This has now been rectified, and the machines made a successful trial run at full speed yesterday. It is expected that they will be running on the load by the middle of next week. We hope that the delay will not be longer, for much dissatisfaction is being expressed by those consumers who are deliberately switched off during the time of heaviest load to prevent overloading and consequent drop of pressure at the Manchester-square station.

Obituary.—We announced in our issue of Oct. 20 the departure of Lieut.-Colonel the Hon. A. E. Wrottesley, R.E., superintending engineer for the Southern District Postal Telegraphs, to join the troops in South Africa. He joined his regiment and embarked at Southampton on Oct. 21, and on Oct. 27 was, we regret to say, drowned off Teneriffe. Lieut.-Colonel Wrottesley had only just been gazetted Director of Telegraphs under Sir Redvers Buller, commander-in-chief in South Africa. He was a son of Lord Wrottesley, and was born on Dec. 29, 1855. He was an accomplished electrical engineer, and his early death is much regretted in the service.

Civil and Mechanical Engineers' Society.—The 1899-1900 session was opened yesterday, when Mr. G. A. Burls read "A Short Account of Some Modern Steam Waggons." Seven other meetings have been arranged for the session, and all will be held on Thursdays, at 8 p m. in the "Dublin Room" of the Hotel Victoria, Northumberland-avenue, S.W. Among the Papers are "Graphical Solutions of Certain Problems in Engineering," by F. H. Hummel; "Ventilation of Large Buildings," by M. O'Gorman; and "Fly-wheel Accidents," by Prof. A. Sharp. The President of the Society is Mr. B. Baines Dadley, and the Vice-Presidents Mr. W. M. Binny and Mr. W. N. Twelvetrees. Mr. A. S. E. Ackermann is hon. sec.

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Personal.—Mr. Gibbings, city electrical engineer of Bradford, has for some time past been in negotiation with the Southend-on-Sea Corporation to take over their provisional order, and with the Cleckheaton District Council to act as their consulting engineer. The former matter is still in abeyance, but Mr. Gibbings has accepted the latter appointment, and has sent in his resignation to the Bradford Electricity Committee. The Bradford Corporation will no doubt be sorry to lose Mr. Gibbings, who has held his present position for four years. He was one of the pioneers of the 220-volt supply movement, successfully completing the work initiated by Mr. S. W. Baynes, of converting the Bradford supply network from a 2 × 115-volt to a 2 × 230-volt three-wire system.

South African Telegrams.—The Eastern Telegraph Company give notice that the cable between Delagoa Bay and Mozambique, on the East Coast of Africa, became interrupted on Tuesday morning last; but telegraphic communication with South Africa is maintained by the cables on the West Coast of Africa, which are working well. In order that all war correspondents may be able to have their telegrams forwarded, the number of words handed in daily by each correspondent is to be so limited that the capacity of the cable during every 24 hours shall not be exceeded. The cable-ship "Great Northern" is due at Delagoa Bay to-day (Friday), and the company is endeavouring to send her instructions to stop at the position of the break in the cable, so that no time may be lost in putting the line through.

Mr. Marconi and the United States Government.—The United States Navy Department has ordered a board of four officers to inspect and report upon the availability of Marconi's system of wireless telegraphy for signalling purposes aboard ship and between vessels and the shore. The *Electrical Review* of New York understands that Mr. Marconi wants the Government to pay him $1,000,000 for the unlimited use of his apparatus, or to pay $500 for each set of his instruments and $500 per year royalty on each set. Our contemporary does not believe, however, that the Government will pay any such prices for Marconi's apparatus, and states that it is rumoured that negotiations are in progress with another European inventor who has produced similar apparatus, which can be secured at a much more reasonable figure. We can obtain no confirmation of this report.

The Institution Visit to Switzerland.—We have been asked to reprint the following circular, which is being sent round to those who took part in the Institution visit to Switzerland last September:—

By kind permission of the Council of the Institution, an exhibition of photographs, taken by members during the recent visit to Switzerland, will be held in the library at the offices of the Institution, from Tuesday the 5th to Tuesday the 12th of December inclusive. A committee has been formed to carry out the exhibition, and all members who are willing to do so are requested to forward prints. Photographs should be mounted in a manner suitable for exhibition, and subjects should where possible be named: in the case of small photographs it would assist the committee if each exhibitor mounted as many as possible on one mount; owing to the exigencies of space, framed photographs are undesirable. The committee would also be obliged if members would at the same time express their willingness to lend at a later date the negatives of any of their pictures which may be selected for reproduction in albums for presentation to the Institution library, to the President and to the Secretary of the Institution. It is also proposed to enable members to obtain copies either of these albums or of such photographs as they may wish to obtain. A number of members have already expressed their willingness to send photographs, to lend such negatives as are required, and to defray the expense of the exhibition. The committee feel that, as possibly all members who took part in the visit would like to join in the presentation of the albums, the best plan will be to open a subscription for this purpose; subscriptions are limited to five shillings. In order to give as much time as possible for the preparation of the exhibition, the committee would be much obliged if members willing to send photographs would forward them as soon as possible; these, and subscriptions for the presentation albums, can be sent to Mr. R. S. Erskine, 22, Stanford-road, Kensington, London, W.

The members of the committee who are organising this exhibition are Messrs. R. E. Crompton, G. L. Addenbrooke, C. W. S. Crawley, R. S. Erskine, W. P. J. Fawcus, W. C. Mountain, Prof. J. Perry, J. Raworth, and A. A. C. Swinton.

Electrolysis from Tramway Circuits.—Mr. W. S. Wynkoop read a Paper on this subject before the sixth annual convention, at Toronto, of the American Society for Municipal Improvements, on October 3rd, referring more particularly to the conditions existing in Brooklyn. In that city there are some 600 miles of single track, six power houses, and an average of 1,900 cars in daily operation. Underground there are gas and water pipes, railway tracks, Edison tubes, cement-lined iron subway ducts, earthenware subways containing lead-covered cable, and supplementary wires and bundles of old rails used as earth returns. In addition, the structure of the elevated railway is bonded to the track which it supports. All these conductors, says the author, are jumbled together, forming an irregular network through which the stray electricity is dodging hither and thither. In earlier days the most generally accepted method of dealing with electrolysis was to attach a bond wire to the damaged spot, and Mr. Wynkoop states that by means of these bonds some of the companies concerned are caring for stray currents ranging between 20 and 80 amperes. Each of these companies or corporations has its own expert and its own remedies, regardless of the effect on its neighbours. The cast iron water pipes belonging to the city and the cast iron pipes of the gas company have enjoyed immunity from electrolysis. These pipes consist of a very hard, dense, heavy-grained, white cast iron containing alloyed rather than combined carbon, and coated with some variety of asphaltic varnish. On the other hand, the wrought iron and steel service pipes in the gas system have been attacked, and the company is suffering from an abnormal leakage of gas. The cast iron coupling boxes of the Edison Electric Illuminating Co. have also been badly corroded in places. Singular expedients have been resorted to in order to secure relief from electrolysis In one case a pipe had been carried across the street to avoid near approach to the rails. In other instances heavy rubber hose had been slipped over the lead service lines in places where electrolytic trouble had been experienced. The electrical remedies, the author states, have thus far failed. An improved track return was a palliative, but not a cure. Nor have inter-bonding, the application of an auxiliary potential, or the insertion of insulating sections of pipe along the pipe lines fulfilled anticipations, and all up to the present have only afforded a temporary and not a permanent relief. The author concludes that the problem must be attacked from the standpoint of chemistry. Such disastrous consequences as these need not be anticipated in this country, where sufficiently strict Board of Trade regulations as to insulated returns and earthed returns have been enforced from the outset.

MEETINGS OF SCIENTIFIC AND ENGINEERING SOCIETIES, &c.

(To-day) FRIDAY, November 3rd.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.

7:30 p.m. The First General Meeting of the Session, in the Lecture Hall of the Literary and Philosophical Society, Westgate-road, Newcastle-on-Tyne.

INSTITUTION OF JUNIOR ENGINEERS.

8 p.m. Meeting at the Westminster Palace Hotel, when the Hon. C. A. Parsons, F.R.S., will deliver his Presidential Address.

MONDAY, November 6th.

ROYAL INSTITUTION.

5 p.m. General Monthly Meeting.

SOCIETY OF ENGINEERS.

7:30 p.m. Ordinary Meeting at the Royal United Service Institution, Whitehall. Paper to be read: "The Electrolytic Treatment of Complex Sulphide Ores," by Sherard Cowper-Coles.

SOCIETY OF CHEMICAL INDUSTRY.

8 p.m. Meeting in the Chemical Society's Rooms, Burlington House, Piccadilly, when the following Paper will be read: "On 'Velril' Material, a New Substitute for India-Rubber and Gutta-Percha," by Walter F. Reid.

TUESDAY, November 7th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Presidential Address by Sir Douglas Fox, President, and Presentation of Medals and Prizes awarded by the Council.

FRIDAY, November 10th.

PHYSICAL SOCIETY.

5 p.m. Meeting in the Physical Laboratory of the Central Technical College, Exhibition-road, South Kensington. Agenda: (1) "Contact Electricity," by F. S. Spiers; (2) "On the Heat of Formation of Alloys," by J. B. Tayler.

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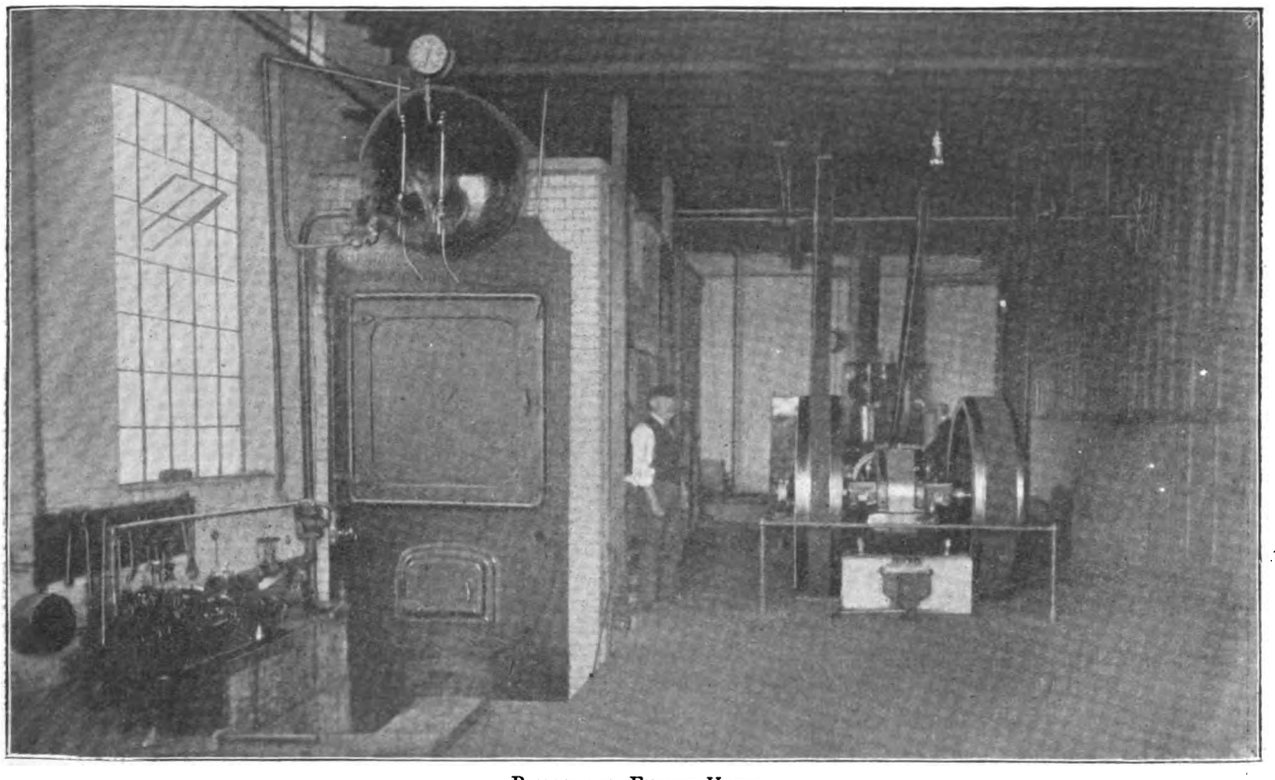
BERRENBERG INCANDESCENT LAMP FACTORY.

One of the essential operations in the manufacture of an incandescent electric lamp is the production of a good vacuum in the glass bulb. This vacuum is required not only for the preservation of the carbon filament from combustion, but also in order that the luminous efficiency of the lamp may be as high as possible. It is therefore necessary that the vacuum should be as perfect as possible from the point of view of the *degree* of exhaustion; and it is further important that the chemical properties of the residual gas should not injuriously affect either the filament or the inside surface of the glass bulb.

Broadly speaking, there are two methods of producing a vacuum for an incandescent lamp bulb or any similar piece of apparatus. These are: First, the mechanical pump, which by means of a cylinder and piston and an arrangement of valves sucks the air from the enclosed space in which the vacuum is required. Secondly, the automatic Sprengel pump, worked either by falling mercury or water, by means of which the air is drawn out of the enclosed space between the falling drops of liquid. The second method is that which has been most commonly adopted by manufacturers of incandescent electric lamps; in fact, it is to Mr. Berrenberg that the successful introduction of the mechanical method of exhaustion is to be attributed. The objection generally raised against the mechanical pump is that it cannot produce so high a degree of exhaustion as that obtainable by means of the Sprengel pump. This defect arises from the continual leakage of air inwardly through the valves and joints of the pump and connected pipes. On the other hand, there is a decided objection to the Sprengel pump method of exhausting glow lamps—*i.e.*, that the vapour of the fluid used, whether mercury or water, must necessarily pervade the resulting vacuum. Mercury is, of course, the fluid always used in commerce, and the vapour of mercury is found to be very prejudicial to the good working of a glow lamp. The effect of mercury vapour appears to be to transfer carbon from the filament to the inner surface of the glass bulb. This process gradually renders the bulb opaque, thus slowly deteriorating the efficiency of the lamp. It is not, however, absolutely certain that this effect is entirely due to the mercury vapour, and, as is well known, the best firms of glow lamp manufacturers are able to produce lamps exhausted by mercury pumps which exhibit very little blackening in ordinary commercial use.

As already stated, Mr. Berrenberg has attacked the problem of lamp exhaustion from the mechanical pump point of view, and he has overcome in an extraordinarily high degree the objection we have already mentioned—*i.e.*, the leakage inwards of air through the valves and joints. The method adopted to prevent this inward leakage is very ingenious. It consists in surrounding the parts liable to produce leakage by a vacuum jacket, which is maintained by another pump capable of producing what is called a rough vacuum. Our readers have been made acquainted from time to time with the gradual development of the Berrenberg process, and they must have noted with what persistence this inventor has attacked and overcome the many difficulties involved in the commercial development of the method and has brought his system to commercial success.

The process is so far perfected that the Berrenberg Electric Lamp Syndicate (Limited) have felt themselves justified in erecting extensive works for the manufacture of glow lamps by the Berrenberg process. A brief description of these works, together with the accompanying illustrations, will enable our readers to judge of the present position of this interesting undertaking.



Boiler and Engine House.

Approaching the works, whether from the railway side or from the road frontage, a visitor has an opportunity of judging, from the large area covered by these works, that the syndicate anticipates an early output on a very extensive scale. The works are, indeed, capable of turning out a maximum of 40,000 lamps per week. Entering at the main frontage and passing through the various offices, we arrive at the engine and boiler room, which is equipped with a water-tube boiler driving a 100 H.P. horizontal steam engine coupled from one flywheel to the works main shaft and from another flywheel to the dynamo generating electric current for the testing, flashing, and other operations. This engine house is shown in one of our illustrations. The overhead shaft passes through a partition into another spacious and well-lighted

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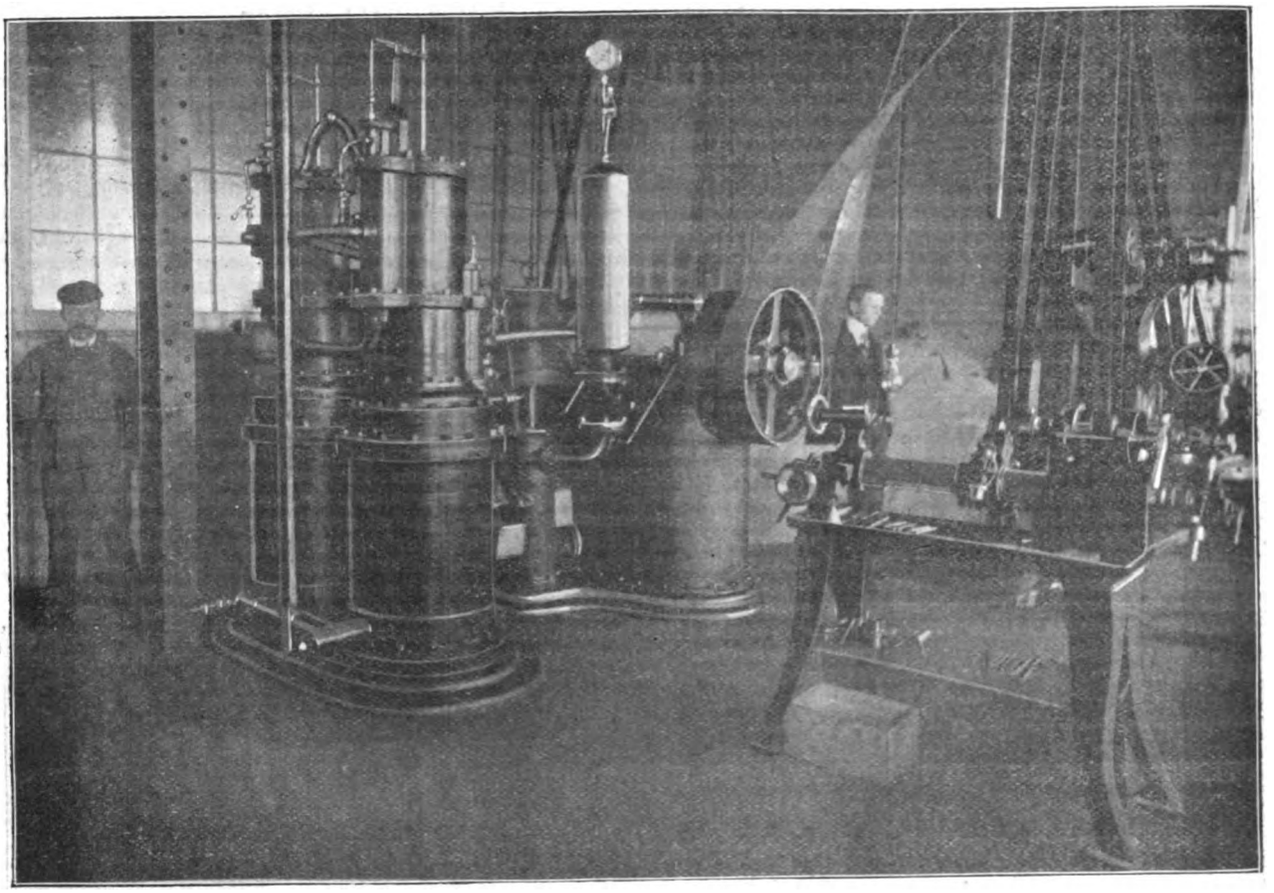
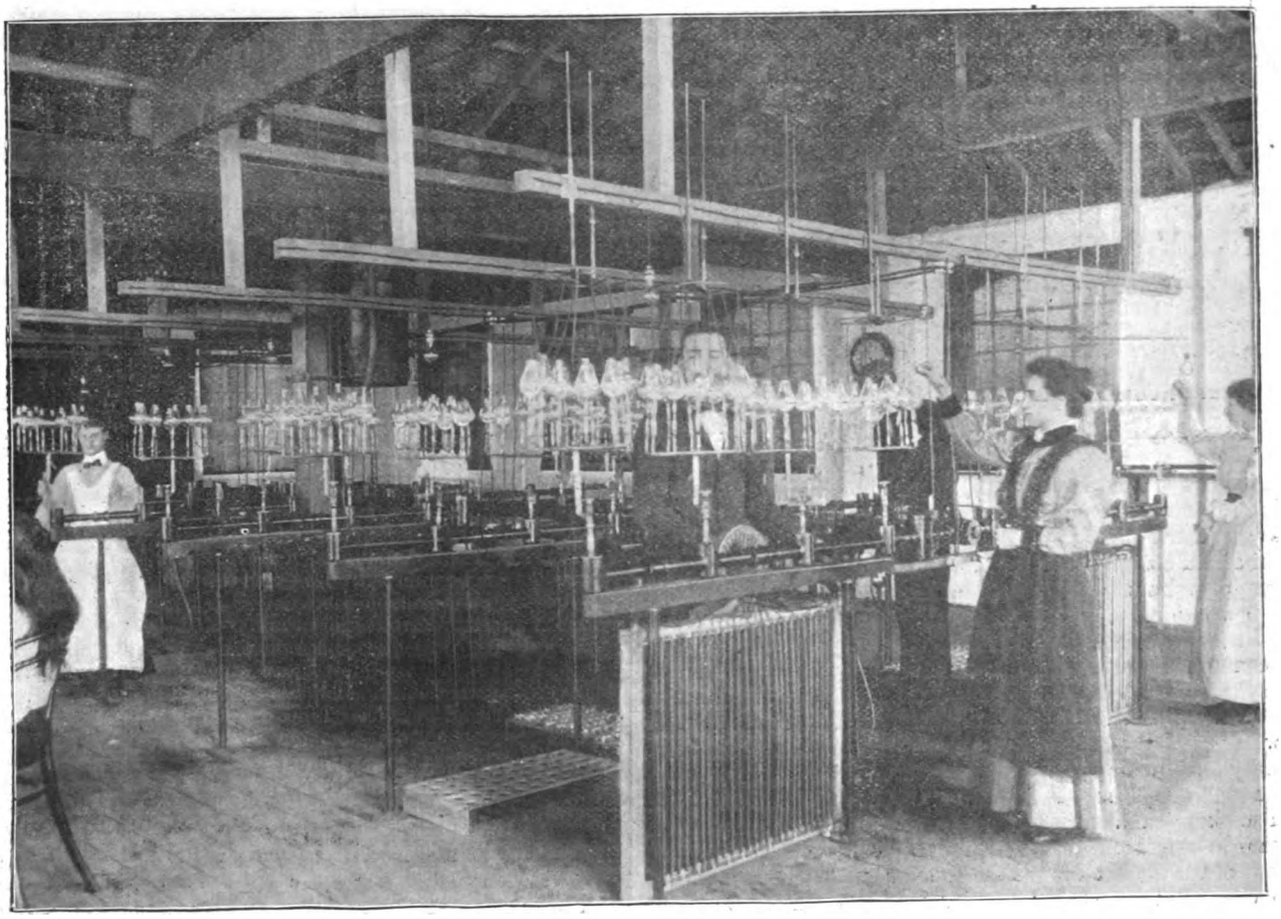


PUMP ROOM AND WORKSHOP.



LAMP EXHAUSTING AND SEALING DEPARTMENT

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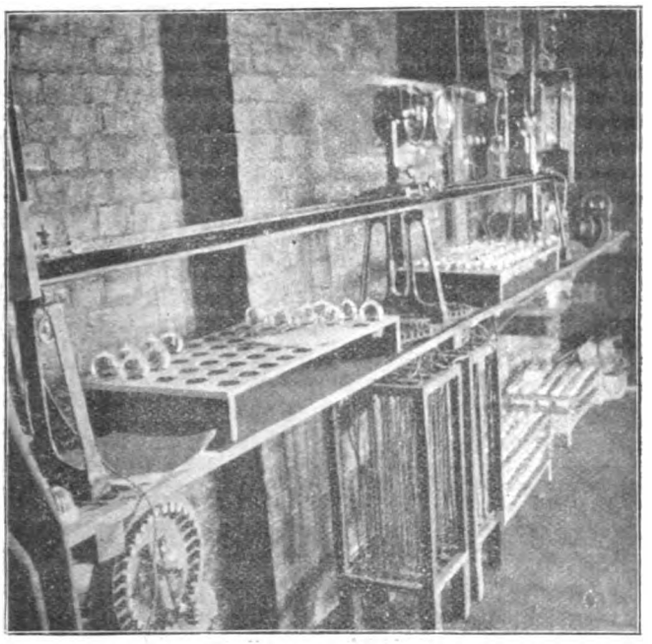
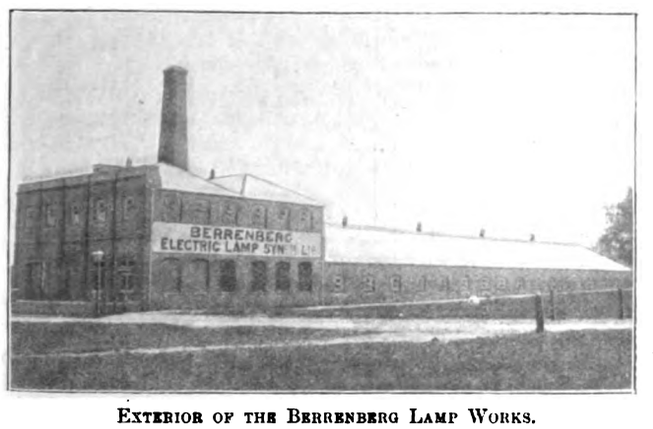
shop containing the exhausting pumps, together with the machine tools for effecting repairs, &c. A portion of this shop, with one of the pumps, is shown in another illustration. These pumps, our readers will remember (see *The Electrician*, Vol. XXXVI., p. 417), produce two degrees of vacuum—*i.e.*, the rough vacuum and the finishing vacuum—all the valves and joints in the pumping apparatus being vacuum jacketed. From the pump room a system of pipes distributes vacuum throughout the works to the shops where the bulbs are exhausted and the lamps are finished, tested, &c. Similarly a system of electric mains conveys current at different pressures from the engine-house dynamo to all the shops where current is required.



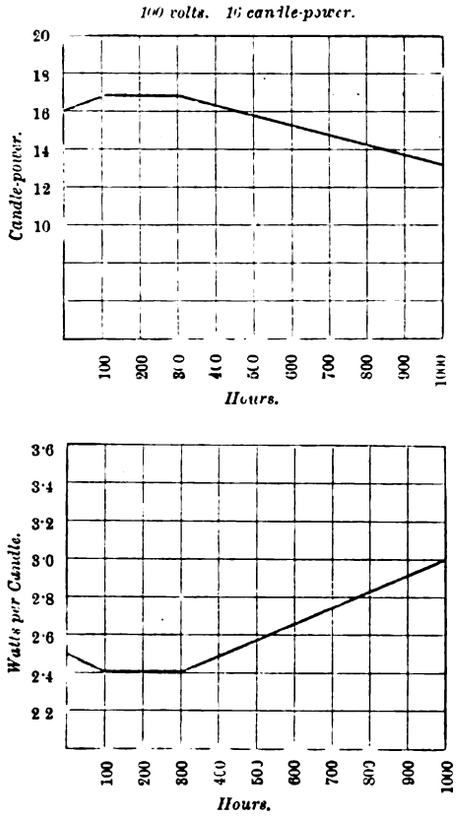
THE PHOTOMETER ROOM.

From the pump room we may now pass to the department where the bulbs, already fused on to the connecting glass stems and fitted with filaments, are exhausted. The illustration of this department shows that the method of pumping consists in mounting the bulbs in a group to be connected by glass tubes to one common stem, which is connected to the pump main pipe. The lamps in process of manufacture are thus arranged in groups of 12, in the manner shown in the illustration, and attendants at each set of lamps adjust the vacuum and flash the filament until the proper degree of exhaustion has been arrived at and all the air has been expelled from the filament. An indicator is attached to each group of lamps to show when the proper exhaustion has been attained. The electric current is then gradually raised over the normal voltage for a short time until the filament is momentarily raised to very much more than its normal candle-power. Thus a 16-c.p. lamp will momentarily be flashed up as high as 150 c.p. The purpose of this is twofold—firstly, to drive out any residual gas that the filament may have tenaciously retained; and secondly, to show up any latent defect in the filament itself. The lamps which pass this severe test are duly sealed by means of a blowpipe and removed from the stand. The simple operation of putting on the caps really completes the manufacture of the lamp, which is now ready to be tested before being classed for commercial use. The sealed lamps are removed to the dark room adjoining the photometer room, and are then tested by means of an induction coil to ascertain whether the vacuum is satisfactory. If by any means air has found its way into the lamp, indicating a defect in the sealing, &c., this is at once indicated by the presence of a phosphorescent glow, which accordingly condemns the lamp and leads to its being rejected.



EXTERIOR OF THE BERRENBERG LAMP WORKS.

The next step is to determine the exact candle-power and voltage of the lamp, and for this purpose it is passed from the dark room to the photometer room. Our illustration of the photometer room would seem to indicate a very unsatisfactory excess of outside illumination, but we may explain that, the room being curtained and darkened in every possible manner, it became necessary, in order to obtain a good view of it, to remove nearly all the obstacles to daylight. Even as it is, the blackening of the walls has prevented some of the more important details from being properly shown up. The photometer room is fitted with a Hefner standard lamp at one end of the photometer bar, the manufactured lamps being quickly placed at the testing point at the other end of the bar, while a Lumner and Brodhun photometer head is adjusted on parallel rails between these two lights. The process of testing is carried out with wonderful expedition, the lamps being quickly tested and marked either for rejection or according to the classes to which they are to be sent. Simultaneously the voltage at which the lamp gives the standard candle-power is duly registered, as also is the current through the filament.



EFFICIENCIES AND CANDLE POWERS OF BERRENBERG LAMPS.

It will be noticed, of course, that in dealing with a large batch of lamps for commercial use the Hefner standard is only used for the first lamp, which serves as a comparison lamp for the

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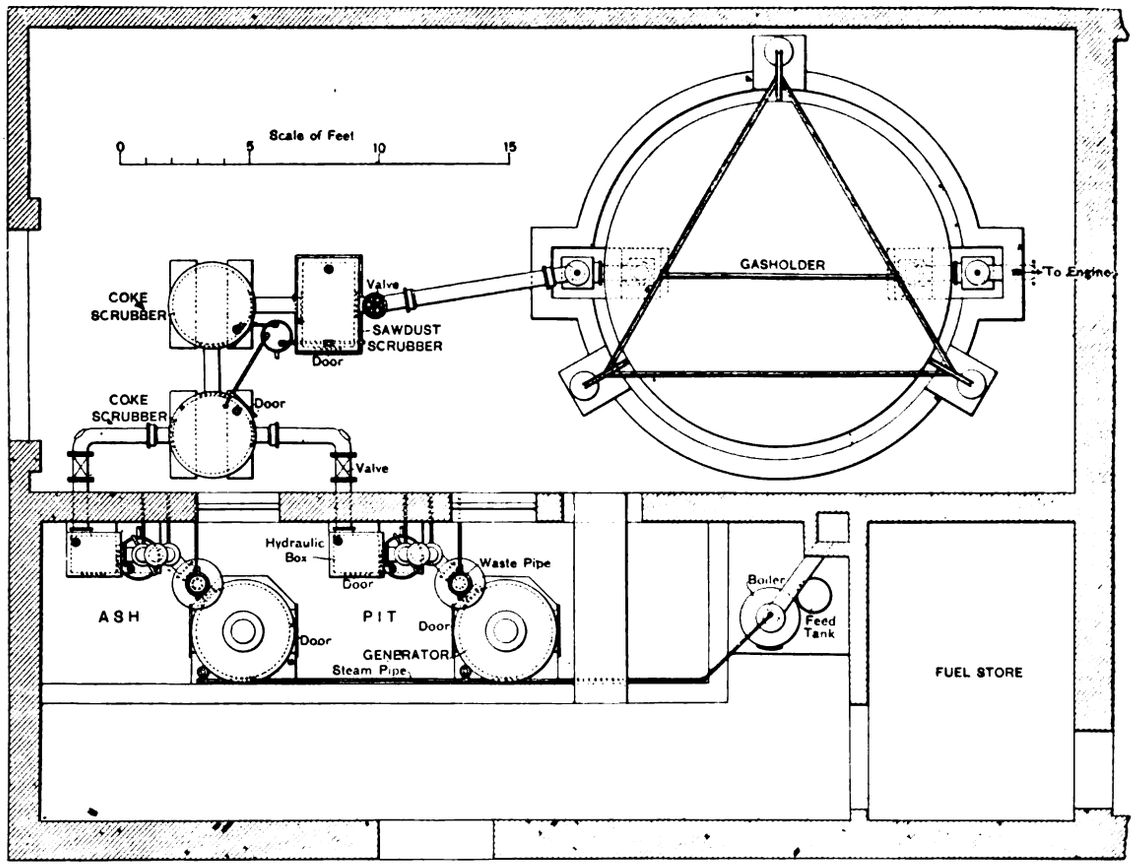
remainder of the batch, the comparison lamp being changed with each batch of different candle-power or voltage. We have received from the Berrenberg Syndicate the accompanying curves which they give as the latest achievements.

It is claimed for the Berrenberg lamp that absence of injurious residual substance from the vacuum, such as mercury vapour, enables the lamp to burn for a much longer period without blackening, and thus enormously increases the average efficiency and extends the life of the lamp. It cannot be denied that the Berrenberg lamp will stand a high degree of incandescence without showing any tendency to blackening, and, so far as we have been able to ascertain, at the end of a lengthened period of use these lamps show as clean and transparent a bulb as when new.

In conclusion, we may add that the works above described and illustrated will, when fully equipped, give employment to about 200 operatives, most of whom will be girls, as the class of work is best suited to the female worker.

A SMALL DOWSON GAS ELECTRICITY STATION.

The Saltburn electricity works erected by the Cleveland and South Durham Assets Company were opened with formal ceremony last week. Electrically the station is of no very great interest, as the present lamp connections only amount to the equivalent of about 1,200 8-c.p. lamps and the plant capacity is some 50 kilowatts which may be extended by 50 per cent. in the near future. The chief point of interest is that it has been judged economical to erect a gas generating plant and drive the machines by gas instead of by steam. The gas-producing plant is in a building by itself, the arrangement being as shown in the plan. It has been supplied by the Dowson Economic Gas and Power Co. of 39, Old Queen-street, Westminster, and consists of two generators, each of 100 H.P. capacity and each having its own set of cooling pipes dipping into a hydraulic box. These boxes have each a valve to shut off one generating set when the other is working. Thence the gas passes into the usual coke scrubbers provided with water sprays and fitted with double grids, so that the portion of the coke which is more quickly affected by the passage of the gas can be conveniently replaced. Next comes another scrubber, which is filled with damp sawdust and fitted with a valve whose chief function is to prevent the gas from returning from the gas-holder when the apparatus is stopped for cleaning and repairs. The cleansed gas passes into the gas-holder, which is of rather smaller diameter and consequently larger depth than is usual for its particular capacity. Its diameter is 13ft. 6in. and its depth 13ft., this special size having been necessitated by the limited amount of ground space at disposal. The fuel employed in the generators is Welsh anthracite peas, which costs considerably less than the anthracite nuts formerly used in the Dowson apparatus, and therefore cheapens the gas. The small vertical boiler which supplies the steam for the producers is heated with gas coke. The two generating sets each consist of an Otto gas engine of 80 nominal horse-power, driving a dynamo designed to furnish 100 amperes at 220 volts. The engines are by Messrs. Crossley Bros., and the dynamos have been supplied by Messrs. Cox-Walkers. There is also a battery of cells, and a motor-driven booster raises the voltage for charging this. The cells are of the Chloride type, 120 in number, in glass boxes, and each cell contains 21 plates of the "R" type. A 3-ton travelling crane, by Messrs. Carrick and Ritchie, spans the engine room. It is of the firm's standard make, the main carriage consisting of two steel-rolled beams of H section, suited for the 30ft. span, with cast-iron end carriages, single and double purchase heaving gear, and a powerful strap friction brake. It runs on flat bottom steel rails spiked to timber beams. The mains run overhead for a short distance, but in the town the distribution is from underground. The mains are concentric cable, paper-insulated, lead-covered and armoured, some by the British Insulated Wire Co. and some by the Johnson and Phillips Cable Works, with lead-covered and armoured service cable of the British Insulated Wire Co.'s make. The latter firm have also supplied the end connections and terminal boxes. The price for current is 6½d. per Board of Trade unit in cases where the company has provided free house wiring, and 6d. where the consumer has done his own electric fitting.



PLAN OF GAS PLANT.

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EUROPEAN AND AMERICAN PRACTICE IN ELECTRIC TRACTION.

The October number of the *Street Railway Journal* is, we believe, the largest number of our American contemporary that has yet been published, containing, as it does, 144 pages of reading matter and double that amount of advertisements. Both parts of the volume contain many well-executed illustrations. It is to the eighteenth annual convention of the American Street Railway Association, taking place at Chicago from Ocober 17th to 20th, that this issue has been dedicated, and the first article is a full review of the various electric traction systems of that city, which may be said to represent typical present and past American practice in electric tramways and overhead railways. A short description of these will be found in another column.

To justify its title of the "World's Practice Number," the publication also includes articles on electric tramway practice in Great Britain, Germany, Austria, and Argentina. The first mentioned, by Prof. S. H. Short, is interesting as the impressions on an American of the methods prevailing in this country. The writer seems to be most enthusiastic over our road-beds and steam piping, and a large part of the article is taken up with the specifications for track laying in Glasgow.

German practice is well treated in an article by Mr. Louis J. Magee, but, although profusely illustrated, views are lacking of the typical sliding-bar collector which replaces the trolley in Messrs. Siemens and Halske's system, and of the span-wire construction in narrow streets. The accumulator and "mixed" systems are described, but the costs of working these, published from time to time, have not been included. "Electric Railway Practice in Austria," by E. A. Ziffer, includes good drawings of the construction of the famous Budapest slotted conduit, and of the underground line running only a few feet below the level of the roadway in the same city. It is pointed out, however, that the overhead trolley system is the one principally employed both in Austria and Hungary.

Mr. E. Manville has contributed the article on Argentina. He says that probably few, if any, of the cities of the world have a greater length of tramways per head of population than Buenos Ayres. The tramways are all owned by companies. In some cases the concessions are to be considered perpetual, and in others terminable only after many years. Three companies have already electric traction, two have obtained powers to equip their lines electrically, and the remaining six have still horse traction. The municipality, however, imposes a tax of 6 per cent. on the gross receipts, and will not allow overhead wires within the city. Other systems being too expensive in view of the estimated revenue, only lines outside the town have been equipped electrically up to the present. American rolling stock and power-house equipment is employed.

Another article, brimful of figures, is on "Financial Characteristics of the Large City Transportation Systems of the World," by Mr. Edward E. Higgins. He compares London, with its 242 miles of "street railway track," an investment of $3.50 per head, and having a gross earning power of $1.27 per head, with greater New York, in which the corresponding figures are $58.34 and $7.46, and points out that the omnibus lines in London earn nearly as much net profit as the tramway lines with a capital expenditure of less than half. A table showing the financial results of the transportation systems in 51 large cities in various parts of the world is included in the article.

We quote in full the editorial summary of what our contemporary calls the "valuable engineering symposium" contained in the number:—

Europe builds its street railway roadbed with heavy masses of concrete as substructure, considering that the desirable end is *rigidity*. The drift of American practice is, however, rather toward *elasticity*. It is certainly necessary with rigid roadbed to adjust car springs most carefully in order to avoid the peculiar jarring effect in the car, which is excessively irritating to passengers as well as destructive to rolling stock; but this can quite as surely be done if sufficient pains be taken. In defence of the American method it may be said that it is impossible to ride more smoothly and pleasantly at high speeds than on a rock ballasted steam railway roadbed with rails spiked to wooden ties, but this smoothness of running is attained at the cost of close daily attention on the part of a comparatively large force of track men, and such attention as this in paved streets is physically difficult and financially expensive. The disadvantages of a concrete substructure do not come out so clearly with the low speeds common abroad as with high speeds, and there is no question that a more solid and durable construction from a purely engineering standpoint can be obtained with concrete than without.

The depth and weight of rail in each country necessarily varies with the character of paving, but we believe that Europe is using, as a rule, too light a rail for electric traction, and is still using some sections which are a relic of old horse railway practice, and ought to have no place in modern electric railroading at higher speeds. In many of these sections there is no room for a proper size of wheel flange to provide for safety against derailment, the municipal authorities having apparently yielded more to the demands of carriage and wagon traffic than to those of the far greater number who patronise street railways. There are several rail sections in common use in America which are so well adapted to both, that it seems difficult to understand why they are ruled out by European municipalities. The common foreign practice of mortising and overlapping rail ends so as to form a more nearly continuous rail, is, in the light of American experience, of doubtful value, because of large first cost and of heavy annual maintenance charges. The rail can hardly help being weakened at the very point where it should be strongest. Our best American joints, including the cast welded, are well able to hold up rail ends to form a continuous surface. It is impossible, of course, to speak positively in general recommendation of details of roadbed practice. At the end of 60 years of steam railroading, engineers still have wide differences of opinion as to roadbed construction, and it can hardly be hoped that all electric railway problems are to be finally settled in a 10 years' experience.

To American eyes, foreign street railway cars look heavy, cumbersome, and ungraceful, but there is no international artistic standard for judgment on questions of this kind. The American cars perhaps look light and weak to European managers. Wood being far more expensive in Europe than America, iron enters largely into the construction of European car bodies, which perhaps has something to do with their appearance of weight. The best types of cars in each country are certainly good, and are possibly best adapted to the character and habits of local riders. If, for example, a first and second class division of traffic were to be made in America, it would be necessary to radically change the design of our cars. Speed is so urgent a necessity here that, in order to obtain it, travellers are denied the many pleasant features of top-seated cars, for there is nothing which will so interfere with maintaining high speed schedules as the long stops necessary for getting up and down the roof stairways. Moreover, the higher the speeds the less is the pleasure of riding on top, particularly in a raw climate, because of both wind and motion. If European riders wish a view of the streets from the tops of cars, they must sacrifice time in transit.

We believe it is well within the truth to say that the American electric motor and car-controlling apparatus have set the standard for the world. It is inevitable that this should be so, for when the home market is such that a single manufacturing establishment can turn out 25,000 motors of exactly the same type, as has been done in America, special machinery can be built, labour can be sub-divided, and attention can be given to each detail to the end of producing motors which are more likely to be perfect and interchangeable in their parts than are the few hundred motors called for to satisfy a narrow local market. Nevertheless, German and British manufacturers are now building excellent machines, which are filling not only the home demand, but are going to many foreign countries as well, so that the scale of production has been greatly increased.

European municipalities are far more careful of life than are American, and as a consequence they almost universally require safety appliances and air or electric brakes, or their equivalent, upon electric railways. In this respect their example might well be followed by American companies, for there is no question that the common chain brake is too slow of application to suit modern high-speed electric railway requirements, and many an accident would be averted if the motorman were given the power of instantly applying brakes by a single turn of a lever, as can be done with air brakes, electric brakes or with some forms of mechanical brake. It is the emergency stop, however rarely put in practice, which saves a heavy bill for damages amounting often to the entire cost of the equipment of a road with improved braking apparatus, to say nothing of the relief to the manager's conscience in not having the blood of a fellow-being on his head.

American electric railway power stations are using much larger units on an average and as a maximum than are European stations, which still regard a 500 kilowatt generator as large, whereas 1,500 kilowatt, 2,000 kilowatt, and 3,000 kilowatt machines may now be regarded as common American practice for stations in the larger cities. Here, again, European practice in this respect is justified in most cases, on the theory of "small beginnings" in electric railroading, which have made necessary the adoption of small power station units. The larger sizes will quite surely be used as the stations grow. Water tube boilers and station auxiliary devices of all kinds are of much the same types in all countries, as the engineering principles in the design of steam plant are the common property of all manufacturing nations.

Overhead electric construction in Europe is probably superior to that in America, judged from the standpoint of the artist and of the engineer, for great pains have been taken, particularly in Germany, to produce highly ornamental designs for poles, rosettes, &c. Nevertheless, there is much to be said in favour of the simpler pole designs, which are usually less conspicuous in the street than are the more ornamental ones; but it cannot be denied that many American street railway companies have erred in imposing wooden poles, feed-wires, and other eyesores upon the public in the smaller cities. In line material America has again set the standard of the world, chiefly, of course, because it was here that commercial electric railroading was first developed.

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Germany has been quite successful in adapting storage batteries to the propulsion of electric cars on what is known as the "mixed system," by which means the overhead wires have been avoided in the business district. The batteries are charged from a line in the suburbs, and carry the car to the city termini without direct current supply. How costly this combined service is we do not know, but it would be difficult to apply it in America, for the reason that our street railway lines stretch far into the country, and the storage batteries would often have to be carried as dead weight for 90 per cent. or more of a round trip in order to work for 10 per cent. or less. This would be not only costly in power consumption, but in car and track depreciation as well, while the storage batteries themselves, always a source of expense for maintenance, would add still further to the operating cost of the mixed system in America.

European practice is distinctively more conservative than American in the matter of insisting upon small losses in both outgoing and ground return circuits, particularly the latter. The regulations of the British Board of Trade permit a drop of but seven volts in the ground circuits, seeking thus to prevent electrolysis, and in the best engineering practice this drop is even lower than that called for by the Board of Trade, negative boosters being often used to bring this about.

The policy of American municipalities has always been and is now that of permitting private capital to handle its street railway enterprises. This is true to nearly the same extent also in Germany and in Austria, though latterly there has come into vogue in these countries a plan of municipal ownership of roadbed and private ownership of equipment, which is working to the apparent satisfaction of all concerned. In Great Britain the tendency is very strong towards municipalisation of all public service enterprises, and private capital finds it almost impossible to obtain a foothold in tramway development, though still permitted to take some part in the building of "light railway" or inter-urban lines. Without attempting in this place to comment on the wisdom of this decision, it may be said that it is quite certain to be persisted in to the end, and that 10 or 15 years hence practically all municipal service enterprises of this kind will be owned and operated by the public. As a consequence, tramway development in the British Isles will follow with lagging steps and to a limited extent only that of Germany and the United States, as has been the case during the past ten years.

APPARATUS FOR OBTAINING HIGH FREQUENCIES AND PRESSURES.*

BY ELIHU THOMSON.

In 1889, Prof. Henry A. Rowland, of Johns Hopkins University, in a discourse at the annual meeting of the American Institute, drew attention to the high frequency effects, and employed experimentally a Ruhmkorff coil, the discharge of the secondary of which charged some Leyden jars or condensers (Fig. 1), which were discharged over a spark gap through a few turns of wire carried on a frame as a large open coil with an air coil, as shown. Opposite to this and parallel in plane—that is, in inductive relation to it—was another coil, acting as a secondary circuit receiving the high frequency induction, and between the terminals of which sparks were discharging at every discharge of the jars through the primary. He showed also that by attuning the two circuits, as by connecting condensers to the secondary circuit, the results were such that the frames or coils could be placed far apart without preventing the inductive action of the high frequency currents.

Prof. Rowland had thus in this apparatus all the elements of a high frequency coil except the step-up ratio between primary and secondary. As far back as 1877 it was my custom, in lecturing on electricity, to show the effects of the discharge of Leyden jars through the primary of an ordinary induction coil upon the secondary as step-up apparatus, and the reverse; having, in fact, received the first suggestion of electric welding while discharging a battery of Leyden jars through the fine wire secondary, while noting the extremely heavy current set up in the primary circuit. By abolishing the iron core and winding only a single layer of secondary upon an insulating frame placed inside of a primary layer of but few turns, and immersing the whole in a tank of oil, we are enabled to produce the now well-known high frequency, high potential coil. It uses an alternating current of ordinary frequency with a step-up transformer to charge the condensers, sometimes with a strong air blast blowing upon the spark gap to insure regularity of discharges. Prof. Rowland had employed the ordinary induction coil for charging his condensers and an ordinary spark gap. Tesla employed a high frequency dynamo to charge his condensers, and a blow-out magnet over the spark gap, while in his high frequency coil he at first retained the iron core, discarding it later. A well-arranged, high frequency, high potential coil is adapted to reproduce many of the well-known beautiful effects of Ruhmkorff coils using a rapid break, but with increased brilliancy and effect, while other actions are peculiar to the very rapidly reversed discharges of the high frequency order. The construction of high frequency, high potential apparatus may, of course, be greatly varied. As an example of one form which has been employed by me, I may here insert a description of an apparatus giving 30in. sparks between its terminals.

A step-up transformer, whose secondary gives 20,000 volts alternating current, is connected to charge the condensers, the discharge from which passes by air-gaps through the primary coil of the high-frequency apparatus. This primary consists of 10 turns of wire wound on a wooden frame. The conductor is of two No. 6 wires placed side by side. This open coil is 18in. long and 15½in. diameter. Its resistance is 0·0088 ohm and inductance 0·0076 millihenry. The secondary coil has 396 turns of No. 26 wire, wound as a single layer in notches on a hard rubber frame, the wires being spaced apart to form a coil 18in. long. The diameter of the secondary is 12in. and the weight of the wire about 1lb. The wire of the secondary coil layer equals 1,250ft., representing a resistance of 41·6 ohms and inductance of 25·2 millihenrys. These coils are immersed and supported concentrically in a vat of oil, and the secondary has its terminals carried to the brass rods and balls which form the discharge terminals of the apparatus. There are used two condensers, all or portions of which may be connected for the primary coil discharge, each contained in a box 7in. by 15½in. inside and 17½in. deep. Each box contains 84 built-up mica sheets 15in. by 15in. and 0·075in. thick; 42 of these are coated with tinfoil 10in. by 11in. = 110 sq. in. Effective foil surface = 4,510 sq. in. The condensers are immersed in oil in the boxes. The capacity of each condenser box is about 0·03 microfarad.

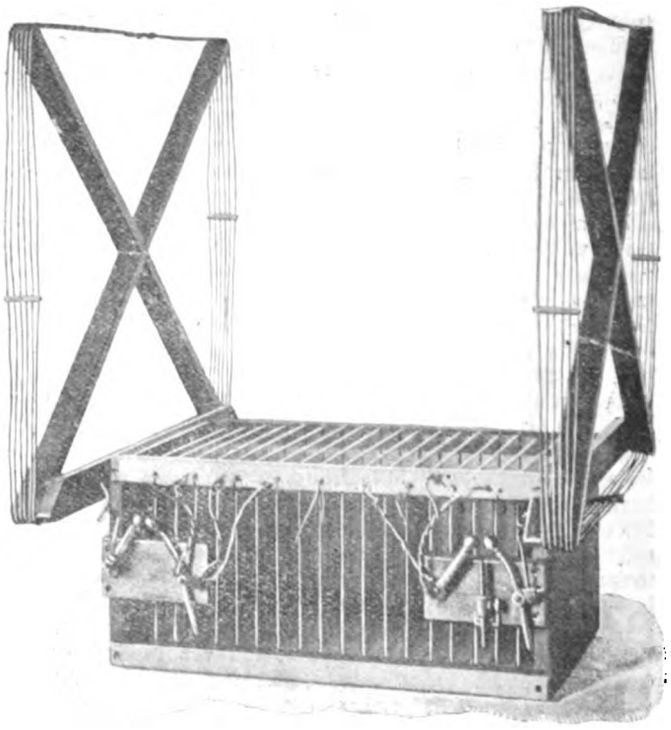

FIG. 1.—APPARATUS FOR HIGH FREQUENCY EFFECTS.

In the apparatus which gave 64in. sparks between the terminals the primary coil has a length of 28in. and diameter of 22in. It has 15 turns of double No. 6, 85ft. of wire, doubled; its resistance is 0·0147 ohms, and inductance 0·09 millihenry. The secondary coil length is 28in., its diameter being 17in. The wire forms one layer, with the turns spaced apart and carried in notches in a hard rubber frame, 580 turns in the layer. The wire is No. 26, about 2¼lb., or 2,600ft. total length. The condensers used with the primary were in three boxes, the dielectric being of mica plates and oil. When all were in use the capacity was 0·046 microfarad. These were charged by a large step-up transformer to 30,000 volts, and discharged across air gaps through the primary. An air blast was kept blowing on the gaps. The greatest distance at which it was possible, on account of the construction, to set the terminals was 64in., which was crossed with ease. The probability is that if the terminals could have been more widely separated, longer discharges could have been obtained. The current used in the primary of the step-up transformer being of 125 cycles, there were at least 250 of the 64in. discharges in each second.

Prof. Trowbridge, of Harvard, has in recent years greatly magnified the effects of the Planté machine. He has arranged small storage cells to be charged in sets or in multiple by a dynamo, and then connected in series so as to give 10,000 volts or more of continuous potential at the terminals. With this battery of relatively high potential he charges in multiple a range of condensers consisting of glass plates coated on the two sides with tinfoil except near the edges. By a large shifting frame worked by a lever he throws the connection of the condensers, after charging, into series order or

* Abstract of a lecture on "Electricity at High Pressures," delivered before the New York Electrical Society.

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cascade. The end condenser foils of the set are connected with the discharge terminals of the apparatus. In this way he obtains with great ease discharges of 3ft. or 4ft. in length, and of great brilliancy and beauty, one spark at each throw of the commutator lever. With a large machine of this type he has obtained sparks of 7ft. in length, the distance covered being in fact limited by too close proximity of the walls of the building, its floor, its roof, &c., and not by the real capability of the apparatus, which, without the leakages and lateral discharges, would be capable of producing potential differences of 3,000,000 volts.

It was while studying the action of Prof. Trowbridge's apparatus that it occurred to me to dispense with the large series of battery cells used in charging, and employ instead thereof the tops of the waves of a high potential alternating current suitably delivered in one direction. I was thus enabled to produce a new machine for obtaining high potential discharges. It consists partly of a motor-dynamo, such as is obtained by taking an ordinary continuous-current motor and tapping the winding so as to obtain alternating currents. To this end two of the commutator segments or leads are connected to a pair of insulated metal rings on the shaft. Brushes resting on these rings yield alternating currents of a periodicity depending upon the speed and number of field poles. This machine may be driven by continuous current, or as a synchronous alternating-current motor after starting, or it may be driven by mechanical power as a self-exciting alternating-current dynamo. The alternating-current brushes are connected to the terminals of the primary winding of a step-up transformer, giving in the secondary a potential of, say, 10,000 to 15,000 volts. Driven by the shaft of the machine is a frame of insulating material as wood having at one side a pair of metal strips which periodically connect the high potential secondary terminals of the step-up trans-

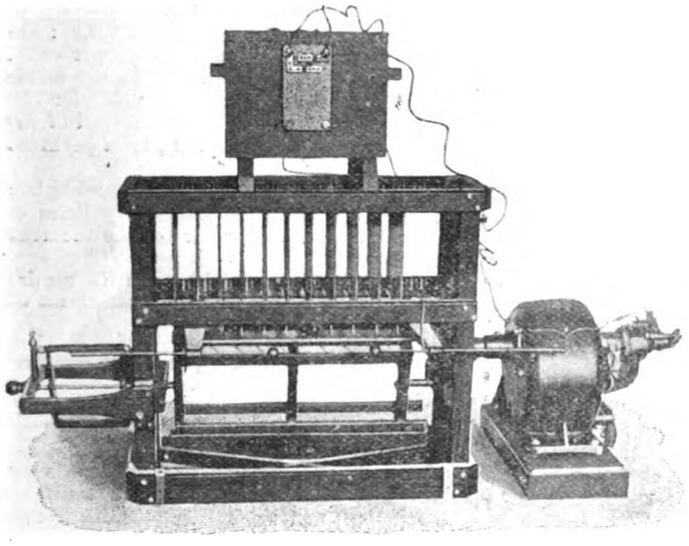

Fig. 2.—Dynamo-static Machine.

former to the plus and minus foils of a set of condensers (11 glass plates coated with tinfoil) in parallel. These connections, to avoid noise and friction, are made without actual contact—that is, over a small spark gap. The revolving frame is so adjusted that the charging shall be completed only at the tops of the waves, and thus a high potential be available for charge. Moreover, in the particular machine before you (Fig. 2) the tops of only every third alternating wave of same polarity are employed, and thus the condenser plates or foils are always given the same polarity. In this way the chopped-up alternating discharge becomes, for charging the condensers, a substitute for a high potential battery. The revolving frame carrying the charging strips also carries a set of series connectors, whereby, after the charging strips have withdrawn from proximity to the stationary contacts led from the condenser foils, these contacts are connected in series as in the Planté or Trowbridge machines, and the terminals or end foils discharge across a wide air-gap at high potentials giving a rapid series of sparks of about 12in. in length in the apparatus here shown. The length of spark is governed by the number of condenser plates and the potential of the charging current. This may be made to correspond with the maximum potential of the wave in the secondary of the high potential or step-up transformer. I find shellacked wood sufficiently insulating for the parts of the machine outside of the condensers and metal connections.

The machine has been further developed and improved by me until it actually becomes a practical substitute for a static machine, independent of the weather. It therefore needs no outer case nor means for drying. I have added a simple attachment whereby Leyden jar batteries may be charged or a stream of thin sparks obtained, and with this attachment the machine may be used to excite the sectors of large influence machines, if desired, in all states of the weather.

This attachment consists of a revolving connector covering a wide gap between one of the terminals or end condenser foils and a stationary insulating ball or conductor This connector itself, consisting of a pair of balls or rounded surfaces connected by a wire, is insulated and synchronously bridges the gap of several inches between the end condenser terminal and the insulated ball. The time of making this connection coincides with the series connection made by the revolving frame. The insulated ball or conductor thus is synchronously charged, while the opposite terminal of the apparatus may be put to earth. The ball may be made either positive or negative by changing the alternating-current connections from the collector rings to the primary of the step-up transformer or in other ways. A Leyden jar battery or condenser may be charged by connecting its interior coating with the insulated ball and its exterior to earth or to the opposite terminal of the apparatus, and from the charged jar condenser a string, dipped in very weak acid or rubbed in graphite, may be made the means for conveying the jar charge slowly to a prime conductor for weak or thin sparks, whereby the effects of a static machine may be closely reproduced. The whole apparatus combines so many features of transformation of energy as to become a highly instructive apparatus for schools, and its capabilities are quite varied, as can be readily understood. I call it my dynamo-static machine. I may mention as an interesting fact that the new machine may be used to charge a set of condensers to a high potential in a second rheostatic machine, after which, series connections being made as in Prof. Trowbridge's apparatus, a second multiplication of potentials would result. Very high potentials may thus be obtained.

THE GENERATION AND ELECTRICAL DISTRIBUTION OF MOTIVE POWER.*

BY JOHN S. RAWORTH, M.INST.C.E., M.INST.E.E.

In approaching the subject on which I have undertaken to express my views, I have been met in the first instance by the difficulty that the title of the Paper, although wide enough to include everything that I want to say, lacks to some extent descriptive detail. My object is not so much to traverse the whole breadth of the question of the generation and distribution of electrical power, as to explain to what extent that system may be economically applied to the driving of machines employed in engineering and general manufactures carried on in Lancashire. This Paper will suffer very much from the fact that it was promised before it was written; for, had I realised at the time of making the promise how imperfect it must necessarily be, the probability is I should have preferred to defer taking up the task until the world had provided us with more exact data. At the same time, although I cannot promise that the figures which I have to lay before you shall possess scientific accuracy, yet I hope they may be of some value to those who are satisfied that, at all events for their purpose, electric transmission of power is the thing they want.

Every engineer and most users of steam power are now sufficiently educated in the details of the progress of electricity that they have been enabled, each one for himself, to form some idea as to the applicability of electricity to his own particular business. There are some cases, as for instance such as those which are met with in a shipbuilding yard, where power has to be transmitted to a vast number of isolated tools, very often unprotected from the weather, where the advantages of electric driving are so obvious and the savings to be effected so great, that it is not necessary to use a pair of scales to determine on which side the balance of advantage lies. It is not remarkable, therefore, that in these instances electric driving is going ahead at a great rate, and rapidly supplanting the old and costly method of distributing power by long steam pipes. Again, we have other manufactures, such, for instance, as those of the engineer and machinist, in which the practical convenience of the use of electricity is obvious; but it is an open question whether in each particular case there may be an actual financial saving or otherwise, particularly as in most cases the changes from the one method of driving to the other would involve the abandonment of a considerable amount of now valuable machinery, and its replacement by new plant of a very expensive nature.

Pursuing the same train of thought still further, we come to such cases as those of the cotton spinner and manufacturer, where a large amount of power in the aggregate has to be distributed to an immense number of machines, for the most part symmetrically arranged and driven by methods which have been well tried, and which, under the circumstances, are not excessively expensive. To show to the owners of such works that there would be a direct

* Paper read before the Manchester Association of Engineers, Oct. 28.

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financial saving to them by the substitution of electrical driving for long shafts and belts would be a very difficult task. But in the case of new mills about to be erected the task would be slightly less difficult, and if a large number of mills were banded together, taking their power from an external generating station well situated as to coal and other natural advantages, it is quite possible that a distinct balance of advantage may be shown in favour of electricity.

It will be obvious that the whole question is bound up intimately with the cost and efficiency of various sizes of motors. For instance, it may be perfectly easy to show that 40 H.P. may be economically transmitted by electricity, and the power reproduced at a distance by means of a motor of 90 per cent. efficiency. But if the same power is required to be very much subdivided and reproduced by motors having an aggregate cost of three times that of the motor aforesaid, and having an efficiency of no more than 75 per cent., the balance may be entirely on the other side.

The object of this Paper is to show how these various problems can be dealt with, and to what extent successfully, in the present state of the electrical engineering art. In the first place, I propose to consider the cost and efficiency of motors of various powers. Nearly all the well-known makers have been kind enough to furnish me with particulars, which I have checked by comparing them with the results of tests that have come under my own observation. Prices, of course, vary considerably; but there is no difficulty in arriving at an average of those prices which lie moderately close together.

On this basis a motor of—

½ H.P. costs	£8	10 H.P. costs	£100
1 „ „	24	20 „ „	150
2 „ „	34	50 „ „	250
6 „ „	50	75 „ „	320

It is obvious from these figures that extreme subdivision of power by electric motors can only be carried out by the expenditure of considerable capital; for instance, whereas a motor of 20 H.P. is worth £150, twenty motors of 1 H.P. would cost no less than £480, with the addition of at least £80 for switches and fixings. This accounts for the fact that we usually find in electrically-driven factories motors coupled or geared to line shafts, and not directly to the machines, except in special cases. There is also this further consideration, that whereas 20 motors of 1 H.P. may be required to drive 20 machines, one motor of 10 H.P. may suffice to drive the whole collectively. This is especially true of engineers' machine tools.

This leads us immediately to the question of efficiency, which must be considered under two heads: First, mechanical (including electrical) efficiency; and, second, commercial efficiency. Unfortunately, these two aspects of efficiency have no direct or mathematical relation to each other. Your mechanic deals with figures which are the fundamentals of his education, and are subject to calculation; but the commercial man has to take account of interest, depreciation, repairs, lubrication, and superintendence. Thus it often happens that the engineer is happy and the owner miserable; the engineer may be getting an efficiency of 90 per cent., while the owner gets no profit at all. This applies to steam just as much as to electricity, and it is only by taking this aspect of the question into most careful consideration that economy can be obtained. For instance, a large Corliss engine driving a steady load is a most economical source of power; but usually no more than 30 to 60 per cent. (depending on circumstances) arrives at the machines, and even to this severe loss, expressed in money, must be added the upkeep cost of shafting, gearing, and belts. The effect of this is that, whereas one indicated horse-power costs, under the best of such conditions, about ¼d. per hour, the actual horse-power delivered to the machines costs something between ½d. and 1d.

In engineers' shops the cost is never less than twice and very seldom less than three times the above. This increased wastefulness is due partly to the use of smaller and less economical engines, but principally to the fact that the losses are nearly constant, while the power actually used fluctuates, and scarcely ever rises to the possible maximum for which the engines were designed. With a non-condensing engine, the power required to exhaust the steam into the atmosphere at all loads varies from one-fourth to one-third of the full power of the engine (depending on steam pressure and design); therefore, if the engine be too large for its work, as it usually is, it may quite easily waste one half of its steam supply without being, as an engine, in the slightest degree defective. I make no apology for mentioning these simple facts, because it is obvious to all of us that engineers are just like doctors: they can prescribe for the public, but they sink to the level of ordinary mortals in the face of their own family ills.

For those who desire to use electric transmission of power within their works there are three possible sources of supply:—(1) A private installation. (2) The local electric supply service. (3) The general power distribution service (not yet established). The second, being the most definite, I propose to discuss first. The Manchester Corporation now supplies electric energy for power purposes at the low price of 1½d. per unit, which is equivalent to ·93d. per electrical horse-power hour at the meter, and in all probability other corporations and supply companies will soon endeavour to follow their example.

The question for us to consider is, What percentage of this 1 H.P. will actually be utilised at the machines? The loss in the internal distribution is usually arranged to be about 2 per cent. at full load; but, unlike mechanical loss, it is not constant, but falls off even more rapidly than the load, so that at half load (or more correctly at half current) the loss would be ¼, or say, ½ per cent. It is obvious, therefore, that under the ordinary conditions of varying loads an allowance of 1 per cent. on this account is ample. The only other source of loss is in the motors. Unfortunately this loss is nearly constant while the motor is at work, and varies very little (except in the case of series motors) with the actual work done. Happily, when the current is cut off the loss ceases. The actual internal loss in electric motors, stated as a percentage of the full power, varies between 8 and 50 per cent. This may be roughly divided as follows:—

Large motors	8 per cent.
60 to 100 H.P.	10 „
30 „ 60 „	12 „
5 „ 25 „	15 „
2 „ 4 „	18 „
½ „ 1 „	26 „
⅒ „ ¼ „	50 to 30 per cent.

It is evident from the above table that, although small motors are not by comparison with large ones very efficient, yet they are in this particular a long way ahead of small steam engines.

Assuming that a number of machines be driven by motors of 2 to 25 H.P., having an average loss of 15 per cent., that two-thirds of the total number of machines are in operation at one time, and that the average load be one-half of full power, the then total efficiency is 74 per cent., so that our 1 H.P. is reduced to 0·74 H.P., or, in other words, the price of 0·93d. per horse-power at the meter is increased to 1·25d. at the machine shafts. Under the conditions which I have assumed, the amount of energy metered would be 38½ per cent. of the maximum possible if all the machines were kept constantly at work at full power. For the sake of example take 50 B.H.P.: the efficiency at full load would obviously be $98 \times \frac{85}{100} = 83\frac{1}{3}$ per cent., which would make the price per horse-power hour at the meter 1·12d., or for 50 H.P. 4s. 8d., equal to £642. 12s. per year of 2,754 hours. But, as explained above, the consumer gets the call of his full 50 H.P., and the use of all the power he requires, for a payment of about 38¾ per cent.—say £250 per annum.

It is obvious, therefore, that under the assumed conditions electric power is not more costly than steam, the special convenience of electric driving being thrown in. Let us consider for one moment what this convenience brings us:—

(1) Absence of overhead shafting and belts, which ordinarily require special construction of workshops and interfere with the arrangement of machines.

(2) Saving of time in repairing belts.

(3) Easy application of power to special appliances, such as boring bars for large cylinders, and key seating tools for flywheels.

(4) Facility of working overtime on even one machine without any increase in the cost of power.

(5) Increase of output.

Probably many manufacturers and engineers will have very serious doubts on the subject of increased output, as the cause of such increase is by no means apparent at first sight. My friend, Mr. John Holmes, of Newcastle, informs me that the owners of printing works which he has fitted with electric motors have assured him that their output has been increased 20 per cent. He confesses that he has found much difficulty in accounting for this increase, although he is unable to dispute the fact.

There is one other incidental convenience attendant on the use of electric power from an outside source, which in particular cases almost outweighs all the other conveniences. I refer to the unlimited power of expansion by small steps. In all rapidly expanding manufacturing businesses the limitation of power by the capacity of the steam plant always gives trouble at intervals more or less rapidly recurring. More machines would be put in work but for the fact that such increase would involve large capital expenditure on engines and boilers. Consequently gradual growth must give place to a series of leaps, which are commercially uneconomical and generally unsatisfactory. With electric driving, on the contrary, additions of power can be made from time to time as required with no more than a *pro rata* expenditure of capital.

During the recent visit of the Institution of Electrical Engineers to Switzerland, I observed that electric driving was general in the newer shops; and in the older shops it was being used for special purposes. Many operations were being effected by portable motors. I came away with the impression, based on personal observation and consultation with the leading Swiss engineers, that within ten years all the Swiss factories would be electrically driven. At Rheinfelden and at Schaffhausen we saw examples of the generation and distribution of power on a large scale, the power being utilised in woollen mills, ironworks, metallurgical and electro-chemical processes.

The installations were naturally commensurate with the available power in the water, consequently they were of greater output individually than steam installations in this country, excepting perhaps

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that of the City of London Electric Lighting Company, at Bankside, Southwark, which now exceeds 20,000 H.P. The dimensions of the Rheinfelden power station excited the wonder and admiration of our English engineers, and they attributed the success of the undertaking to cheap water power, which enables the company to sell power in wholesale quantities at a low price. Nevertheless the price is only low when compared with the prices charged for supply by local companies or municipalities, who are simply groping their way and reducing their price from time to time as surplus profits accrue.

I have endeavoured to show you that the Manchester price of 1¼d. per unit (a low price for an urban service) is by no means prohibitive for ordinary manufacturing purposes, yet I am well aware that the figures I have laid before you would absolutely fail to beguile a cotton-spinner. His power usually costs him very much more than he thinks it does, but still little enough to beat electricity at 1¼d. We are thus brought face to face with the question: Can we hope to obtain electrical energy at a price which will induce our cotton-spinners in equipping new mills to use electric driving in preference to steam? The answer to this question, in my opinion, is Yes, without any reservation. I am informed that at Rheinfelden the best terms to large consumers are £6 per horse-power per annum, with unlimited use. Therefore, if the consumer can work his plant continuously he obtains his power at the rate of ¼d. per horse-power hour, or 0·224d. per unit; but, if he is limited to factory hours, the price works out to ½d. per horse-power, or 0·673d per unit. It is obvious that with river water power the *annual* charge is the correct one; it matters very little to the producer whether the consumer uses his power 1,000 hours or 8,000. With steam, however, the compensated meter system is the best, because the principal current expenses are proportionate to the supply, and the standing charges constant.

In my Paper on "Cheap Steam Power," read before the Northern Society of Electrical Engineers in November, 1896, I ascertained the total cost of steam power in a modern cotton mill to be ¼d. per indicated horse-power hour; therefore the cost of the power at the machine pulleys cannot be less than ½d., and is probably much nearer ¾d. (This estimate, of course, covers the loss in the engine, in transmission, and the interest, depreciation, and maintenance of shafting, &c., concerning which latter items I can gather no trustworthy information.) We have now to inquire whether electrical energy can be delivered to the axes of the machine at anyting like the above prices, for I take it that the conveniences of electric driving would turn the scale in favour of electricity at equal prices.

Those of you who did me the honour of reading my address to the Northern Society of Electrical Engineers,* delivered on January 10, 1898, know that I look forward with intense interest to the early establishment of electric power stations on a large scale. On the occasion referred to I gave it as my opinion that power could be generated in an installation of 50,000 H.P. at about £4 per indicated horse-power for continuous service, or about one-half that amount for factory hours.

The details of the estimate are given below:—

Basis, 50,000-H.P. plant. Coal at 7s. per ton.

—	2,754 hours.		8,760 hours.	
Coal	(1¼ tons) £0 8 9		(4 tons) £1 8 0	
Margin for bad coal and starting boilers, 25 p.c.	0 2 2		0 7 0	
Labour & management	0 5 0		0 10 0	
Repairs and stores	0 2 6		0 7 6	
		£0 18 5		£2 12 6
Interest, 5 per cent.	£0 12 0		£0 12 0	
Depreciation, av'rage on total capital, 4 p.c.	0 9 6		0 9 6	
		1 1 6		1 1 6
		£1 19 11		£3 14 0

The capital cost, including land, buildings, and 20 per cent. spare, is taken at £12 per horse-power.

This price of 40s. per annum is equivalent to 0·174d. per indicated horse-power hour, a price at which I do not think there is much prospect of supply being offered at a very early date; but I believe that twice this price, viz, 0·348d., would certainly tempt capitalists to embark in such an undertaking. Electric motors in a cotton mill would have an all-round efficiency of about 83 per cent. at full load, or at average load about 80 per cent., which, multiplied by the conductor efficiency of 98 per cent., gives a total efficiency of 78·3 per cent., making the price per horse-power hour at the machine 0·45d.—a price certainly not higher than the present cost of steam power, even in the very best examples.

You will remark at once that the price of 0·348d. per electrical horse-power hour shows an enormous advance on the Manchester price of 0·93d., but it is not such a startling advance on the rates which are being offered and accepted by the Trafford Power Co. They are taking contracts at 0·560d. per horse-power hour, and I have no doubt that, under the guidance of their skilful and enlightened engineers, Messrs. Lacey, Clirehugh and Sillar, they will achieve a splendid success.

You will quite naturally ask me: "If power can be supplied by companies at such prices—why not by the Manchester Corporation?" This is a very proper question, but it should be addressed to them, not to me. I should say that they will probably do it some day when others have done it and have demonstrated the profit; but in the meantime they will prevent others doing it within their area of control. In the case of the Manchester Corporation there is some show of reason in their attitude of objection, because they have done and are still doing much to popularise electricity. Mr. Wordingham informs me that he has at present 1,419 H.P. of motors on the mains, and applications for 348 H.P. more. But the opposition of some of the outside councils to the introduction of cheap power is perfectly inexplicable, except on the theory that the possession of a "one-horse" electrical station is the sole object of their existence.

There is at present no precedent in large power stations, consequently no municipality or local authority can attempt the experiment; but private enterprise is ready and willing to provide the capital and take the risk, and Lancashire has had the opportunity of being first in the field. But, except in the circumscribed area of Trafford Park, which is private property, the local authorities would have none of it. In the face of my knowledge of Lancashire, I cannot believe that this policy is approved by the men who lead the great textile and mechanical industries of the county. If they are content to follow at the heels of our foreign competitors, then they are not the men I have taken them to be.

In dealing with this question of the electrical distribution of power I have not entered upon the differences between direct and alternating currents. The prices are sufficiently alike for the purposes of this Paper to allow them to be treated on the same basis; and although the efficiency of alternating-current motors is at present something less than the efficiency of direct-current motors, there is reason to believe that even this small difference is gradually disappearing. There is a very general impression that alternating current is at a disadvantage for power purposes as compared with direct current, but this is only true of single-phase alternating current. The objection does not apply to multiphase alternating currents. Even with single-phase alternating current, motors can be used to advantage and with success, if suitable arrangements be made for starting up the motor without load. Such motors are in general use by consumers in the city of Worcester, and are giving satisfaction. I have also heard of their successful use in other places, although, with the exception of those at Windermere, they have not yet come under my own personal observation.

In the preparation of this Paper I have collected a large amount of information bearing upon various aspects of the use of electricity for motive purposes This information is in many cases not adapted for abstraction or condensation. I have therefore presented the most useful portions of it under three sectional headings in the Appendix. I do not claim that nothing of interest has been overlooked or omitted; but I believe the Appendix will be found to contain a large mass of fairly exact information worth the attention of all interested in the utilisation of electric power for manufacturing purposes. Under sectional heading (A) will be found a set of tables giving the losses observed by different experimenters in shafting and pulleys, and also the power required for driving tools of various types. In section (B) are gathered together the names of some engineering and other firms who have adopted electric driving in their shops and factories. The final section of the Appendix (C) contains the details of efficiency trials carried out by various observers with different types of motors, the figures for the average efficiencies, supplied by the manufacturers, being all presented in a general table, in order to facilitate comparison. Four diagrams, showing the result of the tests of three Oerlikon motors and of a Langdon-Davies motor, are also given in this section of the Appendix.

In conclusion, I desire to thank Mr. J. B. C. Kershaw for the very valuable assistance he has given me in the preparation of this Paper. I am also indebted to the gentlemen and firms whose names are given below for supplying me information as to the costs and efficiencies of motors made or tested by them:—The Brush Electrical Engineering Co., Mr. S. V. Clirehugh, Messrs. Ernest Scott and Mountain, Mr. J. L. Fuller, Messrs. Greenwood and Batley, Mr. W. Geipel, Mr. S. H. Heywood, Mr. Wilson Hartnell, Messrs. Heath, Snoxell and Co, Mr. C. R. Heap, Messrs. J. H. Holmes and Co., Mr. T. Hawkins, Messrs. P. R. Jackson and Co., Messrs. A. G. Keen and Co., the Langdon-Davies Motor Co., Messrs. F. H. Royce and Co., Messrs. Veritys Limited, Messrs. White, Jacoby and Co., the Westinghouse Electric Co., 32, Victoria-street, London, S.W., Mr. A. B. Blackburn, Mr. C. N. Russell, and the Electrical Co.

Since the completion of the Paper I have received from Mr. C. E. Hodgkin, the manager of the Falcon Works, Loughborough, particulars of some tests he has been so good as to make at my request. The figures show the number of watts required to drive the motor alone, the motor and 82ft. of 2½in. shafting at 500 revs. per minute, also the same with

* [See *The Electrician*, Vol. XL., p. 383.—ED. *E.*]

13 idle belts. Particulars are also given of the watts (net) required to drive sundry tools.

Tests of Pattern Shop Motor and Machines.

MOTOR—U 12, No. 3,077, 15 B.H.P., 1,025 REVS.

Shafting	500 revs.	No. of bearings.....	10
Length of do.	82 ft.	Length	7½ in.
Diameter	2½ in.		

Motor running light—Armature watts	880	
Shunt „	200	
Total	1,080	motor only.
Driving shafting only—Total watts	2,870	
	-1,080	
Net	1,790	shafting.
Driving shafting and 13 idle belts—Total watts.	3,742	
	-2,870	
Net	872	idle belts.

	Net watts.
Wood Planer (12in. cutter)—Cutter running light	1,078
Cutter and bed running	1,188
Cutter take cut 3 cuts to ⅛in. on 3in. pine	1,738
Circular Saw—10in. diam.—Running light.....	1,007
Cutting 3in. pine	2,290
Band Saw—wheel 28in. diam., saw ⅜in.—Running light	958
Cutting	1,738
Grindstone, 4ft. diam., 7in. wide	164
Lathe, 2ft. 6in. centres—Light	768
Working	1,200
Two 12in. Lathes—Light	318
Drill—1½in. spindle, 6in. stroke—Light	404
Drilling 1in. hole	818

The following is a comparison of the power lost in a steam engine and shafting in one case, and in an electric motor and shafting in the other case.

The engine, which is a "D Universal," is capable of indicating 45 H.P. It drives 288ft. of 2½in. shafting and 46 belts.

The indicated horse-power required to drive the shafting and idle belts is 9·1, equal to 6,788 watts.

The average load (indicated) is 17 H.P., and the maximum load 30 H.P., consequently the average efficiency is only 47 per cent.

Another line of shafting of the same size (2½in.) and 144ft. long, driven by a motor of 15 H.P., takes 2,570 watts; but in this case there were only 16 idle belts. Consequently, to make the comparison fair, we must add 7 belts at 67 watts each = 469, making a total of 3,039 watts. If this be doubled, to make the comparison fair with the steam engine driving double the length of shaft, we obtain a total loss of 6,078 as compared with 6,788.

This result is much more favourable to the steam engine than is commonly supposed.

(To be concluded.)

ELECTRICITY WORKS ACCOUNTS.

Yarmouth Municipal Electric Supply Works.

The Yarmouth undertaking is making steady if rather slow progress towards a self-dependent position. In spite of the fact that the concern has now completed its fourth year, the working profit was insufficient to meet the capital charges. On the other hand, the general position of the undertaking will bear favourable comparison with many places of similar size, and the progress last year in the matter of increased lamp connections and output is very promising. With 69 new consumers the equivalent lamp connections show an increase of 45 per cent. The output of 232,779 units sold is an increase of 22·5 per cent. as compared with 1897. The average total revenue per unit has remained practically constant at 5·07d. per unit. It is satisfactory to see 0·2d. knocked off the total costs, thus reducing them to a very fair average figure at the output.

When we come to look into the several items of generating costs, some things are not quite so satisfactory. For some reason the fuel charge, at 1·24d., is above the normal by something like 0·4d. Oil, water, and stores are also too high by about 0·1d. These two rather high items are to some extent balanced by station wages and repairs and maintenance, which are sufficiently low to make the collective figure of generating costs very satisfactory. Nothing can be said also against management and property charges at 0·726d. per unit.

The working profit amounted to £1,861, representing 5·38 per cent. of the mean capital expenditure, and although the net result of the year's operations was a deficit of £160, yet it must be admitted that the capital charges in respect of interest and sinking fund, amounting to 5·84 per cent. of the capital, were fairly adequate.

The following table serves to indicate the progress of the concern since 1895:—

Year	No. of consumers.	Lamp connection. Equiv.	Output. (Units sold.)	Max. supply d'm'nded KW.	Plant capacity. KW.	Total costs per unit.	Net loss. Total.	Net loss. % to capital.
1895	130	6,500	114,645	140	360	3·69d.	£766	3·79%
1896	192	8,200	157,254	185	390	3·71d.	616	2·47%
1897	245	10,000	190,000	220	390	3·35d.	437	1·38%
1898	314	14,500	232,779	267	435	3·15d.	160	0·46%

Scarborough Electric Supply Co. (Limited).

The accounts of the working during 1898 of the Scarborough Electric Supply Co.'s undertaking show that steady progress is being maintained. During the year 53 additional consumers with the equivalent of 2,277 8-c.p. lamps were added to the mains. The output, at 217,254 units sold, shows an increase of 5,847 units or 27·6 per cent., and was productive of a total revenue of £5,402, or at the rate of 5·97d. per unit.

Although a slight reduction in the costs has been effected—about 0·1d.—they are still, at 3·43d., rather too high, even at the low output. Works costs at 2·67d. are also too high by nearly 0·5d., fuel and station wages being the mischievous items.

The working profit of £2,296, representing 6·1 per cent. of the mean capital, is a material advance upon the £2,021 of 1897. With but £483 in the depreciation fund after five years of working, we cannot but think that the directors have made an unfortunate step in recommending a dividend of 5½ per cent. while the vote to the depreciation fund was only £417 or 1·1 per cent. of the mean capital.

In the appended table are given a few figures indicative of the progress the concern has made:—

Year	No. of consumers.	Lamp connection. Equiv.	Output. (Units sold).	Max. supply d'm'nded KW.	Plant capacity. KW.	Total cost per unit.	Gross profit. Total.	Gross profit. Mean capital.
1894	183	10,480	86,594	150	300	...	—	...
1895	235	12,788	135,177	215	525	4·39d.	£998	3·19%
1896	298	17,727	174,514	246	525	3·80d.	£1,603	4·93%
1897	330	20,067	211,407	286	525	3·53d.	£2,021	5·83%
1898	383	22,344	217,254	274	675	3·43d.	£2,295	6·07%

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

Aberdeen (Municipal)	Jan. 6, 1899	Kingston-upon-Hull (Mun.)	June 9, 1899
Ayr (Municipal)	Sept. 22, „	Kingston-on-Thames (Mun.)	April 21, „
Bedford (Municipal)	May 19, „	Lancaster (Municipal)	Oct. 21, 1898
Belfast (Municipal)	Sept. 15, „	Leeds (Company)	Mar. 3, 1899
Birmingham (Company)	Sept. 15, „	Leicester (Municipal)	Jan. 20, „
Blackpool (Municipal)	Sept. 29, „	Leyton (Municipal)	Sept. 8, „
Bournemouth (Company)	April 28, „	Liverpool (Municipal)	June 9, „
Bolton (Municipal)	Dec. 9, 1898	Manchester (Municipal)	Aug. 11, „
Bradford (Municipal)	April 14, 1899	Newcastle and District (Co.)	Oct. 6, „
Brighton (Municipal)	May 12, „	Newcastle-upon-Tyne (Co.)	April 14, „
Bristol (Municipal)	July 14, „	Northampton (Company)	Oct. 20, „
Burnley (Municipal)	Aug. 25, „	Norwich (Company)	Dec. 2, 1898
Burton-upon-Trent (Mun.)	April 21, „	Notting Hill (Company)	Mar. 17, 1899
Bury (Municipal)	Sept. 22, „	Nottingham (Municipal)	July 21, „
Cambridge (Company)	Mar. 10, „	Oldham (Municipal)	Nov. 18, 1898
Cardiff (Municipal)	Jan. 6, „	Oxford (Company)	May 19, 1899
Charing Cross (Company)	Mar. 17, „	Pontypool (Company)	May 5, „
Chelsea (Company)	Mar. 31, „	Portsmouth (Municipal)	July 14, „
Cheltenham (Municipal)	Oct. 7, 1898	Preston (Company)	Sept. 29, „
Chester (Municipal)	June 23, 1899	Reading (Company)	Oct. 13, „
City of London (Company)	May 12, „	Richmond (Company)	Oct. 13, „
Clerkenwell (Company)	Aug. 18, „	Scarborough (Company)	April 1, 1898
Derby (Municipal)	Dec. 9, 1898	St. James' & Pall Mall (Co.)	Feb. 24, 1899
Dewsbury (Municipal)	Nov. 25, „	St. Pancras (Vestry)	May 26, „
Dover (Company)	June 2, 1899	Sheffield (Company)	Dec. 16, 1898
Dundee (Municipal)	Nov. 4, 1898	Shoreditch (Vestry)	Oct. 27, 1899
Eastbourne (Company)	July 22, „	Southampton (Municipal)	June 3, 1899
Edinburgh (Municipal)	Oct. 14, „	Southport (Municipal)	July 7, 1899
Exeter (Municipal)	Aug. 5, „	South Shields (Municipal)	July 7, „
Glasgow (Municipal)	Sept. 1, 1899	Stafford (Municipal)	Oct. 21, 1898
Guildford (Company)	May 5, „	Sunderland (Municipal)	July 28, 1899
Halifax (Municipal)	July 21, „	Taunton (Municipal)	June 16, „
Hammersmith (Vestry)	May 26, „	Tunbridge Wells (Mun.)	Sept. 1, „
Hampstead (Vestry)	Aug. 25, „	Walsall (Municipal)	June 23, „
Hanley (Municipal)	April 28, „	Wandsworth (Company)	Aug. 12, „
Harrogate (Municipal)	Oct. 20, „	Westminster (Company)	Feb. 24, „
Harrow (Company)	June 16, „	Whitehaven (Municipal)	July 28, „
Hast'gs & St. Leonards (Co.)	April 29, 1898	Windsor (Company)	Dec. 30, 1898
H'use-to-H'useCo. (K'ns'gt'n)	Mar. 31, 1899	Wolverhampton (Municipal)	June 30, 1899
Hove (Company)	Mar. 10, „	Woolwich (Company)	Jan. 13, „
Huddersfield (Municipal)	Oct. 6, „	Worcester (Municipal)	April 7, „
Islington (Vestry)	Oct. 27, „	Yarmouth (Municipal)	June 17, 1898
Kens'gton & Knightsbr' (Co.)	Mar. 3, „		

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	GREAT YARMOUTH.		SCARBOROUGH.	
Undertaking Worked by	Great Yarmouth Corporation.		The Scarborough Electric Supply Co. (Ltd.)	
Date of Commencement of Supply	October, 1894.*	[transformers.	September, 1893.	[partly house trans.
System of Supply	Alt.-cur. transformer sub-stations and house		Alternate-current transformer sub-stations and	
Chief Engineer	Gordon Bryant.		F. G. Holden.	
YEAR ENDED	DEC. 31, **1897.**	DEC. 31, **1898.**	DEC. 31, **1897.**	DEC. 31, **1898.**
QUANTITIES—				
Units generated	271,420	322,371	214,044	443,066
„ **SOLD (TOTAL)**	190,000	232,779	211,407	217,254
„ sold to consumers	120,760	150,329	211,407	217,254
„ sold for public lighting, &c.	69,240	78,250	nil.	nil.
„ used on works	73,760	5,883	2,637	2,755
UNITS SOLD PER 8 C.P. LAMP CAPACITY	15·8	17·1	12·9	10·3
Maximum supply demanded	220 kilowatts	267 kilowatts	286 kilowatts	274 kilowatts
Number of public lamps	72 arc	77 arc	none	none
Number of consumers	245	314	330	383
Connections to mains in 8-c.p. lamps	10,000	14,500	20,067	22,344
CAPACITY OF PLANT IN 8-C.P. LAMPS	12,000	13,600	16,400	21,100
CAPACITY OF PLANT IN KILOWATTS	390	435	525	675
CAPITAL—	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.
AUTHORISED (TOTAL)	£35,200 / £90·3	£40,000 / £92·0	£50,000 / £95·2	£50,000 / £74·1
Share	— / —	— / —	50,000 / 95·2	50,000 / 74·1
Loan (including Debenture charges)	35,200 / 90·3	40,000 / 92·0	— / —	— / —
RECEIVED (TOTAL)	33,008[a] / 84·6	34,908[a] / 80·3	35,967 / 68·5	38,083 / 56·4
Share	— / —	— / —	35,167 / 68·5	38,083 / 56·4
Loan (including Debenture charges)	32,795 / 84·1	34,695 / 79·8	— / —	— / —
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	2,405 / 6·17	5,305 / 1·22	14,033 / 26·7	11,917 / 17·7
Share (unissued)	— / —	— / —	10,000 / 19·0	5,000 / 7·41
Share (uncalled)	— / —	— / —	4,033 / 7·68	6,917 / 10·3
Loan (including Debentures)	2,405 / 6·17	5,305 / 1·22	nil / —	nil / —
REPAID (TOTAL)	nil / —	1,550 / 3·56	— / —	— / —
RESERVE OR SINKING FUND	2,092 / 5·37	1,559 / 3·59	— / —	— / —
DEPRECIATION FUND	— / —	— / —	250 / 0·476	900 / 1·33
EXPENDED (TOTAL)	33,622 / 86·2	35,533 / 81·7	35,563 / 67·8	40,039 / 59·4
Lands and buildings	5,311 / 13·6	5,321 / 12·2	6,602 / 12·6	7,040 / 10·4
Plant	18,103 / 46·4	19,400 / 44·6	15,273 / 29·1	19,900 / 29·5
Mains	8,345 / 21·4	8,948 / 20·6	11,171 / 21·5	12,452 / 18·5
Miscellaneous	1,862 / 4·78	1,864 / 4·29	2,516 / 4·79	647 / 0·959
BALANCE OF CAPITAL ACCOUNT	−614[b] / −1·57	−625[b] / −1·44	+404 / 0·770	−1,956[h] / −2·90
REVENUE—	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.
TOTAL	£4,015 / 5·07d.	£4,918 / 5·070d.	£5,182 / 5·880d.	£5,402 / 5·972d.
Revenue from supply	2,984 / 3·77d.	3,774 / 3·890d.	5,025 / 5·700d.	5,231 / 5·782d.
„ meters, &c.	130 / 0·164d.	156 / 0·161d.	155 / 0·176d.	171 / 0·189d.
„ public lighting	901 / 1·14d.	988 / 1·018d.	nil / —	— / —
„ sale of lamps, &c.	— / —	— / —	2 / 0·002d.	— / —
„ miscellaneous sources	— / —	— / —	— / —	1 / 0·001d.
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	£2,650 / 3·35d.	£3,057 / 3·150d.	£3,108 / 3·530d.	£3,106 / 3·434d.
WORKS COSTS	2,032 / 2·57d.	2,352 / 2·423d.	2,416 / 2·740d.	2,416 / 2·670d.
Generation of electricity	*1,720 / 2·17d.*	*2,040 / 2·103d.*	*2,190 / 2·490d.*	*2,229[i] / 2·464d.*
Fuel (including cartage, &c.)	1,080 / 1·36d.	1,200 / 1·236d.	1,139 / 1·290d.	1,080 / 1·194d.
Oil, waste, water, stores	199 / 0·251d.	239 / 0·246d.	67 / 0·076d.	101 / 0·112d.
Wages at station	360 / 0·455d.	388 / 0·400d.	772 / 0·876d.	733 / 0·811d.
Repairs and maintenance at station	82 / 0·104d.	213 / 0·220d.	212 / 0·251d.	249 / 0·275d.
Distribution of electricity	*59 / 0·075d.*	*37 / 0·038d.*	*226 / 0·256d.*	187 / 0·207d.
Wages, &c.	38 / 0·048d.	28 / 0·029d.	120 / 0·136d.	99 / 0·109d.
Repairs, renewals of mains, &c.	21 / 0·027d.	9 / 0·009d.	106 / 0·120d.	88 / 0·097d.
Public lighting	*253 / 0·320d.*	*275 / 0·283d.*	nil / —	nil / —
Attendance	178 / 0·225d.	184 / 0·190d.	— / —	— / —
Renewals	75 / 0·095d.	91 / 0·094d.	— / —	— / —
MANAGEMENT AND PROPERTY CHARGES	618 / 0·781d.	705 / 0·726d.	692 / 0·786d.	690 / 0·763d.
Royalties	— / —	— / —	— / —	— / —
Rent, rates, taxes	*66 / 0·083d.*	*142 / 0·146d.*	*124[a] / 0·141d.*	*217[j] / 0·240d.*
Management	*552 / 0·698d.*	*563 / 0·580d.*	*568 / 0·646d.*	*473 / 0·530d.*
Salaries	451 / 0·570d.	434 / 0·447d.	281 / 0·319d.	272[k] / 0·301d.
Stationery, &c.	17 / 0·022d.	24 / 0·025d.	54 / 0·061d.	63 / 0·070d.
Establishment charges	7 / 0·009d.	12 / 0·012d.	169[b] / 0·192d.	46 / 0·051d.
Law charges, &c.	77[c] / 0·097d.	93[c] / 0·096d.	64[c] / 0·073d.	92[l] / 0·102d.
FINANCIAL RESULTS—	Total. / % to mean cap.exp'nded	Total. / % to mean cap.exp'nded	Total / % to mean cap. exp'nded	Total. / % to mean cap.exp'nded
WORKING PROFIT FOR YEAR	£1,365 / 4·32%	£1,861 / 5·38%	£2,021[d] / 5·83%	£2,296 / 6·07%
Sum carried to Depreciation Fund	— / —	— / —	250 / 0·722%	417 / 1·103%
Sum carried to Reserve or Sinking Fund	853 / 2·70%	963 / 2·78%	— / —	— / —
Net interest on loans (incl. Debenture charges)	950 / 3·01%	1,058 / 3·06%	18[e] / 0·052%	12[e] / 0·032%
BALANCE FROM LAST ACCOUNT	— / —	— / —	192 / 0 554%	189 / 0·50%
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	— / —	— / —	1,845[f] / 5·32%	2,333[m] / 6·17%
Deficit	*437 / 1·38%*	*160[f] / 0·462%*	— / —	— / —
ORDINARY DIVIDEND PAID	— / —	— / —	5% / —	5½% / —
PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE	66%	62·2%	60%	57·5%
Expenditure per kilowatt capacity	£6. 16s. 0d.	£7. 0s. 7d.	£5. 18s. 5d.	£4. 12s. 0d.
REVENUE PER KILOWATT CAPACITY	£10. 6s. 0d.	£11. 6s. 0d.	£9. 17s. 7d.	£8. 0s. 2d.
Expenditure per 8-c. lamp capacity	4s. 5d.	4s. 6d.	3s. 9½d.	2s. 11½d.
REVENUE PER 8-C.P. LAMP CAPACITY	6s. 8¼d.	7s. 2¼d.	6s. 3¾d.	5s. 1½d.
REVENUE PER 8-C.P. LAMP CONNECTED	8s. 0½d.	6s. 9½d.	5s. 2d.	4s. 10d.
Price charged for lighting, per unit	6d.[d]	6d.[d]	6½d. to 5¼d.[g]	6½d. to 5¼d.[n]
Price charged for power, per unit	3½d.	3½d. [ann.		2½d.
Price charged for public lighting	£12. 10s.	£16 per 10-amp. arc per	—	—

GREAT YARMOUTH.—REMARKS—* Public lighting started October, 1894; private supply, January, 1895. *a* Includes £200, value of lands owned by authority, and appropriated for electrical purposes. *b* Over-expended. *c* Includes £43 to insurance. *d* For "places of worship" the charge is 4d. per unit. *e* Includes £14 to insurance. *f* Of which £74 is deficiency to March 31, 1898, £[illegible] 237 from March 31, 1898, to December 31, 1898.

SCARBOROUGH.—REMARKS—*a* Includes rent of telephone. *b* Includes £65 to lighting of works. *c* Includes auditing and £28 for insurance, superannuation, &c. *d* After deducting bad debts, £53. *e* Interest on bank overdraft. *f* £100 having been written off preliminary expenses. *g* Less 5 per cent. discount. *h* Over-expended. *i* Includes £65 for lighting of works. *j* Includes £166 rent of station and offices, £37 income tax, and £14 telephone. *k* Inclusive of £100 directors' remuneration. *l* Includes £35 to auditing and £54 to insurance. *m* After adding £278 premiums on shares. *n* Accounts over £75 on Wright system, 7d. to 3½d. on one-hour scale.

The Electrician.

The Oldest Electrical Journal (established as a weekly Journal 1861—1878)

Published every Friday, Price Sixpence; Post Free, Sixpence-Halfpenny
Editorial, Publishing and Printing Offices,

1, 2 & 3, SALISBURY COURT, FLEET ST., LONDON,

Telephone: 949 Holborn. *Telegrams:* "ELECTRICIAN NEWSPAPER LONDON."

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"THE ELECTRICIAN" *is published every Friday morning, in time for the morning mails. It is on sale at the railway bookstalls throughout the Kingdom on Friday morning, and can be obtained of all Booksellers and Newsvendors; or direct from the Publishing Offices, as above*

New Volumes of "THE ELECTRICIAN" *commence in April and October.*

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	Year	Half-Year	Quarter	
United Kingdom	26s. 0d.	13s. 6d.	7s. 0d.	Post free, payable in advance.
Postal Union	30s. 0d.	15s. 0d.	8s. 0d.	

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THE PACIFIC CABLE AND ITS ALTERNATIVE.

IN the half-yearly report of the Eastern Extension, Australasia and China Telegraph Co., just issued, reference is made to the offer of the Company, in conjunction with the Eastern Telegraph Co., to provide a new cable from England to Australia, viâ the Cape of Good Hope. Those who have read the able and exhaustive report of the POSTMASTER-GENERAL of South Australia, published in full in our issue of October 20th, will have seen that the proposal in question is important and far-reaching. It is at once to reduce the rates on ordinary messages to 4s. per word (an average reduction on Australian telegrams of 9½d. per word), to 3s. per word for Government messages, and to 1s. 6d. per word for Press telegrams. In addition, the company offer to lay a cable from Durban to Fremantle (West Australia), viâ Mauritius, Rodriques, and Cocos Islands. This will be an extension of the direct submarine line from England to the Cape of Good Hope, touching, amongst other places already connected by cable, at Ascension and St. Helena, messages passing from Cape Town to Durban by existing land lines. The companies seek no subsidy or guarantee, but ask only, in consideration of these liberal concessions, that they should be allowed to open offices in Perth, Adelaide, Melbourne, and Sydney, as they have always done in the principal towns of Great Britain. They further agree that, when the revenue from Australasian traffic, after the successive reductions, again reaches an average for three years of £350,000, the rates shall be successively reduced to 3s. 6d., 3s., and 2s. 6d. for ordinary messages. The existing cables to Australia and South Africa being duplicated throughout, and tripled for the greater part of the distance, the new route will form a complete triplicate connection with those places; will open up communication with Ascension and St. Helena, at present telegraphically isolated; will give duplicate lines to Mauritius, and form another alternative route to India, China, &c., in the event of interruption to the Mediterranean or Red Sea cables, as well as secure an additional connection between many intermediate places. Sir CHARLES TODD, the Postmaster-General of South Australia, recommends the acceptance of this spirited offer; and it will, we think, be admitted that the com-

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panies concerned are showing no lack of enterprise in meeting the commercial and strategical needs of the Empire so far as justice to their shareholders permits them to do. They are willing to surrender the natural increase of traffic, stimulated by considerably lower rates, for many years to come, in order to make immediate and successive reductions of tariff, as well as to spend during the next two years, on providing the alternative communication, about two millions, with its concomitant increases in interest, working expenses, repairs and renewals.

Sir CHARLES TODD deals also with the Pacific cable question, and as an expert unflinchingly lays bare its weak points. The existing routes have many feeding places, while the Pacific line will connect no places of importance except the termini, and must draw its revenue from messages between the United Kingdom and Australia, *plus* the small traffic between Australia and Canada and the United States. To save cost, it has been suggested to land at Hawaii; but even if the Pacific sections only touched at British territory, it could not be called an "all-British" route, as it would use an Atlantic cable owned in the United States. Again, to secure the communication it would be necessary to lay a duplicate line in the Pacific, which would make the loss on working exceedingly heavy—and even then would afford no certainty against "faults" which would stop transmission. For instance, three sections—short, compared with the Pacific line—in the eastern part of the Australian route have been simultaneously interrupted, thus cutting off communication with the Antipodes; and more than once the cables on each side of Africa have been broken at practically the same time. The report contains a list of interruptions to Atlantic cables, which are only about one-third of the length of the Pacific line, for the nine years from 1887 to 1895. It is shown that in each of four years two cables out of seven were broken at the same time; in four other years, three out of seven were simultaneously interrupted; and in 1894 four lines out of seven were unworkable at the same time.

Sir CHARLES TODD'S examination of the financial aspect of the Pacific cable scheme is decidedly not encouraging. Assuming a through rate of 3s. 6d. per word and an annual growth of revenue of 7 per cent., which he thinks too high an estimate, the deficit with two cables would not even for the tenth year be less than £140,539; or with one cable £10,039. Sir CHARLES TODD estimates the cost of a Pacific cable at more than two millions sterling, and draws attention to the scarcity and very high price of gutta-percha. With the extensive cable-laying programme which is projected during the next two years, it is not too much to say that, if it were decided to attempt to carry out the Pacific scheme also within that time, gutta-percha would go to such a price as would make the cost of that cable so heavy that even the Government would not care to face the inevitable loss. Sir CHARLES further points out that, in any circumstances, the Australian Colonies would have to bear a serious loss under the Pacific scheme, while by the adoption of the Eastern Extension Co.'s proposals they would derive at no cost all the advantages of an additional cable, with reduced uniform rates, commencing at 4s. and gradual reductions to 2s. 6d. With such a report before them, the Australian Colonies will probably think twice before they burden themselves with Pacific cables from sentimental or other equally unpractical considerations. The probability of a United States competitive cable in those waters, which would greatly augment the estimated deficits, is a further obvious reason for having nothing to do with such schemes.

REVIEWS.

Copies of any of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price.)

Practical Magnetism and Electricity. By J. REGINALD ASHWORTH, M.Sc. (Vict.). (London: Whittaker and Co. 1899.) 2s. 6d.

The title of this little book is hardly appropriate, as it partakes more of the nature of an elementary laboratory manual of experiments in electricity and magnetism. It is intended as a guide to an experimental knowledge of electricity for students attending elementary lectures. The work is divided into three parts—viz., "Magnetism," "Electricity at Rest," and "Electricity in Motion," in the order named. The reason given for this order is that the experiments in magnetism require only a moderate amount of skill and are comparatively easy to understand; those in electrostatics a higher order of skill, etc. We must say that we cannot agree that this is an adequate reason for the course taken. The collective subject admits of being presented to the student in more logical sequence, and of therefore being more scientifically apprehended by him than it would be in the order of treatment in which "Electricity at Rest" is discussed after "Magnetism." With these strictures, we must say that the experiments are well chosen and described, and the error is not fallen into of making the explanations more minute than is absolutely necessary. The student is thus called upon to exercise his ingenuity—an exercise more than anything calculated to impress upon him the why and wherefore of the phenomena he produces.

Measurement and Weighing: a First Year's Course in Elementary Physics. By EDWIN EDSER. (London: Chapman and Hall. 1899.) 2s. 6d.

In this volume we have the result of Mr. Edser's endeavour to arrange a course of experimental physics suitable to a first year student, which should form a basis for ensuing scientific work, and impart a physical definiteness to those elementary mathematical conceptions and trains of reasoning which so frequently occur in physical investigations. The field selected has been purposely limited with the object of ensuring greater thoroughness of treatment. The chapter which deals with mass and density handles these subjects with much detail, and in a slightly novel manner which should render them more intelligible to the reader.

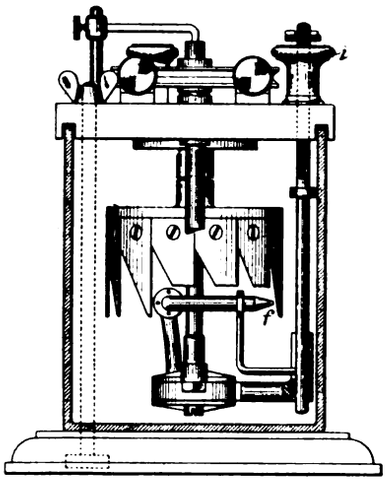
Specification. No. 4, September, 1899. (London: The Proprietors of the *Builders' Journal and Architectural Record.*)

This half-yearly publication continues to enlarge, No. 4 containing a hundred pages more than its immediate predecessor. It presents itself also in a somewhat more serviceable binding. There is an enormous amount of matter and data, useful to engineers and architects, contained in the 726 large pages constituting the volume. Among the data of direct interest to electrical engineers there are some figures given in the section "Architect" on the cost of erection of central station buildings and on the cost of wiring for electric light in different establishments. Mr. K. S. MacKinlay gives another instalment, discussing "A Country House Electric Lighting Installation," and deals with the choice and position of lights and fittings. In the section on "Wind Motors" there appears a short description of an interesting electric lighting plant worked by a modern wind-engine which has been erected and, it is stated, is very successfully running at Boyle Hall, West Ardsley, Yorkshire. We learn that "the whole plant has been specially arranged to run without anyone in attendance," and that it is estimated "that not more than three hours a week will be spent in looking after the engine and dynamo, and this time will be mainly occupied in oiling the engine." This statement appears intended to exclude the attendance necessary on the storage cells, of which there are installed sufficient to run the lights (about 109) for about eight days in winter and fourteen in summer, should there be no wind. The section "Legal" contains a lot of information on the law pertaining to engineers and engineering contracts, and is followed by a useful supplement sheet table of the wages paid in different trades in various districts in the British Isles and abroad. In this number each section is followed by a short index, while there is a general index at the end of the volume.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

Universal Mercury Interrupter.—An interrupter of a particularly interesting type has been devised and constructed by Max Levy, Berlin. Its most valuable feature is its power of adjustment, which not only extends to the number of interruptions per second, but to the fractional value of the interruption in comparison with the closing of the circuit. It consists essentially of a fine jet of mercury forming one contact piece, and a series of teeth cut in a cylindrical surface forming the other contact piece. The construction is shown in the diagram. An electromotor drives both the wheel and the pump of the mercury jet *f*. By turning the ebonite nut *i* the jet may be raised or lowered, and thus the ratio of contact to interruption varied between zero and infinity; hence, whatever may be the E.M.F. used, the mean current strength may be brought to the same uniform value. When not in action there is always interruption of the current, a circumstance which is practically very convenient. The ordinary arrangement of the driving mechanism provides for a speed of 800 to 1,000 revolutions per minute, or, since there are 24 teeth on the wheel, and the teeth can be separately mounted or omitted, the interruptions per minute can be varied between



300 and 24,000, or from 5 to 400 per second. All the effects of Wehnelt's interrupter can be repeated with the new interrupter. Moreover, any induction coil can be driven direct from the local lighting system without the interposition of resistances, since the mean current strength can be regulated at will. The interrupter should have a great future before it.

[M. Levy, *Electrotechn. Zschr.*, October 12, 1899.]

Cooling Device for Röntgen Tubes.—For keeping the anti-cathode cool, and thus avoiding the inconveniences and dangers attending the use of high-rate Röntgen tubes, several devices have been adopted. B. Walter described one recently in which the anti-cathode was connected by an iron rod with a small flask of water outside the tube. A. Buguet and V. Chabaud have brought the water into direct contact with the anti-cathode. A wide tube of platinum is soldered directly into the glass tube. Its end is cut at an angle suitable for carrying the anti-cathode, which seals the tube hermetically at that end. The other end projects outside the tube. It is bent upwards, and carries at its extremity a flask of water. The water being on the inside of the anti-cathode itself, the latter can never reach a temperature superior to the boiling point of water as long as the supply of water is kept up. If the temperature is to be kept still lower, a concentric tube can be inserted in the platinum tube and water circulated through the system. The anti-cathode is made wider than the platinum tube, so as to form a flange stopping the stray cathode rays. The platinum tube is also protected by a sleeve of glass. In practice the new device has proved eminently satisfactory. It is capable of withstanding the discharges produced by the largest induction coils actuated by the most rapid interrupters, which would fuse an ordinary anti-cathode in a few seconds. The vacuum does not undergo any change in the process. The intensity and composition of the Röntgen beam can now be kept constant for any exposure practically necessary, and many dangers are thus eliminated.

[Buguet and Chabaud, *Comptes Rendus*, October 16, 1899.]

New Radio-active Substance.—By further analysis of the materials contained in pitchblende A. Debierne has isolated a substance generally resembling titanium, but possessing in addition a remarkably high radio-activity, estimated at 100,000 times that of uranium and its salts, and about the same as that of radium and polonium, from which substances, however, the new material differs decidedly in chemical characteristics. Polonium has the chemical properties of bismuth, and only separates from it on fractional crystallisation. Similarly, radium goes with barium. The new substance was isolated in the course of a detailed study of the constituents whose acid solutions are not precipitated by sulphuretted hydrogen, but are completely precipitated by ammonia or by ammonium sulphide. After eliminating as completely as possible the known radio-active substances like uranium, polonium, and radium, a residue was obtained consisting largely of iron oxide and alumina, but also containing small quanties of zinc, manganese, chromium, titanium, lanthanum, and other rare elements. The portion containing the titanium group of metals showed considerable radio-activity, and after a complicated treatment, the details of which are promised in a subsequent Paper, a material was finally evolved showing the high radio-activity of radium, without, however, being self-luminous. It makes gases capable of discharging electrified bodies, excites the fluorescence of barium platinocyanide and other screens, and acts upon the photographic plate.

[A. Debierne, *Comptes Rendus*, October 16, 1899.

Wireless Telegraphy on Mont Blanc.—It might be expected, *a priori*, that wireless telegraphy would be as successful in the higher regions of the atmosphere as on sea level, if not more so. But it is by no means certain that the peculiar conditions as to atmospheric electricity, and the continuous surface covering of permanent snow, which are characteristic of the Alpine landscape, do not offer hitherto unknown obstacles to the new telegraphy. The experiments in sending messages between Chamonix and the top of Mont Blanc, carried out by J. and L. Lecarme, are therefore of considerable interest. The sender was stationed at Chamonix, 1,000m. above sea-level, and the receiver at the Vallot Observatory, at an altitude of 4,350m. The lineal distance between the stations was 7½ miles. The coherer used was one of Branly's gold-filing pattern. The hammer was constructed so as to interrupt the current traversing the coherer before the shock, thus enabling a feeble knock to decohere the apparatus and keeping its sensibility practically constant. The transmitting mast wire was 25m. long, and was mounted at an inclination of 30deg. to the ground. The best signals were obtained with a sparking distance of 2cm. in the oscillator. The absence of liquid water was found to be no disadvantage. Clouds did not interfere with the signals. Atmospheric electricity did interfere with the receiver, but not so as to spoil the messages. The greatest and indeed the only serious obstacle was the three-phase electric lighting system of Chamonix, which made telegraphy impossible at night time, at least with the type of coherer used. The stations were visible to each other, and the telegraphic messages could be verified by optical means.

[J. and L. Lecarme, *Comptes Rendus*, Oct. 16, 1899.]

Improvements in Lippmann Photography.—O. Wiener, who has for some time been actively studying the Lippmann process, points out and explains the faults in the pictures produced by the peculiar interference of the rays reflected from the gelatine surface with the rays proceeding from within

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the gelatine itself. There is always a difference of phase between the surface wave and the wave reflected from Lippmann's first elementary stratum, and this difference of phase displaces the spectrum colours towards the red, and produces wrong colouring. The obvious remedy is to eliminate the surface reflection altogether. This can be done by immersing the finished plate in a bath of benzol, which has about the same refractivity as gelatine, and therefore eliminates the reflection at the surface of the latter. A less circumstantial remedy consists in producing a large difference of path between the surface wave and the first elementary wave, by coating the gelatine with a layer of collodion. If this layer is made of such a thickness as to make the phases of the two waves coincident, very brilliant and true effects are obtained, but that can only happen by a fortunate accident, as the thickness required differs with the colour.

[O. WIENER, *Wied. Ann.*, No. 10, 1899.]

Electro-photography.—A study of Lichtenberg figures has led L. Fomm to devise a plan for photographing sections of different kinds of wood by simple contact. The sections must be thin and smooth. They are covered on one side with tinfoil, and on the other with a sheet of bromide paper, with the gelatine in contact with the wood. A negatively-charged metallic point is mounted at a distance of 5cm. from the paper surface. An influence machine produces a good impression in about half a minute, showing clearly the cambium rings and medullary rays of the wood. What happens is that the paper is negatively charged, and the narrow layer of air between it and the wood is filled with photographically active glow-light, which varies in intensity according to the nature of the woody substance. The electrophotograph thus obtained is not necessarily similar to an ordinary photograph, since the light and shade does not depend upon the optical character, but upon the physical or chemical structure of the surface. Thus the medullary rays of oak come out bright, those of beech dark, though optically they are both bright. The reason is that the medullary rays of oak contain much starch, those of beech little. The author does not seem to have attempted to print drawings, writing, or type in this manner, but if that could be done it would be very useful, as a lens could then be dispensed with.

[L. FOMM, *Wied. Ann.*, No. 10, 1899.]

THE THEORY OF THE POWER FACTOR.

BY ALEXANDER RUSSELL, M.A.

It is found to be convenient in practice to call the ratio of the real watts expended in an alternating-current circuit to the apparent watts the power factor of the circuit. The following investigation is an attempt to show how the power factor is related to the shape of the waves of current and potential difference, and their relative positions. The inventor of new alternating-current motors or arc lamps nearly always claims that his apparatus has a high power factor. It may, however, have a higher power factor on some circuits than on others. It will not be uninteresting, therefore, to try and see from first principles how the power factor depends on the shape of the waves.

A study of the curves shown and the figures given in Messrs. Duddell and Marchant's Paper on "Experiments on Alternate-Current Arcs by Aid of Oscillographs"* illustrates how the power factor varies with the shape of the waves. We see, for example, from the photographs they give, that the more the P.D. waves and the current waves approach similarity the higher the power factor. We also see that the power factor has very little to do with the cosine of the angle of lag except in the very particular case when both the waves are sine curves.

The insertion in the circuit of a piece of apparatus like an arc lamp possessing variable resistance and inductance makes the direct analytical treatment of the problem very difficult. We will therefore consider a few simple mathematical curves, and see how their power factors are related, and whether these relations bear out what Messrs. Duddell and Marchant discovered experimentally. Before doing this we will prove a fundamental theorem on the power factor, and define what we mean by phase difference.

The Power Factor.—The power factor of a circuit is the ratio of the real watts being expended in it to the apparent watts.

In mathematical symbols the power factor

$$= \frac{\int_0^T e\,i\,dt}{\left\{\int_0^T e^2 dt \int_0^T i^2 dt\right\}^{\frac{1}{2}}}, \qquad \text{(i.)}$$

where e and i denote the instantaneous values of the volts and amperes, t is the time in seconds and T the period of the alternating current.

Theorem.—If the power factor of a circuit equal unity, then the instantaneous value of the volts divided by the instantaneous value of the amperes is constant.

The current wave and the P.D. wave are therefore similar curves vanishing at the same instant, and also attaining their maximum and minimum values at the same time.

To prove this we notice, from the meaning of the integral sign, that

$$\frac{1}{T}\int_0^T e^2 dt = \mathrm{L}_{n=\infty} \frac{e_1^2 + e_2^2 + e_3^2 + \ldots\ldots + e_n^2}{n},$$

e_1, e_2, &c., being equidistant ordinates of the E.M.F. wave.

Dividing up the current wave into the same number of ordinates, we see that if the power factor equals unity, then

$$\frac{(e_1 i_1 + e_2 i_2 + e_3 i_3 + \ldots\ldots + e_n i_n)^2}{(e_1^2 + e_2^2 + \ldots\ldots + e_n^2)(i_1^2 + i_2^2 + \ldots\ldots + i_n^2)} = 1,$$

$$\therefore\ (e_1 i_1 + e_2 i_2 + \ldots\ldots)^2 - (e_1^2 + e_2^2 + \ldots\ldots)(i_1^2 + i_2^2 + \ldots\ldots) = 0,$$

$$\therefore\ (e_1 i_2 - e_2 i_1)^2 + (e_1 i_3 - e_3 i_1)^2 + \ldots\ldots = 0.$$

Now, since the square of a number is always positive, therefore every term on the left hand side is positive; and since the sum of them is zero, therefore every term must be zero.

Hence $e_1 i_2 - e_2 i_1 = 0$; $e_1 i_3 - e_3 i_1 = 0$; &c.,

$$\therefore\ \frac{e_1}{i_1} = \frac{e_2}{i_2} = \frac{e_3}{i_3} = \ldots\ldots = \frac{e_n}{i_n},$$

which proves the theorem.

Again, since $(e_1 i_2 - e_2 i_1)^2 + (e_1 i_3 - e_3 i_1)^2 + \ldots\ldots$ is always greater than zero except when each term equals zero, it

FIG. 1.

easily follows, by going through the above proof backwards, that the power factor is less than unity except in the very particular case when the current and E.M.F. waves are similar curves.

By defining the power factor as the cosine of a certain angle, we are able in many cases to give a geometrical interpretation to the quantities involved, and hence we can easily prove many algebraical relations between them by the help of known theorems in geometry and trigonometry. We will consider a simple case.

Suppose that B_2C (Fig. 1) is part of an alternating-current circuit. Let the resistances between BB_1 and B_1B_2 be R_1 and R_2 respectively, and suppose them non-inductive. Let e_1, e' be the instantaneous values of the P.D. between B_1 and C, and between B and C respectively, and let the instantaneous value of the current be i.

Then evidently we always have

$$e' = e_1 - R_1 i,$$

$$\therefore\ e'^2 = e_1^2 + R_1^2 i^2 - 2R_1 e_1 i.$$

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Hence by summation over a whole period

$$V'^2 = V_1^2 + R_1^2A^2 - 2R_1W, \quad . \quad . \quad . \quad . \quad (ii.)$$

where V', V_1, A and W are the effective values of e', e_1, i, and $e_1 i$ respectively.

Now, if we denote the power factor of the circuit B_1C by $\cos \phi_1$,

$$\cos \phi_1 = \frac{W}{V_1 A}.$$

Hence substituting in (ii.) we get

$$V'^2 = V_1^2 + R_1^2A^2 - 2R_1V_1A \cos \phi_1.$$

If we now construct a triangle CBB_1 (Fig. 2), whose sides CB, BB_1, and B_1C are V', R_1A, and V_1 respectively, we see by trigonometry that the angle CB_1B is ϕ_1. The cosine of CB_1B is therefore the power factor of the circuit CB_1 (Fig. 1).

Similarly producing BB_1 (Fig. 2) to B_2 and making B_1B_2 equal to R_2A, it is easy to show that the cosine of the angle CB_2B is the power factor of the circuit CB_2 (Fig. 1), and that CB_2 (Fig. 2) is the P.D. between C and B_2. If V_2 denote this P.D. and ϕ_2 denote the angle CB_2B, then by trigonometry

$$V_2 \sin \phi_2 = V_1 \sin \phi_1.$$

Interpreted electrically, this means that the reactance of the circuit between C and B_2 equals the reactance between C and B_1.

If we denote the angle CBK by ϕ' then

$$V_1 \cos \phi_1 - V' \cos \phi' = RA.$$

$$\therefore V_1A \cos \phi_1 - V'A \cos \phi' = RA^2.$$

Since $V_1A \cos \phi_1$ is the work done between B_1 and C it follows from this equation that $V'A \cos \phi'$ is the work done in the

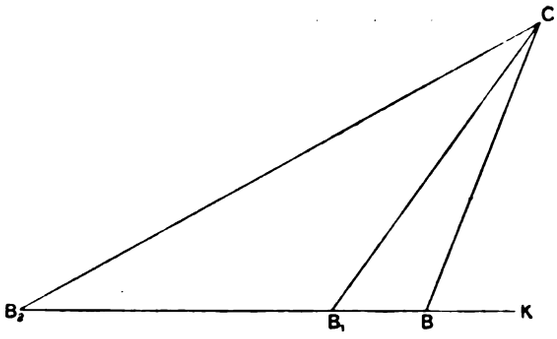

Fig. 2.

circuit BC. Hence $\cos \phi'$ is the power factor of BC. Fig. (2) then can be used to prove many relations between the volts, amperes, and watts in the circuit, and hence defining the power factor as the cosine of an angle is a real help in understanding the relations of the various quantities involved.

Definition of Phase Difference—It is convenient to call the angle whose cosine is the power factor as the phase difference between the curves of P.D. and current. More generally, if e_1 and e_2 be two periodic functions of the same frequency and ϕ be their phase difference then

$$\cos \phi = \frac{\int_0^T e_1 e_2 dt}{\left\{\int_0^T e_1^2 dt \int_0^T e_2^2 dt\right\}^{\frac{1}{2}}} \quad . \quad . \quad . \quad . \quad (iii.)$$

ϕ being an angle between 0deg. and 180deg.

Example.—If ϕ be the phase difference between e_1 and e_2 calculated from (iii.), and V_1 and V_2 be their effective values, then the effective value V of $e_1 + e_2$ is got by finding the length of the diagonal of the parallelogram constructed with V_1 and V_2 as adjacent sides, the angle between them being ϕ.

We must be careful to make a distinction between the angle of phase difference as defined in (iii.) and the angle of phase difference as we are accustomed to consider it when discussing sine curves. The P.D. wave and the current wave may have their zero points coincident and attain their maximum values at the same time, and yet their phase difference as defined above may be a considerable angle. This will be best understood by solving a few numerical examples.

(To be concluded.)

SOME RECENT APPLICATIONS OF ELECTRO-METALLURGY TO MECHANICAL ENGINEERING.*

BY SHERARD COWPER-COLES, ASSOC M.INST.C.E., M.I.M.E., M I.E.E.

Electro-chemistry and metallurgy are beginning to play an important part in large engineering works: for instance, electricity is now being applied to galvanising, the removal of mill scale, the production of metallic reflectors, the manufacture of copper tubes and sheets, the recovery of tin from tin scrap, and for the coating of iron and steel with brass, for welding, brazing, soldering, and for sharpening files. It is also being introduced to allied industries, such as the manufacture of white lead. Time will not permit of my giving a description of more than the three first applications.

Galvanising.—Electro-galvanising is at the present time extensively used for coating the frames and plates of torpedo boat destroyers, and for the galvanising of tubes for water-tube boilers such as the Normand. One feature that makes this process particularly suitable for this class of work is that it does not cover up defects; nor does it reduce the tensile strength of iron and steel of small section, or distort it, as in the case of hot galvanising; but it shows up any defect in the steel, which means a considerable saving of time and money, as any flaw in the steel is detected at an early stage of manufacture, and not in the final testing—as, for instance, when all the parts of a boiler have been assembled. Another advantage of electro-galvanising is that the plant can be worked intermittently without loss, and varying thicknesses of zinc can be obtained at the will of the operator; the thickness of zinc usually applied to such work as boiler tubes is ¾oz. to 1¼oz. per square foot.

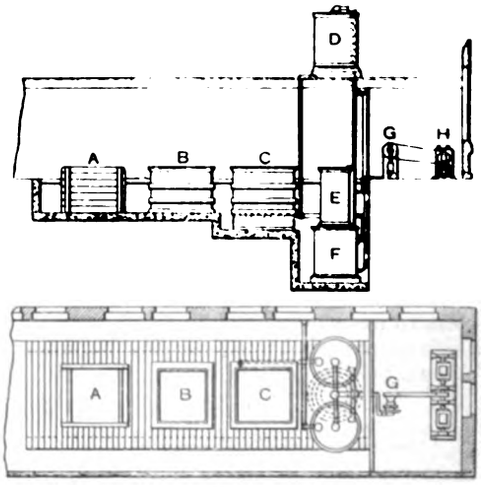

Fig. 1.

Scale ¼in. = 1ft.

A Pickling tank. B Wasting tank. C Zincing tank.
D Regenerating tank. E Overflow tank. F Compressed air tank.
G Air compressor. H Dynamo and motor.

The process of electro-galvanising consists of first removing the scale and rust from the work to be galvanised, either by immersing in an acid solution or by sand-blasting. It is then placed direct in the galvanising bath, which is composed of a solution of zinc sulphate containing about 30oz. to the gallon of solution. The work to be galvanised is suspended by means of gun-metal carriers which rest on bars or girders running the length of the tank; the electric current is conducted into the solution by means of lead or zinc plates, the voltage at the terminals of the dynamo being six, and the number of amperes per square foot of cathode surface 15 to 20. The solution is rapidly circulated through the bath by means of a small centrifugal pump or air compressor, and is regenerated as the zinc is deposited by passing it over a filter bed composed of carbon, coke, or sand, mixed with zinc dust, which is obtained as a by-product during the distillation of zinc from its ores.

Fig. 1 illustrates a plant suitable for coating plates up to 7ft. in length, and is also applicable for coating tubes such as those of the "Belleville" water-tube boilers. The plan and elevation both show the regenerating tanks and circulating arrangements. The regenerated electrolyte enters at the bottom of the zincing tank, the liquid which is returned to the regenerators being drawn off from the top of the solution over a wood sill placed in the corner of the zincing vat. Fig. 2 shows the carriers and compound anode and cathode bars which are used for carrying the anodes and cathodes. On the table are a number of specimens of electro-galvanised tubes, &c., also some interesting specimens of sheets which have been electro-galvanised under a pressure of about 1 ton to the inch.

* Abstract of a Paper read before Section G of the British Association.

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Removal of Mill Scale.—The removal of mill scale is a matter of considerable moment with many large engineering firms. The ordinary pickling process is tedious and costly, and electricity is now being used to hasten the process. The removal of oxide and scale from forgings and plates has always been a matter of difficulty, the scale in many cases being over $\frac{1}{64}$th inch in thickness and very adherent. The usual practice is to place the iron in a solution containing one part of hydrochloric or sulphuric acid to 10 parts of water, for a period varying from half an hour to 24 hours—half an hour for close annealed sheets, 24 hours for plates and forgings such as are employed for ship and bridge building.

Many experiments have been made to quicken the process and to reduce the cost. One of the first experiments was to make the iron to be pickled the anode in an acid bath, but this was found to pit the plates, as the iron which was not protected by the mill scale was more readily dissolved than that covered by the magnetic oxide. To overcome this difficulty, the current was reversed every few minutes, the iron being alternately made anode and cathode.

A device for catching the scale after it is removed from the iron, so as to prevent the further unnecessary consumption of acid by dissolving the mill scale and oxide after removal, has been tried with satisfactory results. The pickling solution is circulated by means of a small pump or an externally heated lead coil, through a lead lined box or chamber, behind which are placed electromagnets. As the solution flows past the poles of the magnets, the magnetic oxide in suspension is attracted and retained, and can be removed from time to time. In America another electrical pickling process has been tried, the solution being sulphate of soda or sulphuric acid. The plates to be cleansed form the negative electrode, and an iron plate the positive electrode; the hydrogen set free from the surface of the plate removes any grease that may be present, and reduces any oxides on the surface.

A voltaic method is said to do the work with more certainty and with less danger to the surface of the metal in the way of pitting.

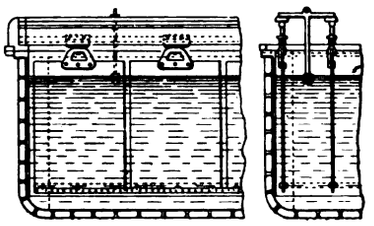

FIG. 2.

The articles to be cleansed are used as the positive pole of the battery, the negative pole being either carbon or wire gauze, electroplated with silver and covered with amorphous platinum black. The bath consists of dilute sulphuric acid, containing a depolariser, such as nitric or chromic acid: the use of the latter agent, it is claimed, completely prevents the evolution of offensive gases.

Another process, which also depends on the use of electro-magnets, being a modification of the one I have already described, consists of an apparatus containing an electro-magnet encased in copper. The scale collector is placed in any convenient position in the tank, and connected by means of terminals to a depositing or electric lighting dynamo, the current required to work it being about 10 amperes when an E.M.F. of 6 volts is employed.

In the case of large pickling tanks two or more scale collectors can be employed, or only one may be used, this being moved about to different parts of the bath at suitable intervals. From time to time the scale collector is taken out, and the adhering scale removed, either by breaking the circuit or by means of a suitable brush or scraper.

The remainder of the Paper is devoted to a description of the manufacture of palladium-plated reflectors, to which Mr. Cowper-Coles's recent Institution Paper was devoted (see *The Electrician*, Vol. XL, pp. 583 and 625).

BOOKS RECEIVED.

(Copies of any of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price.)

"The Official Gazette of the United States Patent Office. Nos. 3 and 4, Vol. LXXXIX. Published by authority of Congress. (Washington: Government Printing Office.)

"The Manufacture of Carbons for Electric Lighting and other Purposes." By Francis Jehl. (London: "The Electrician" Printing and Publishing Co.) 10s. 6d.

"The Arithmetic of Chemistry." By John Waddell. (New York: McMillan and Co.)

"Electric Bells and Alarms." By F. E. Powell. (London: Dawbarn and Ward.) 6d.

PHYSICAL SOCIETY.

At the ordinary meeting, held October 27th, Prof. W. E. Ayrton, F.R.S., Vice President, in the chair, Dr. S. W. RICHARDSON read a Paper

"On the Magnetic Properties of the Alloys of Iron and Aluminium."

Observations were made upon four alloys containing respectively 3·64, 5·44, 9·89, and 18·47 per cent. of aluminium. The alloys were used in the form of anchor rings, and were wound with primary and secondary coils separated by asbestos paper. The temperatures used ranged from −83°C. to 900°C. The low temperatures were produced by the rapid evaporation of ether surrounded either by ice and salt or by carbon-dioxide snow. The high temperatures were obtained either electrically or by gas muffles. In both cases the actual temperatures were deduced from the resistance of the secondary, which was made of platinum wire and wound next the metal. The author employed Maxwell's null method, of measuring mutual induction, increasing the sensitiveness by the introduction of a secohmmeter making about three revolutions per second. In order to test the accuracy of the method, some of the experiments were repeated with a ballistic galvanometer in the ordinary way, and the agreement obtained between the results in the two cases was well within the limits of experimental error. The chief conclusions to be drawn from the experiments may be summed up as follows:—(1) The alloys behave magnetically as though they consisted of two distinct media superposed. (2) The general roundness of the curves and their lack of abruptness near the critical point seems to indicate that the alloys are heterogeneous in structure. (3) The permeability decreases with rise of temperature near the critical point, until a minimum value is reached, when further rise of temperature produces very slight diminution, if any, in the permeability. (4) The experiments suggest that the maximum value of the permeability for an alloy containing 10 per cent. of aluminium is reached at about 90°C. (5) An alloy containing 18·47 per cent. of aluminium has a critical point at about 25°C., and gives no indication of temperature hysteresis. This alloy probably has a maximum permeability much below −90°C. The author has found that at high temperatures there is a second maximum in the induction curve. This maximum becomes less and less noticeable as the field is increased.

The SECRETARY read a note from Prof. BARRETT

"On the Electric and Magnetic Properties of Aluminium and other Steels."

The first part of the note dealt with the electrical conductivity of various alloys, and discussed the effect of composition and annealing upon the value of the conductivity. The second part of the note referred to magnetic effects. The most remarkable effect produced by aluminium on iron is the reduction of the hysteresis loss. The permeability of nickel steels is shown to be very much influenced by annealing. It is found that the addition of a small quantity of tungsten to iron hardly affects the maximum induction yet increases the retentivity and coercive force. The experiments show that the best steel for making permanent magnets is one containing 7½ per cent. of tungsten. The magnetometric method was employed throughout.

Prof. S. P. THOMPSON drew attention to the wide range of temperature over which Dr. Richardson had conducted his experiments, and also to the small number of alloys used. He said a very much finer connection between the properties could be obtained from the examination of more alloys, and expressed his interest in the existence of the second maximum on the induction curve. He would like to know how the percentage composition of the alloys had been determined. Turning to Prof. Barrett's note, Prof. Thompson referred to the difference in the breadths of the hysteresis curves for aluminium and chromium alloys.

Mr. APPLEYARD asked for information upon the permanence of the curves.

Dr. RICHARDSON, in replying, said the compositions were determined by analyses made after the experiments had been performed. It was proposed to carry on the research upon a series of aluminium alloys which he had obtained.

The CHAIRMAN expressed his special interest in the agreement which the author had obtained between the ballistic method and the null method of Maxwell increased in sensitiveness by the secohmmeter.

Mr. ADDENBROOKE exhibited

"A Model illustrating a Number of the Actions of the Flow of an Electric Current."

The model consisted of a spiral of steel wire in the form of a closed circuit. Inside the spiral was placed a wire which was supposed to be carrying the current, and which directed the motion of the spiral. A rotational movement given to one part of the spiral was transmitted by the wire, and produced a rotational movement at another part of the spiral. The resiliency of the spring represents capacity and the torque electromotive force. Self-induction can be represented by weighting the spring.

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Prof. EVERETT expressed his interest in the way that the correspondence between the propagation and the rotation agreed with that between the direction of a current and the direction of the magnetic force.

Prof. S. P. THOMPSON agreed that many analogies could be worked out by the model, but he gave one or two examples to show that erroneous conclusions might be drawn by pushing the analogy too far.

Mr. W. WATSON repeated

"Some Experiments with the Wehnelt Interrupter"

devised by Prof. Lecher. The experiments showed in a clear and striking manner the fact that subsequent sparks tend to pass through the portion of air heated by the first one. In the first experiments, motion of the heated air was caused by differences in density, and in the later experiments by allowing the sparks to take place in a strong electromagnetic field. The continuous rotation of the spark in a given field proves the unidirectional nature of the discharge. In reply to Mr. Blakesley, Mr. Watson said he used the word "ionised" in his explanations to express simply the fact that the air had been rendered a conductor by the passage of the spark.

The CHAIRMAN referred to one of the first experiments performed. In this experiment the electrodes consisted of two copper wires in a vertical plane, slightly inclined to one another and nearest together at their lowest points. On switching on the current the spark passed between the lowest points, but as the ionised air ascended so did the most conducting path, and consequently the spark worked its way to the top of the electrodes. Here the heated air passed away and the spark returned to the lowest point, to rise again. The Chairman thought that these effects might be due to the magnetic forces produced by the circuit itself. That similar effects in the arc light were due to this cause had been proved many years ago.

Mr. WATSON repeated some of the experiments under new conditions, and proved that the explanation of the phenomena was not to be found in the tendency of the circuit to enlarge itself owing to magnetic forces.

Mr. BOYS pointed out that the relation of the heating effect to the current, which was small in the arc light, was very large in the case of the spark discharges used, and therefore the movement of the spark in the latter case was practically determined by the heating effect in consequence of the relatively small importance of the electromagnetic effect.

Prof. S. P. THOMPSON remarked that similar effects could be produced by an alternating current working an ordinary induction coil.

The Society then adjourned until November 10th, when the meeting will be held at the Central Technical College.

ELECTRIC TRACTION IN CHICAGO.

In view of the approaching convention of the American Street Railway Association, which takes place this year in Chicago, our American contemporaries have published articles containing a survey of the electric traction systems in that city. There are no less than nine companies operating street railways in Chicago, and the track mileage amounts to 844 miles. There are 1,919 motor cars and 987 trailers. Besides these there are four elevated railways, which have altogether 70 miles of track, 146 motor cars, and 418 passenger cars. The city contains examples of all kinds of practice, from fairly ancient down to the most recent. Of the latter the South Side Elevated Railway may be taken as an example, this railway having 18·62 miles of track, 46 motor cars, and 180 passenger cars. Its present power house equipment consists of four 800-kw. 12-pole Westinghouse compound-wound machines with a large overload capacity. The field pieces are vertically split, and slide at right angles to the shaft, thus giving access to the armatures, which are mounted directly on the engine shaft. Each is directly connected to a horizontal cross-compound Allis engine, rated at 1,200 H.P. The generators are guaranteed to operate continuously at 1,230 amperes, and for three hours without injury at 1,835 amperes, the voltage being 650. Two additional units of double the size are being put in. The boilers, 12 in number, are of the Babcock-Willcox type, fitted with mechanical stokers, and there is a complete system of coal-handling apparatus. Not being situated favourably with regard to condensing water, a Wheeler cooling tower is employed, 34ft. high, 16½ft. wide, and 64ft. long. It contains vertical wire screens, down which the water flows. Ten fans, 10ft. in diameter, operate in pairs from the same shaft, forcing air into the tower. Two large storage batteries, situated on the line, each three miles from the generating station, provide for the fluctuations in the load. Each consists of 263 cells, and has a capacity of 750 kilowatts, delivering 2,400 amperes to the line, and at times 4,300 amperes have been taken from one battery. The only attendance on the battery is that given by the ticket agent at one station and the train despatcher at the other, who have merely to attend to the circuit breakers. The cars, which are operated on the Sprague multiple unit system, require 2 kilowatt hours per car mile in summer, and 3·35 in winter, these figures including lighting, heating, station lighting, and all auxiliary motors. During the first six months of the present year the company claims to have produced electrical energy at an average of ·427 cent per kilowatt-hour. The Calumet Street Railway is chiefly interesting through the illustration it affords of the progress in the equipment of power houses. There are four 150-kw. railway generators belted to Ball cross-compound engines which have been transformed from non-condensing to condensing; also a 500-H.P. Buckeye engine directly connected to a 50-kw. G.E. generator. The Walker generators were substituted for the original Detroit generators, and one is at times operated as a booster to raise the voltage to 900 or 1,000 volts if required. When condensing was introduced, two Deane condensers were put in and a system of cooling tables installed. By this means a vacuum of 22in. or 23in. is secured when the temperature of the atmosphere is 90 deg. and the cooling tank 120deg. The tables are 12ft. wide and 70ft. long, the water passing from the delivery pipe to one extremity of the first table, flowing to the other end in a thin sheet, thence falling upon a second table, from which it finally flows into a pond and is pumped to the condensers. The largest power station in Chicago is that of the Chicago Union Traction Co., recently formed by the consolidation of two other companies, and operating 249 miles of track and 607 motor cars. It contains six engines—four of 2,000 H.P., one of 1,700 H.P., and one of 1,000 H.P. They are of three different makes, but all cross-compound and directly connected to their generators. The dynamos first put in had commutators on the periphery of the armature, but the majority of these have been altered and the usual shaft commutators substituted. The Chicago City Railway Co., operating 157 miles of track, 776 motor cars, and 749 trailers, has three stations, with an aggregate capacity of 10,700 kilowatts, all the dynamos being rope-driven and all the engines non-condensing.

CORRESPONDENCE.

THE INVASION OF FOREIGN MACHINERY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have read with much interest the leader contained in your last issue with the above title, and as I have been a frequent victim to the sanguine yet fallacious promises of the British manufacturer, I venture to relate some portion of my experiences in support of the fears you express. The appalling delays in the delivery of all plant required for power stations seriously jeopardises the progress of the industry, and if the real cause of these delays can be ascertained, you will deserve the thanks not only of the user but also of the manufacturer of plant. I suggest that this cause will be found chiefly in the difficulty of obtaining raw material, especially in iron and steel.

Steam pipes of wrought iron or steel can be ordered from many firms in this country under "guarantees" for prompt delivery; but penalties for delay are politely declined, and during the last 10 years I have not known one instance where a guarantee of punctuality has been carried out. One large order was placed in August, 1898, under promise of delivery within three months, yet the pipes did not commence to arrive until nine months had elapsed, and the finishing template pipes in some instances could not be obtained under three months; the only excuse offered being the difficulty of obtaining rolled plates. Other orders for steam pipes when promised for delivery in three months have generally taken four months, with a similar excuse, but sometimes accompanied by the remark that the time given was unnecessarily short, as the order might have been given some time before. The difficulty of obtaining suitable material

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is also shown by most quotations for dynamo and other electrical plant containing the ominous provision of delivery within a specified time after the raw material has been obtained. Rolled joists and sections and compound girders are also delayed in delivery, with the inevitable result that building work is retarded, generally in the best summer months, and miracles have to be performed to get engine house or boiler house extensions ready to receive additional plant before the winter demand overloads the capacity of works. Orders for cable frequently have to suffer because makers cannot get the required section quickly drawn, but this difficulty will probably be met by cable manufacturers putting down plant for drawing their own wire. A similar remedy in the case of the makers of electrical plant, steam pipes, &c., is of course impracticable; but it seems deplorable that the credit of home industries should be jeopardised by the restricted and unsatisfactory output of our iron and steel makers.—Yours, &c., FRANK BAILEY.

London, S.E., Nov. 2.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: At the present time a very bitter feeling appears to exist on the part of a number of persons, some of whom constitute themselves champions of manufacturers and others of company promoters, against municipalities chiefly and to some extent against consulting engineers. So many *ex parte* statements are made and so much abuse is indulged in, that it is refreshing to read so moderate and impartial an article as that in your issue of the 27th inst.

As the responsible adviser to a Corporation which has recently given a large order to an American—though let us not say foreign—firm, I may perhaps be allowed to state the case of the municipality. Some three years ago it was determined to put down a slow-speed continuous-current generator of 1,500 kilowatts, and so far as I am aware no such machine of even one-fourth of this capacity had been built in England at the time, though they were common in America. Did we go abroad? No. We did not even ask any but English firms to tender, and we awarded the contract to an English company, who guaranteed delivery by a certain date. The first run took place 14 months late. In consequence of this breach of contract we had to stop connecting new consumers and to work our existing plant nearly 25 per cent. above its rated capacity, with great loss of economy, to say nothing of the risk of breakdown. Notwithstanding this severe blow to the undertaking, we ordered our next generator of the same size from another English firm, who, like their predecessors, guaranteed delivery by a certain date. That date has passed by 13 months, and the machine is not yet running.

We have to provide plant for further extensions and for running the trams in about 18 months' time. Any failure to do so would be fraught with most disastrous results, not only to the electricity department, but to the Corporation as a whole. In awarding the contract we accepted the tender of an American firm for the dynamos; but we retained the English maker for the engines, as he had already served us well with the two preceding generators, and his share in the responsibility for delay was a small one and beyond his control. The American firm's work is above suspicion and their price was substantially lower than that of English firms, while the delivery of the plant is practically certain. I ask, could any responsible adviser do otherwise that recommend the acceptance of the American plant, when the undertaking had already been nearly wrecked twice by an honest endeavour to support English manufacturers? Patriotism is a virtue that none appreciate or admire more than I, but to let it run away entirely with common sense would, in my opinion, be culpable folly.—Yours, &c.,

Manchester, Oct. 30. C. H. WORDINGHAM.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have read with much interest the leading article on this subject in your last week's issue. That so many orders for electrical machinery are placed abroad is a matter of the greatest importance, not only to the electrical industry, but to the nation generally; and I trust your article may lead to a discussion which will enable us to arrive at a sound conclusion on the subject.

The various causes advanced by manufacturers for this foreign competition are set forth in your article, and while not seeking to derogate their importance, you are driven to the conclusion that they are mere excuses, and that the real causes are want of foresight and aptitude on the part of manufacturers themselves. Dealing with these so-called excuses, it must not be forgotten that the present boom did not begin until 1897, and that in consequence of the engineering strike the greatest dislocation was caused at the very outset, and in many instances arrears of work were not overtaken for six or twelve months. The increased demand for electrical machinery had been anticipated, and several firms had made important extensions of their buildings, but in consequence of the strike machine tools could not be obtained for many months. By this time the Light Railways Act had come into operation, and, in consequence of the disorganisation produced by the strike, found manufacturers unprepared to meet the demand. American competitors of great experience in traction work knew exactly how to take advantage of this condition of affairs, and, assisted by depression at home, they have by speedy delivery and abnormally low prices been enabled to procure a very large proportion of orders for tramway plant.

American competition has also been stimulated by the action of consulting engineers, who have on more than one occasion issued specifications for both lighting and traction plant of new types and sizes, and specified such prompt delivery that some manufacturers did not tender at all, or others, in consequence of penalties and onerous conditions, had to cover their risk by an increased price. Finding the response unsatisfactory, recourse was had to America, where it is believed standard sizes and types were accepted. In the name of common sense, why did home manufacturers not have the opportunity of offering their standard sizes, which in all probability would have been produced in time and certainly at less cost?

Let us now look for a moment at the attitude of municipalities themselves. Prompted no doubt by the Labour Party, conditions are inserted in many contracts that trades union rates of wages and hours must be paid and observed under severe penalties, and in the case of the London County Council the scheduled rates must be posted in the works under a further penalty. Such interference is often conducive to misunderstandings between a contractor and his workmen, and leads to increased cost of production; and so onerous have these clauses proved that in some instances the larger manufacturers decline to tender at all to certain municipal bodies, and prominently to the London County Council. But what happens? Foreign competitors, recognising that the clauses cannot apply to them, are placed in a favourable position to quote; and so the work goes abroad. Could anything be more absurd?

Again, British manufacturers are charged with indifference as long as sufficiently high dividends are earned. Now, it is a fact that many well-known American manufacturing companies have returned little or nothing to the Ordinary stock holders, and while British companies have had their own period of depression, they certainly could not exist indefinitely as non dividend paying concerns, and therefore regard must be had to the commercial as well as the technical side of the question, which is apparently not always done in America.

I venture to think, too, that if any of the larger companies returned to a non-dividend paying position, their sphere of usefulness would be much impaired, for it is during prosperous times that new types and new designs can be best matured. While, therefore, regretting that so much traction plant should be imported, I do not think home manufacturers would be justified in rejecting remunerative orders simply to suppress competition in another class of work in which Americans have been madly competing at home for years. Moreover, can anyone point to an American installation in this country

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which, from an engineering point of view, could not have been undertaken by our own large firms? If not, then it would appear that progress is not being sacrificed to present returns.

In conclusion, I am pleased to note your opinion that the best machinery in the world can still be produced in British workshops, and I think our electrical engineers can claim their full share of credit, notwithstanding the much-vaunted American machines. On completion of the large extensions which are now being made, quicker delivery will be obtainable. With improved organisation, fewer promises will be broken, in which respect I fear home manufacturers have much to learn from their rivals. When American companies are established in this country we shall compete on equal terms, although their inauguration will probably lead to "cutting of prices" until they fully appreciate the effect of trades unionism and the consequent increase in the cost of production. But that British manufacturers will hold their own in the struggle may confidently be expected.—Yours, &c.,

London, Nov. 1. MANUFACTURER.

LOW-VOLTAGE DYNAMOS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The letter of Mr. Alfred H. Gibbings on the above subject, contained in your issue of 27th inst., is of considerable interest, as showing the actual behaviour of internal-field dynamos under trying circumstances. His experience bears out the contentions contained in my letter published in the same issue.

As to the remedies suggested, however, I venture to think that in merely compounding the machines Mr. Gibbings is somehow beginning at the wrong end. It would probably be better to increase the air-gap density by slightly reducing the polar arc. This would have the effect of increasing the no-load ampere-turns, and at the same time reducing the magnetic leakage, which is really at the root of the whole evil; and, further, the necessary compounding would be greatly reduced. Also, would it not be better to compound the exciter (if such be used, as Mr. Gibbings proposes) instead of the generator? Putting series turns on a multipolar machine is always an expensive affair, and especially so when such heavy currents have to be dealt with.

Mr. Gibbings has also had difficulty with the commutators from the cause pointed out in my letter—namely, excessive heating due to too high peripheral speed. It is doubtless for this reason that Messrs. Siemens and Halske now frequently add a separate commutator of smaller diameter, even though by so doing they remove the feature which, above all others, makes these machines so fascinating (on paper at any rate). I hardly think that Mr. Gibbings need search long for any particular "form of low-voltage heavy-current dynamos": it is not so much the *form*, as the design, that is of importance. Any ordinary multipolar machine will prove satisfactory so long as it is capable (mechanically and magnetically) of giving considerably more than its normal output. It is not necessary to put extra copper on the armature, however, as the overloads are usually of short duration.

Apologising for again intruding on your valuable space.—Yours, &c., KENELM EDGCUMBE.

London, Oct. 30.

SIGNALLING WITHOUT CONTACT.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I should be much obliged if you would kindly allow me to point out, as a postscript to my recent British Association Paper, that in the case of tender-engines it is not necessary that any of my apparatus should be fixed on the engine itself. The armatures, batteries, &c., may all be put on the tender, the indicator being attached to the end of a suitable length of flexible cable, so that it may be detachably placed where desired in the cab of the engine.

Whenever it becomes necessary to separate engine and tender for overhauling, the indicator can be lifted down and stowed safely away in a box provided for the purpose on the tender, without necessitating the undoing of a single electric connection or the attendance of an electrician. When the engine is ready to go out again, it is only a moment's work to take out the indicator and hook it on to its bracket again.—Yours, &c., W. S. BOULT.

London, S.W., Oct. 27.

THE COMBINED REFUSE-DESTRUCTOR AND ELECTRICITY WORKS AT SHOREDITCH.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Your analysis of and remarks on the Shoreditch accounts for the year ending March 31 are most interesting and instructive to those of us who are being urged on by our local authorities to produce our electric supply current from our town's refuse. From your analysis I suggest the results may be not unfairly stated as follows:—

Electric Lighting—	
Net profits, as stated	£4,581
Deduct estimated value of steam received from destructor works, 664,348 units at 0·9d.	2,491
Real net profits on electric lighting works	£2,090
Destructor Works—	
Net cost of destroying 23,729 tons of refuse, as stated	£6,024
Allow credit for steam supplied to electric lighting works, as above	2,491
Real net cost of destroying 23,729 tons of refuse	£3,533

This is equivalent to 2·98 pence per ton of refuse, as compared with the cost of barging the refuse—viz., 3s. 1d. per ton. This shows that the saving is only about 3½ per cent. on the old method.

It is clear that, so far as the works at Shoreditch are concerned, there is practically no advantage from combining the two works, either as regards the economical disposal of the refuse or the financial success of the electricity works.

Of course, the sanitary advantages of cremating the refuse may be—probably are—very great; but from the accounts it is clear that this could be accomplished quite as successfully, from an economical point of view, on an entirely independent site.—Yours, &c., A MUNICIPAL ENGINEER.

Nov. 1.

COURT OF COMMON COUNCIL.

At yesterday's meeting it was decided to insert, in a Bill proposed to be introduced next session, clauses giving powers to the Corporation to make provision for the accommodation of pipes, wires, cables, &c., under the public ways of the City of London.

It was further decided to appoint an inspector under the Overhead Wires Act, to supervise the erection of wires in the City. This official is to be between the ages of 25 and 45, and his maximum salary is to be £4 per week. The Streets committee are to make the appointment.

In regard to the Electric Lighting Order Confirmation (No. 20) Act. 1899 (Charing Cross and Strand Electricity Supply Corporation, Limited), on the recommendation of the Streets committee Mr. A. A. Voysey was appointed electrical inspector under this order, and the company is to be asked to contribute the sum of £500 per annum towards the expenses of the inspector. The committee is to consider and report upon the salary to be allotted to Mr. Voysey.

The Court approved the proposed site of 7½ acres for a generating station at Marsh Gate-lane, Bow, E., for the Charing Cross Co., in connection with the City supply. The approval is subject to the Corporation on any purchase which it may make under the powers contained in the City of London Electric Lighting Order, 1899, not being compelled to pay at the rate of more than £2,250 an acre, and to the approval by the Corporation of the plans of the station, and to the further right of the Corporation to acquire the whole of the 7½ acres.

The committee, relative to a letter from the City of London Electric Lighting Co. in regard to the proposed alteration in the standard pressure of supply, recommended (1) That the condition agreed to by the Court on Oct. 5, with regard to the price of supply, be adhered to, and the company be informed that, in the event of any abnormal conditions arising, it would be open to the company to ask the permission of the Corporation to increase the price of supply; (2) That the company be informed that the existing means of testing the public and private supply are not satisfactory, and that a copy of a memorandum prepared by the electrical engineer on the subject be forwarded to the company, with an intimation that an acceptance of the testing arrangements specified therein shall not prejudice the rights of the Corporation under the Provisional Orders 1890 and 1891.

The recommendations were agreed to. All the foregoing decisions were arrived at unanimously and without discussion.

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LEGAL INTELLIGENCE.

Postmaster-General v. Edinburgh Corporation.

A sitting of the Railway and Canal Commissioners was held at Edinburgh on Tuesday. The Commissioners were Lord Stormonth Darling, Viscount Cobham and Sir Frederick Peel. Further evidence was given with reference to the application by the Lord-Advocate, on behalf of the Postmaster-General, to be permitted to lay underground telegraph wires in a number of streets in Edinburgh. The Corporation had withheld its consent, and on reference to Sheriff Rutherford consent was granted. The Corporation thereupon appealed to the Railway and Canal Commissioners, averring their proprietorship of the land, that the application was not made in good faith for the purposes of the Post Office, but that the wires were intended to connect the exchanges of the National Telephone Co., and that the *solum* of the streets was essential to the Corporation and the community for carrying water and gas pipes, electric light wires, &c., and was of great pecuniary value. The Corporation also submitted that if consent was given to the application it should be on the condition that the Postmaster-General should be bound to lay his wires under the directions and to the satisfaction of the Corporation and to pay them annually one-half of the sum which might be received by the Postmaster-General or the Government from the National Telephone Co. or other licensee for the use of the wires, or to allow the Corporation within six months to lay the wires at their own expense and as their own property, and the Postmaster-General to pay annually a rent at the rate of 7 per cent. upon the amount of the cost.

The BURGH ENGINEER (Mr. Chas. Cooper) stated that at certain points it was a physical impossibility to lay the pipes containing the wires on the lines in the original plans of the Post Office. They had cable tramways in Edinburgh. To lay a 3in. pipe 15ft. below the surface was not a physical impossibility, but it might be an administrative absurdity. The Postmaster-General could put through his wires without cutting in the North Bridge, as there was a pipe there already which belonged to the Post Office.

Viscount COBHAM: There is the difficulty of repair. If the damage done to the roadway can be expressed in figures, would the Post Office object in principle to paying it?

The LORD ADVOCATE: I don't think so. Of course, my view is that that is worked out afterwards. The statute gives the right of compensation for damage.

Mr. J. GIBSON, superintending engineer of the Post Office, was of opinion that no damage would ensue. He did not consider it expedient in the interests of the Corporation to take the South Bridge route. If they could get another route quite suitable in place of the South Bridge, they had no objections to take the wires that way.

Sir ROBERT HUNTER, solicitor to the Post Office, stated that there was an agreement in 1896 between the Post Office and the Telephone Co., by which the Post Office was to lay wires connecting different exchanges of the company. There was nothing to bind the Corporation. The wires they were asking to lay were in consequence of that agreement. The Corporation had given them the facility of laying wires with regard to exclusively Post Office wires until this question arose. He admitted that they wanted those wires for the use of the National Co., but it was incidentally for the purposes of the Post Office too because everything that increased the facilities of communication between exchange and exchange helped the trunk wires, and therefore the Post Office. The primary cause, however, was the contract between them and the company. He could not say whether the Post Office would take the wayleave if they had to pay for it. It was a fixed principle that the Post Office never paid for roads. He could not agree with the statement that this application was substantially an application of the National Co. made through the Post Office. He did not know whether it was in consequence of failure to get the consent of the Corporation that the National Co. came to the Post Office, but it was possible that if they had come to an agreement with the Corporation they would not have come to them. He considered it a matter of joint interest. They took 10 per cent. of the gross receipts of the National Co. He looked upon this privilege of the company as in the public interest.

The DEAN of FACULTY submitted that the application of the Post Office should not be granted, and that it had been shown that the Post Office had no title to make the application. This was simply a demand through the Post Office by the National Co. to get junction wires which they could not get themselves. It was an insuperable flaw in the application that the Post Office was making it for Post Office purposes, whereas they admitted that they were getting 10 per cent. of the proceeds of the messages proceeding on those wires, while 90 per cent. was going to the company.

The LORD ADVOCATE submitted that the application should be granted and the rehearing refused. The general policy of helping those companies was dealt with in the Glasgow case. What the Post Office was doing was in accordance with the bargain they made with the Telephone Co. under the Act of 1896.

Lord STORMONTH DARLING said he thought they had decided that when the Postmaster applied he must be presumed to do so in the public interest. While reserving all questions, he asked that a plan showing an alternative route to that of the South Bridge should be submitted within a reasonable date.

His LORDSHIP intimated that if within three weeks there was no alternative proposal, they would consider the case as it stood now.

Madras Electric Tramways Co. (Limited).

On Wednesday Mr. Eve, Q.C. (on behalf of the Electric Construction Co. (Limited), judgment creditors for £80,000) applied in the Winding-up Court for the winding-up of the Madras Electric Tramways (Limited). Mr. Reed, Q.C., opposed the application on behalf of the company, and said that arrangements were entered into which resulted in provision being made for the payment of £80,000 to the petitioners, but negotiations were broken off owing to a further £1,500 being demanded as interest. It was, however, quite possible to renew the negotiations. He asked that the matter might stand over, in order that the question of the interest might again be brought before the directors of the Tramways Co. His lordship allowed the matter to stand over for a fortnight, but said if the Madras Tramways Co. were not able to satisfy the court that there was an existing arrangement of some kind, the order asked for would be made.

Sexton v. Dublin United Tramways Co.

An application was made in the Chancery Division, Dublin, on Wednesday, for an injunction to restrain the Dublin United Tramways Co. from proceeding with the erection or construction of the tramways opposite or near to the plaintiff's residence in North Frederick-street between the hours of 9 p.m. and 6 a.m. in such a manner, and accompanied by such noise and disturbance, as to interfere with plaintiff's reasonable use and enjoyment of his residence. The case was learnedly, lengthily, and (but for the privilege of the court) libellously argued. It appeared that the plaintiff, Mr. Thomas Sexton, is a gentleman engaged in work for the *Freeman's Journal*, and he claimed to be entitled to his night's rest, which he averred had been disturbed by the defendant company's operations. Sergeant Todd, who appeared for the plaintiff, complained that the matter had been adjourned from time to time, and while these adjournments were proceeding the company had finished the work in the daytime; and he now asked for the plaintiff's costs. The defendant company's contention was that the plaintiff was acting maliciously in the course he had pursued. The plaintiff now asked for judgment justifying him in bringing the proceedings and entitling him to the costs of the action. For the defendants it was urged that 40 miles of tramways had been laid by the company, and that the plaintiff was the only person who had made any complaint. However, in the end the Vice-Chancellor decided that the action had been properly brought, and that the company must pay the costs.

Phosphor Bronze Co. (Reduction of Capital).

In the Chancery Division on Saturday Mr. Justice Kekewich granted an application for the reduction of the capital of this company from £90,000 to £45,000. It was proposed to effect the reduction by cancelling the capital which had been lost or was unrepresented by available assets.

E. P. Allam and Co. v. Universal Process Co.

In the Westminster (London) County Court yesterday (Thursday) Messrs. E. P. Allam and Co., electrical engineers, Hatton-garden, E.C., sued the Universal Process Co., a firm of photo engravers, for work done. It seemed that defendants' arc lamps wore out very rapidly, and plaintiffs arranged to keep them in repair for £10 a year payable quarterly. This was exclusive of £1. 10s. for putting them in repair at the start, and the supply of carbons. For some time telephonic messages were received asking for assistance, but after the second quarter no further communications were received. When asked for payment, defendants argued that plaintiffs ought to have sent fortnightly to do the work. Plaintiffs' answer was that, having put in special carbons, the necessity for repair did not so often occur.

His Honour said the practice seemed to have been for plaintiffs to have been sent for, and the contract might have been ended at any time. Judgment must be for plaintiffs for the amount claimed, with costs.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week*]

NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London:—

NOW READY.

"The Electrician" Electrical Trades' Directory and Handbook for 1899.—The *Second Edition* of the "Big Blue Book" for 1899 is now ready. The volume contains the large Sheet Tables of Electricity Supply Stations and Electric Railways and Tramways. The price of the Directory and Handbook is now reduced to 6s, post free 6s 9d; abroad, post free, 7s. 6d. (United States 8s. 6d.).

"Electric Motive Power," by Albion T. Snell, contains the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. Price 10s. 6d., post free; abroad, 11s.

"Electrical Testing for Telegraph Engineers."—By J. Elton Young, M.I.E.E. The scope of the book aims at furnishing a fuller treatment of the subject, from the standpoint of the Telegraph Engineer, than it has hitherto received, whilst it endeavours to facilitate a thorough comprehension of the theory of testing as applied to electrical lines in general. Demy 8vo, fully illustrated. 10s. 6d., post free; abroad 11s.

"LABORATORY NOTES AND FORMS."—With the above title we have ready the New Edition of a set of 40 Elementary and Advanced Exercises for use in Electrical Engineering classes. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators and Students. The object of this series is the saving of the time of the Teacher and his Assistants, and to serve as a record of the work done by the Student. Each Form is supplied either singly at 4d., or 3s. 6d. per dozen net; in sets of any three, 1s. net; or the set of Twenty (Elementary or Advanced) Exercises can be obtained, price 5s. 6d. net. The complete set of Twenty Elementary and Twenty Advanced Exercises are price 10s. 6d. net; or in handy portfolio, price 12s. net; or bound in strong cloth case, price 12s. 6d. net. Strong portfolios can be had, price 1s. each.

NOW READY.—The cheaper edition of Dr. J. A. Fleming's "Electrical Laboratory Notes and Forms." These cheaper Forms have been prepared for the use of students and teachers at the Polytechnic and other science classes throughout the country. The demand for the original set of these Notes and Forms has led to a request for a cheaper set for use at the day and evening classes at many of the technical institutes. These new Forms, which differ only from the higher-priced set in being printed on smaller and cheaper paper and with less space for tabulated records, are issued at half the price of the original set.

DRUM ARMATURES AND COMMUTATORS," by Mr. F. Marten Weymouth, also ready. Price 7s. 6d.; abroad, 8s. Prospectus on application.

"THE STUDENTS' GUIDE TO SUBMARINE CABLE TESTING."—A new work by Messrs. H. K. C. Fisher and J. C. H. Darby, with the above title, is now ready, price 6s. net; abroad, 6s. 3d. This work is intended to serve as a guide to operators already in the telegraph service, and to those who desire to enter that service. The great cable companies now insist that their operators and probationers shall pass certain examinations in electrical subjects. The book is very fully illustrated. *Second Edition now ready.*

"SUBMARINE CABLE-LAYING AND REPAIRING."—By H. D. Wilkinson, M.I.E.E., &c., fully illustrated; price 12s. 6d.

"PRACTICAL NOTES FOR ELECTRICAL STUDENTS."—By Messrs. A. E. Kennelly and H. D. Wilkinson. Price 6s. 6d., post free.

"ELECTRO-CHEMISTRY."—By Dr. G. Gore. Third Edition Price 2s. post free.

"WIRELESS TELEGRAPHY: SIGNALLING ACROSS SPACE WITHOUT WIRES BY ELECTRIC WAVES."—By Dr. O. J. Lodge, with many original illustrations. *New and Enlarged Edition nearly ready.*

"ELECTROMAGNETIC THEORY."—By Oliver Heaviside. *Vol. I.*, 12s. 6d *Vol. II.*, just published. 12s. 6d.

"MAGNETIC INDUCTION IN IRON AND OTHER METALS."—By Prof. J. A. Ewing. Price 10s. 6d., post free.

"THE INCANDESCENT LAMP AND ITS MANUFACTURE."—By Mr. Gilbert S. Ram. Price 7s. 6d., post free.

"THE STEAM ENGINE INDICATOR AND INDICATOR DIAGRAMS."—Edited and enlarged by W. Worby Beaumont. Price 3s. 6d., post free.

"THE ART OF ELECTROLYTIC SEPARATION OF METALS."—A second issue of Dr. Gore's book is now ready, price 10s. 6d., post free.

"THE MANUFACTURE OF ELECTRIC LIGHT CARBONS."—A Practical Guide to the establishment of a Carbon Manufactory. Fully illustrated, price 1s. 6d.; post free, 1s. 9d.

"THE CENTENARY OF THE ELECTRIC CURRENT, 1799-1899."—By Dr. J. A. Fleming. Price, paper covers, 1s. net, post free 1s. 3d.; strong cloth, 2s. 6d., post free.

"THE BIBLIOGRAPHY OF X-RAY LITERATURE AND RESEARCH, 1896-97," A valuable, up-to-date compilation. Being an attempt to classify the data relating to X-Ray work. This work contains a quantity of general as well as special information bearing upon the whole subject of electrical discharge research. Price 5s., post free.

"LOCALISATION OF FAULTS IN ELECTRIC LIGHT MAINS."—By F. C. Raphael. Price 5s., post free.

"ELECTRICAL ENGINEERING FORMULÆ," a pocket-book, by Messrs. W Geipel and H. M. Kilgour; price 7s. 6d.; by post, 7s. 9d.; abroad, 8s *New Edition in the press.*

"THE ALTERNATE CURRENT TRANSFORMER," Vol. I.—By Prof. J. A. Fleming M.A., D.Sc., F.R.S. *New Edition.* Price 12s. 6d., post free. Vol. II., price 12s. 6d. post free, is also ready.

"ELECTRIC LAMPS AND ELECTRIC LIGHTING," by Prof. J. A. Fleming M.A., D.Sc., F.R.S., is handsomely bound, and full of original illustrations, designs, initials, &c. *New Edition nearly ready.*

"THE ELECTRICIAN" PRIMERS.—In Two Volumes. Vol. I., Theory Vol. II., Practice. Price, stout paper cover, 2s. 2d. each, post free; cloth 2s. 9d. Single Primers, 3d. each, post free.

"MOTIVE POWER AND GEARING FOR ELECTRICAL MACHINERY."—By E. Tremlett Carter, C.E., M.I.E.E. Price 12s. 6d., post free; abroad 13s. 6d.

"THE POTENTIOMETER AND ITS ADJUNCTS": A Universal System o Electrical Measurement.—By W. C. Fisher. Fully illustrated. Price 6s. post free.

"ARMATURE WINDINGS OF ELECTRIC MACHINES."—By H. F. Parshall and H. M. Hobart. This work has been compiled from notes made by Mr. Parshall in his capacity as Chief Designing Engineer of the Edison and General Electric Companies of America, and is intended to serve as a working treatise on dynamo design. Large 4to, 370 pages 140 full-page illustrations and 65 full-page tables, 30s., post free.

IN THE PRESS.

"THE ELECTRIC ARC."—By Mrs. Ayrton.

"THE MANUFACTURE OF CARBONS FOR ALL ELECTRICAL PURPOSES."—By Francis Jehl. *Ready in October.*

"SECONDARY BATTERIES, THEIR DESIGN AND MANUFACTURE."—By E. J Wade.

"PRIMARY BATTERIES: THEIR CONSTRUCTION AND USE."—By W. R. Cooper. *Nearly ready.*

"PRACTICAL TELEPHONY."—By Dane Sinclair and F. C. Raphael.

"THE ELECTRICIAN' WIREMAN'S POCKET-BOOK."—Edited by F. C. Raphael. *Nearly ready.*

TENDERS INVITED.

The *Bradford* Corporation invite tenders for the supply and delivery of electrical equipments for 25 tramcars, 25 tramcar bodies, and trucks and trollies for 25 tramcars. Specifications and forms of tender may be obtained of the tramway manager (Mr. C. J. Spencer) Horton Bank depot, and tenders must be sent in to the town clerk (Mr. F. Stevens), Town Hall, Bradford, on or before Thursday, Nov 9. Further particulars are given in advertisements elsewhere.

The *Newcastle-upon-Tyne* Electric Tramways committee invite tenders for two 1,000-H.P. generators. Further particulars are given in an advertisement, and specifications, &c., may be obtained on and after 6th prox. from the consulting engineer (Mr. Charles Hopkinson), 29, Princess-street, Manchester, or 26, Victoria-street, London, S.W. Tenders (addressed to the committee) must be left at the office of the town clerk (Mr. Hill Motum), Town Hall, Newcastle-upon-Tyne, not later than noon of Nov. 30.

The *Leeds* Corporation invite tenders for wiring and fitting the Union-street Baths for the electric light. Specifications may be seen and tenders obtained at the city engineer's office, Municipal Buildings, Leeds. Tenders must be delivered at the town clerk's office by noon of Nov. 13. See advertisement.

The Vestry of *St. Mary, Newington* (London), invite tenders for the supply and erection of a 400-kw. steam dynamo and continuous-current transformer for their electricity supply works. Specifications, &c., can be obtained after 3rd inst. at the offices of the engineers (Messrs. Kincaid, Waller and Manville), 29, Great George-street, London, S.W. An advertisement contains further particulars, and tenders must be sent in to the clerk (Mr. L J. Dunham) before noon of Monday, 13th inst.

The *Portsmouth* Corporation invite tenders for the supply and delivery of 40, 60, or 80 electric tramcars. Specifications, &c., can be obtained from the tramways engineer (Mr. E. Rotter), Town Hall, Portsmouth. An advertisement contains further particulars, and tenders must be sent in to the town clerk (Mr. Alexander Hellard), Town Hall, Portsmouth, not later than 10 a.m. 17th inst.

The *Poplar* (London) District Board of Works invite tenders for laying mains upon the solid system for the distribution of continuous current upon the three-wire system. Further particulars are given in an advertisement elsewhere, and specifications, &c., may be obtained from the electrical engineer to the Board (Mr. Alfred Blackman), Electricity Works, Glaucus street, Bromley-by-Bow, E., after the 6th inst. Tenders must be sent to the clerk (Mr. Leonard Potts) by 10 a.m. of Thursday, Nov. 16.

The *Swansea* Corporation invite tenders for the supply and erection of five Lancashire boilers, with jet condensing plant, feed pumps, economiser, piping, &c. Specifications can be obtained after the 4th inst., at the Guildhall, Swansea, and a copy of the specification may also be inspected (but not obtained) at the offices of the consulting engineers (Messrs. Kincaid, Waller and Manville), 29, Great George-street, London, S.W. Additional particulars are given in an advertisement, and tenders must be sent in to the town clerk (Mr. Jno. Thomas), Guildhall, Swansea, before noon of 20th inst.

The Lighting committee of the *Wolverhampton* Corporation invite tenders for the supply and erection of two 500-kw. direct-coupled generating sets. An advertisement contains further particulars, and tenders must be sent in to the borough electrical engineer (Mr. C. E. C. Shawfield), electricity works, Commercial-road, Wolverhampton, not later than noon of Nov. 13.

The *Accrington* Corporation invite tenders for electric cables, wires, street boxes, and connections. Further particulars can be obtained of the town clerk (Mr. A. H. Aitken), or at the offices of the consulting engineer (Mr. J. N. Shoolbred). 22, Victoria-street, London, S.W., and tenders must be sent in to Mr. Aitken by the 18th inst. An advertisement gives additional information.

The Urban District Council of *Bray* (Ireland) require tenders for a jet condensing plant. Specifications and particulars on application to the clerk (Mr. P. MacDonnell). Tenders must be in before the Council meeting on 20th inst. See advertisement.

The *Hoylake and West Kirby* District Council invite tenders for the supply, delivery and erection of—(1) Lancashire boilers, superheaters and Green economiser; (2) quick-revolution steam engines, alternators, motor alternator, feed pumps, piping, tanks, crane, wiring electricity supply works, &c.; (3) high and low-tension switchboards and connections; (4) secondary batteries and accessories; (5) transformers and accessories; and (6) high and low-tension mains, &c. Tenders to Mr. Roderick Williams, Town Hall, Hoylake, by noon of Nov. 15.

The Guardians of the *Croydon* Union invite tenders for electric light wiring and fitting work for their workhouse, infirmary, and union offices. Tenders to the Croydon Union Offices, Mayday-road, Thornton Heath, Surrey, before 5 p.m., on Monday, Nov. 13.

The *Birkenhead* Corporation invite tenders for 13 single-deck and 31 double-deck electric motor cars. Tenders by 4 p.m., Nov. 14.

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Also for boilers, economisers and mechanical stokers, steam dynamos and booster, and storage batteries.

The Electricity department of the *Glasgow* Corporation invite offers for ten miles of 2in. cast-iron pipes. Tenders to Sir J. D. Marwick, City-chambers, Glasgow, on or before Nov. 20.

The *Glasgow* Corporation also invite tenders for the supply and erection of two 800-H.P. compound vertical auxiliary engines for Port Dundas station. Tenders to Sir J. D. Marwick by 5 p.m., Nov. 14.

The *Middlesbrough* Electric Lighting committee invite tenders for condensing plant and pipework. Tenders to Mr. George Bainbridge, Municipal Buildings, Middlesbrough, not later than 4 p.m., Nov. 22.

The order for the electric lighting of Ludgate-hill railway station, London (referred to in our last issue), has been awarded to the Smithfield Markets Electric Supply Co.

The *Chelsea* (London) Vestry require tenders for three motor vans Particulars from the surveyors, and tenders to the vestry clerk, Town Hall, Chelsea, by 21st inst.

Tenders are invited for an electric motor for working the machinery at the Slack Brook sewage works of the Swinton Council. Tenders to clerk by 11th inst.

The *Greenock* Police Board invite tenders for leasing their tramways and equipping same on the overhead trolley system. Tenders to town clerk.

The Governors of *Felsted* School, Essex, invite tenders for the supply and erection of electric lighting plant. Tenders by Nov. 27.

The Municipal Council of *Chiclana de la Frontéra* (Cadiz), Spain, require tenders for electric lighting for five years. Tenders by 23rd inst.

TENDERS RECEIVED AND ACCEPTED.

The Salford Corporation on Tuesday accepted, on the recommendation of their Electric Light committee, the tender of Galloways (Limited) for the supply of boilers and fittings (with Dixon superheaters by Messrs. J. Musgrave and Sons) for the Strawberry-road electricity station, at £15,200. The Corporation have also accepted the tender of the Westinghouse Electric Co. for the supply of 100 electric tramcars complete at £534. 10s. per car. The car bodies are, however, to be made by Messrs. G. F. Milnes and Co. In our issues of Sept. 15 and 22 particulars of the Council's requirements were advertised.

The Belfast Improvements and Electric committees have accepted the tender of Messrs. Dick, Kerr and Co. for the supply of steel tramway rails for the eight new tramway routes which the Corporation are about to construct.

The Leeds Tramway committee recommend the acceptance of the tender of Messrs. Dick, Kerr and Co. for the supply of 50 electric tramcars, at £27.500, for their Dewsbury-road, Beeston-road and Elland-road routes. The Council's requirements were set out in an advertisement in our issues of Sept. 22 and 29.

The tender of the British Thomson-Houston Co. for the supply of 40 tramcars, and that of Messrs. Dick, Kerr and Co. for the supply of 20 cars, have been provisionally accepted by the Blackburn Corporation. Each car will accommodate 60 passengers. An order for the supply of two steam dynamos has been given to Messrs. Mavor and Coulson. The original specification was modified after tenders were invited. The Council's requirements were advertised in our issues of Sept. 8 and 15.

The Wigan Town Council have accepted the tender of Messrs Picksley, Sims and Co, Leigh, for the supply of service boxes for electric lighting purposes at £586. 4s. 2d. Eighteen tenders, varying from £586 to £1,233, were received.

The contract for the electric lighting of the North Riding of Yorkshire Lunatic Asylum, at Clifton, York, has been given to Messrs. Crompton and Co. Mr. A. A. Campbell Swinton is the consulting engineer, and the work will be carried out to his specification.

APPOINTMENTS VACANT AND FILLED.

The Tynemouth Corporation invite applications for the position of clerk of works to superintend (under the direction of the consulting engineers) the erection of electrical plant, &c., at the borough electricity works. An advertisement contains further particulars, and applications must be sent in to the town clerk (Mr. John F. Smillie) not later than Nov. 7.

The Devonport and District Tramways Co. require a clerk of works to superintend the construction of permanent way for electric traction. Applications to the engineers to the company, 20, Victoria-street, Westminster, S.W. See advertisement.

The Burnley Electricity committee require an assistant electrical engineer. Some particulars are set out in an advertisement, and applications must be sent to Mr. W. T. Fullalove, town clerk, Town Hall, Burnley, by Nov. 15.

A railway signal and electrical engineer is required by the New Zealand Government. Salary £400. Further particulars from the Agent-General, 13, Victoria-st., London, S.W. See advertisement.

A physical science master is required for the City of London School. Salary £300, increasing to £450 per annum. Applications to the secretary, Victoria Embankment, E.C., by Nov. 31.

The Watford District Council require an assistant electrical engineer, &c. Application to clerk by 11th inst.

Mr. E. Hatton, of Birkenhead, has been appointed tramway engineer by the Salford Corporation, at a salary of £240 per annum.

Mr. M. Cooper, superintending engineer for telephones, has been appointed principal technical officer, Engineer-in-Chief's Office, General Post Office, London.

BUSINESS NOTICES.

The Phodyne Electrical Co. (Limited), 66, Victoria-street, S.W., has acquired the electrical contracting business of Messrs. A. A. C. Swinton and Co., and has taken over the latter firm's staff and offices. Mr. J. C. M. Stanton, M.I.E.E., who has managed Messrs. Swinton and Co.'s contracting business, is managing director of the Phodyne Electrical Co. The firm of A. A. C. Swinton and Co. was formed in 1888 by Mr. A. A. Campbell Swinton. During this period many extensive electric installations, notably in connection with the electric lighting of country houses, have been carried out, and the new company takes over, among other contracts, the lighting of Bamburgh Castle for Lord Armstrong, and Haggerston Castle. The Phodyne Co. will continue to make a speciality of this class of work, in addition to developing its business in other directions.

Mr. A. A. Campbell Swinton has removed to new offices at 66, Victoria-street, Westminster, where he will continue his consulting practice.

Messrs. Bow, M'Lachlan and Co., William Bow, John M'Lachlan, W. H. W. and W. R. V. Marshall, electrical engineers, trading as Paterson, Cooper and Co., at Paisley, have dissolved partnership as from July 1, 1899. Messrs. Bow, M'Lachlan and Co., W. Bow, and J. M'Lachlan retire. Debts by Messrs. W. H. W. and W. R. V. Marshall, who continue.

Mr. C. Wilkes, 29, Ludgate-hill, London, E.C, requests us to announce that he has been appointed sole agent for the British empire (Canada excepted) for all English advertisements or publicity in the general official catalogue of the Paris 1900 Exhibition; also for the French and English guides and other publications issued by the official contractors to the Exhibition.

Messrs. J. Lovelock, A. J. Osborn, and A. M. Lee (trading as Lovelock, Osborn and Lee), electricians and engineers, 8, Jeffreys-square, St. Mary Axe, London, E.C., have dissolved partnership. Debts by Mr. Lee.

Messrs. Allan and Adamson (Limited) have removed their offices to Clun House, Surrey-street, London, W.C., and, to meet the increasing demand for the Allan accumulator, works have been taken where the manufacture of these batteries can be conducted on a large scale. These works are at Ashsted, Surrey.

The central office of the Compagnie Française des Câbles Télégraphiques in New York is now located at 42 and 44, Broad-street instead of 34, Broad-street.

Mr. A. A. Blackburn, electrical engineer, has removed his offices from Leeds to 376, Dickenson-road, Longsight, Manchester.

BANKRUPTCIES, LIQUIDATIONS, &c.

Under the failure of John G. M. Hilton, electrician, the debtor attended at the London Bankruptcy Court, and was allowed to pass his public examination upon liabilities £2,026 and assets of doubtful value. He stated that in Jan., 1895, he became one of the managing directors of the Nalder and Harrison Construction Syndicate, in which he invested £2,250, but shortly after the syndicate went into voluntary liquidation. He then, with another person, purchased the electrical portion of the business and carried it on until early in 1897. He put into the business £2,000. In March, 1898, in consequence of a disagreement, he retired from the company. In Jan., 1890, he returned to the business, and introduced a further £400, but in May last the company went into voluntary liquidation.

A receiving order has been made against Ernest Max Winter, electrical engineer, Amberley House, Norfolk-street, London, W.C.

An order was made on October 20, by the Board of Trade, removing E. B. Lumb, 85, Gracechurch-street, London, E.C., from the office of trustee of the property of G. F. Rogers, electrician, 81, Maxilla-gardens, Notting-hill, N.W., and 5, Great Winchester-street, E.C., London.

A meeting of Nernst Lamp (Limited) (old company) will be held at 130, Dashwood House, New Broad-street, E.C., on December 4, to receive an account of the winding-up. Mr. W. Chaplin is liquidator.

Claims against Elmore's American and Canadian Patent Copper Depositing Co. (Ltd.), Elmore's Foreign and Colonial Patent Copper Depositing Co. (Ltd.), Elmore's Patent Copper Depositing Co. (Ltd.), and Elmore's Wire Manufacturing Co. (Ltd.), are to be sent by Dec. 9 to Mr. J. Shurmer, Greek-street-chambers, Park-row, Leeds, who is liquidator of the four companies.

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Sales by Auction.—Mr. Herbert Humphries, of Brierley Hill, will sell by auction, at the Grand Hotel, Birmingham, on Thursday, Nov. 16, at five o'clock prompt, the important and extensive freehold property known as the Acetylene Works, Corngreaves, Cradley Heath, together with the goodwill and the costly electrical plant used in the manufacture of carbide of calcium. The Corngreaves works have a railway connection with the Great Western Railway, and the buildings are modern and substantial. The premises have been occupied by the Midland Acetylene (Parent) Syndicate (Limited). The electrical plant and other particulars are set out in an advertisement on another page, and it will be seen that this plant was manufactured by leading firms, and is in a condition equal to new. The works comprise an area of 5,011 square yards. Mr. Humphries' offices are at Brierley Hill and Stourbridge, from which particulars, &c., can be obtained; or from Messrs. Burt and Hairland, solicitors, Bournemouth; Messrs. Homfray, Holberton and Mellor, solicitors, Brierley Hill and Cradley Heath; or of Mr. E. Mason, chartered accountant, St. Paul's Chambers, Dudley and Cradley Heath.

From a preliminary announcement in our advertisement columns it will be seen that Messrs. Wheatley Kirk, Price and Co. have been authorised by the trustee (Mr. Myles Lee, of Lee and Whitfield, 17, East-parade, Leeds) to sell by public auction on an early date the whole of the fixed and loose engineering and electrical plant, dynamos, motors, electrical accessories, &c., at the works of John A. Edmondson, electrical engineer, Globe Works, Leeds. Catalogues are in course of preparation and may be obtained, together with any further particulars, from the trustee, or of the auctioneers, 49, Queen Victoria street, London, E.C., and Albert-square, Manchester.

Factory Premises for Sale.—In an advertisement it is announced that a leasehold factory, suitable for electric or light engineering works, motor-car factory, &c., is for sale. The plant comprises automatic and plain lathes, milling, drilling and profiling machines, a Dowson gas plant, three gas engines, &c., and is in first-class order.

Extensive premises within easy distance of London, suitable for engineering and manufacturing business, are announced for sale in an advertisement.

Glasgow International Exhibition (1901).—An advertisement in another column gives some particulars of the exhibition which will be held in Glasgow between May and November, 1901. There will be eight sections, including Industrial Designs and Manufactures, Machinery, Motive Power, Electricity and Labour Saving Appliances; Locomotion and Transport; Marine Engineering and Shipbuilding; Science, Education, and Music. Prospectuses and forms of application may be obtained from the general manager (Mr. H. A. Hedley), 36, St. Vincent-place, Glasgow.

Revision of Prices.—The British Thomson-Houston Co, 83, Cannon-street, E.C., intimate that prices of their electrical apparatus and supplies are being revised. New lists are in course of preparation, and will be ready shortly. In the meantime the company will be pleased to quote their customers firm prices.

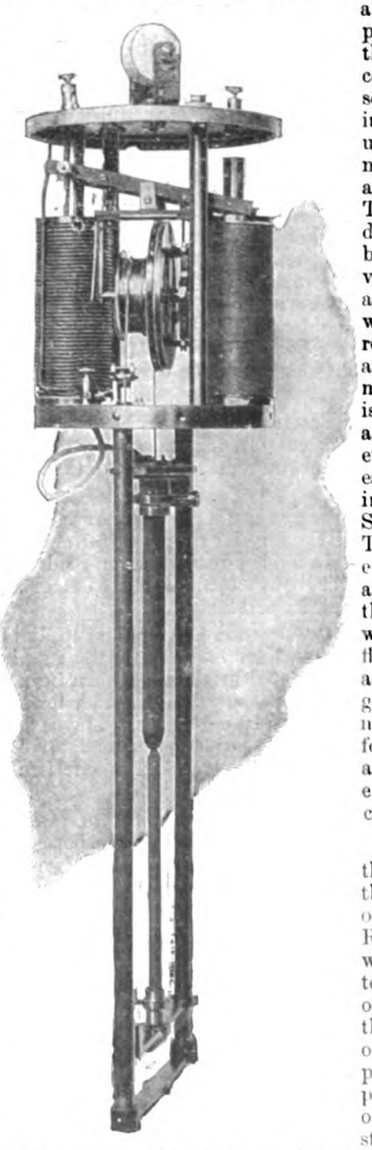
Water Cooler Contracts.—The Klein Engineering Co. have obtained an order from the Bolton Corporation for the supply of a Klein's fan water cooler at their electricity works for cooling the water requisite for condensing the steam from engines of 3,000 H.P. The fans and the circulating pump are driven by electric motors. The firm have also a surface-condensing and Klein's open type cooling plant in course of construction for the London and North-Western Railway works at Crewe, for engines of 800 H.P. to work in connection with electric light and power plant. The Prestwich County Asylum are adopting the firm's jet condenser and Klein's chimney cooling plant for engines of 450 H.P. in conjunction with their electric lighting plant.

Factory Lighting.—The order for the electric lighting of the large bedstead factory of Messrs. E. Wale and Sons, Birmingham, has been given to Messrs. Ellis and Ward. The consulting engineers are Messrs. Berrito, Edwards and Shaw.

The "Synchronome" Electric Time-Service System.—Mr. F. Hope-Jones, manager of the Synchronome Syndicate (Limited), 85, Gracechurch-street, London, E.C., forwards a copy of a pamphlet describing the system of electric time service for which the syndicate hold the patents of Messrs. F. Hope-Jones, G. B. Bowell, and others. The system has been installed in a number of banks, offices, schools, hotels, factories, institutions, private houses, and in church towers and turrets, and in a technical report of the system by Prof. S. P. Thompson the "Synchronome" system of electric clocks is very favourably reviewed. In cases where the surrounding conditions necessitate a large number of clocks, obviously accuracy is the first essential, and next to this that all the dials should indicate the same time at the same moment; and Prof. Thompson certifies that in a number of cases which have come under his personal observation for a lengthy period these conditions have been realised. The system is especially recommended for large industrial establishments and other places where uniformity of time indication is of importance and makes for smooth working. In this system only one pendulum is required, and every dial on the clock circuit indicates this pendulum time. Any number of dials may be worked from this one pendulum, which can be easily fitted to existing dial movements. As no winding or other regular attention is required, and the consumption of electric current is small, the system is very economical, apart from the facilities it offers for placing clock dials in advantageous positions for observation, although these positions may, owing to their inaccessibility, be unsuitable for ordinary clock situations.

West Ham Technical Institute.—This institute, which was opened about twelve months ago, was unfortunately destroyed by fire on Oct. 20. Many of the books were, fortunately, saved, but the whole of the upper floor (including the engineering and physical lecture theatres, drawing office, engineering laboratories, chemical department, &c.) were burnt out and the central hall destroyed. One explanation of the disaster is that a quantity of chemicals spontaneously combusted. The loss was only partly covered by insurance (£47,000). The principal (Mr. A. E. Briscoe), with his assistants, are making arrangements at once to re-start the classes in buildings lent by the West Ham School Board and other authorities. The institute will, we learn, not only be rebuilt, but considerably enlarged.

New Arc Lamp.—The Electrical Transmission Co. (Limited), of Albert Works, Hammersmith, London, are placing upon the market a new arc lamp. The accompanying illustration shows that the mechanism of this arc lamp consists of main and shunt solenoids, which actuate a rocking lever; this in its turn acts upon a friction clutch, by means of which the arc is struck and the feeding controlled. The friction clutch is of a design that admits the lamp being subjected to shaking or vibration without the arc being affected. The carbon holders work along the slides on small rollers which prevent sticking and give smoothness of movement. The lower carbon holder is connected to the cross bar by a simple form of ball joint enabling the carbons to be easily adjusted. The makers inform us that the Electrical Standardising, Testing and Training Institution have examined and tested the lamp, and in their report state that the arc strikes quickly and well, and with no objectionable flickering before settling down, and that the lamp runs with great steadiness, the regulating mechanism working with uniform smoothness. These lamps are constructed to work on either continuous or alternating current circuits.



Barlock Typewriters.—At the ninth annual dinner of the Barlock Typewriter Co., on Saturday last, Mr. W. J. Richardson, managing director, who presided, gave an interesting review of the progress of the typewriter industry in this country and the evolution of the writing machine to its present efficiency. The company present, which consisted of the company's London staff, numbered about fifty, and it was stated that an equal number of country representatives were in the company's service. As evidence of the popularity of the Barlock type of writing machine, it was announced that one commercial firm have 200 of these machines in use at Liverpool, and that a large number of leading firms in the engineering, electrical and other industries employ numbers of Barlock machines ranging from 80 to 20. The magnitude of the typewriting industry may be gauged to some extent by the fact that the working expenses of the Barlock Typewriter Co. reach £12,000 per annum. It was claimed for the Barlock machine that it has reached a high degree of perfection, has realised most nearly the ideal of the perfect mechanical writing machine, and has attained a pheno-

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menal success, which can only reasonably be attributed to its meeting the onerous requirements of this class of mechanism. During the ninth year of the company's existence the sales of these machines have exceeded by 55 per cent those of the previous year.

Instrument and Apparatus Catalogue.—Messrs. Gambrell Bros., electricians and manufacturers of scientific instruments and apparatus, of 17, Giltspur-street, London, E.C., have issued list B, a catalogue of scientific instruments and apparatus manufactured under the personal supervision of members of the firm. Amongst the apparatus illustrated is an improved bar pattern resistance coil in decimal sets, designed for use where great accuracy is required. The sets of ten resistances are so arranged that, by shifting the plug nearest the terminal end, the resistances are ready for use either in series or parallel as may be required. Resistance boxes for all classes of work are included in the list, which also contains particulars of several types of reflecting and direct-reading galvanometers, testing sets, &c.

Cassier's Magazine—The November issue contains articles on "Some Overhead Electric Travelling Cranes," "An Electric Tramway in the British West Indies," "An 83-mile Electric Power Transmission Plant," "Valuation of Manufacturing Property for Taxation," "Recent Practice in Steam Boilers in Great Britain," and "The Safety of Petroleum Fuel."

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Oct. 25 to Oct. 31, with the ports of destination :—

Africa—Alexandria, £25 ; Cape Town, £324 ; Durban, £1,095 (including £824 telegraph material) ; East London, £386 ; Port Elizabeth, £127 ; Port Said, £39. *Argentina*—Buenos Ayres, £1,109 (including £134 telegraph material). *Australasia*—Adelaide, £348 ; Brisbane, £906 ; Melbourne, £156 (telegraph material) ; Sydney, £902 ; Wellington, £370. *British Guiana*—Demerara, £506 (telegraph material). *Burma*—Rangoon, £1,000. *Ceylon*—Colombo, £801. *Channel Islands*—£120 (telegraph poles). *Chili*—Boca, £1,577 (including £409 (telegraph material) ; Valparaiso, £256 (including £144 telegraph material). *Colombia*—Santos, £210 (including £172 telegraph material). *Denmark*—Copenhagen, £263 (telegraph material). *France*—Boulogne, £40. *Germany*—Hamburg, £211 (including £200 telegraph material). *Holland*—Amsterdam, £35. *Hong Kong*—£15. *India*—Calcutta, £397 (including £104 telegraph wire) ; Madras, £244. *Japan*—Yokohama, £140. *Mexico*—Vera Cruz, £30. *North Sea*—£2,200 (telegraph cable). *Norway*—Christiania, £86 (telegraph material). *Portugal*—Beira, £75. *Straits Settlements*—Singapore, £87. *Sweden*—Gothenburg, £161 (including £15 telegraph wire) ; Stockholm, £167 (telegraph material). *Uruguay*—Monte Video, £72 (telegraph material). Total £14,480, against £17,710 in the corresponding week last year (Oct. 26 to Nov. 1).

MUNICIPAL, FOREIGN, AND GENERAL NOTES.

African Trans-Continental Telegraphs.—It is announced that this telegraph has been carried as far as Lungula, but that the operations in the basin of Lake Tanganyika have been suspended owing to the country between the lake and Namyema being in an unsettled condition.

Asylum Lighting.—The North Riding (Yorks.) County Council have decided to apply for a loan of £4,500 for the electric lighting of the North Riding pauper lunatic asylum. The contract has been let to Messrs. Crompton and Co.

Barking (Essex).—An inquiry was held here last week into the application of the Council to borrow a further £13,280 for electric lighting extensions. The clerk to the Council (Mr. E. H. Lister) appeared in support of the application, and the consulting engineer (Mr. W. C. C. Hawtayne) gave technical details.

Barnet.—The agreement for the transfer of the provisional order to the North Metropolitan Electrical Power Distribution Co. has been sealed.

Bath.—At a meeting of the Electric Lighting committee on Friday last the borough electrical engineer (Mr. G. F. Metzger) reported that the Callender Co. had considered the question of the arc lamps, and had found the conductor was not suitable, and although similar cables had worked well on low tension systems they were not suited to high tension, and consequently the Company were prepared to re-make the whole of the 88 services from the existing main free of charge. This offer has been accepted. Mr. Metzger also reported the receipt of a communication from the Company in regard to their contract for the extension of the mains. Mr. Metzger said the Company had carried out more low tension work than was provided for in the contract, but had 13,988 yards of high tension work to complete. The Company were liable to the committee for the supply of 28,000 yards of cable, but 20,000 yards of that would be absolutely useless, because they wanted a much larger sized cable. After discussion the letter was referred to the works committee for consideration.

Bedford.—An inquiry was held here last week into the application of the Council to borrow £41,000 for electric lighting purposes. The town clerk (Mr. T. S. Porter) said the amount already sanctioned for electric lighting purposes was £63,450. The borough electrical engineer (Mr. W. J. Hope Johnstone) said the output had been steadily increasing owing to the numerous demands for current for private lighting purposes. The output for 1899 would be about 750,000 units, and the present loan was required for extensions of mains and plant. There was no opposition.

Berwick-on-Tweed.—The Corporation are considering the question of electric lighting. They have retained Mr. A. A. Campbell Swinton to advise them.

Blackburn.—The Corporation's storeyard at Islington is to be lighted electrically, at a cost of £763.

Bolton.—The electric tramways are approaching completion, and the first trial of the new cars took place on Monday on the Bradshaw and Tonge Moor route. The interest of the present lessees of the tramways (Messrs. Holden and Co.) has been purchased by the Corporation at £55,000. The borough electrical engineer (Mr. Arthur Ellis) has been appointed general manager of the tramway system, Mr. Norman Little has been appointed assistant engineer, and Mr. Harry England traffic manager. The cars are double-decked, capable of being attached to trailers in times of emergency. There are at present 31 miles of track, covering about 28 miles of street.

Bombay.—It is proposed to convert the lines of the Bombay Tramways Co. to electric traction, and application has been made to the Bombay Government for its sanction. The Bombay tramways were opened for traffic in 1874.

Boston.—At a special meeting of the Council the recommendation to purchase the undertaking of the Boston Gas Co. for £60,000 was rejected, and instead an application for a provisional electric lighting order was decided upon.

Bridlington.—Mr. F. H. Medhurst is preparing a report on electric lighting for the Council.

Bristol.—It is proposed that 394 additional arc lamps be erected in place of existing gas lamps in a number of thoroughfares.

Cambridge.—After consideration of the report of their consulting tramway engineer, Mr. Kincaid (Messrs. Kincaid, Waller and Manville), the Council have decided to apply for parliamentary powers for the construction of various tramway lines, which will be equipped electrically, probably on the overhead system.

Cleethorpes.—The report of their consulting engineer (Mr. C S. Vesey Brown) has determined the Council to apply for a provisional electric lighting order.

Colwyn Bay.—The Local Government Board recently held an inquiry into the application of the Council to borrow moneys for electric lighting purposes, and at the last Council meeting a communication was received from the Board inquiring the probable support which the undertaking would receive and the number of lights likely to be required. This return is stated to have been most encouraging, the total number of private lights for which application had been received being 1,164.

Commercial Congress.—The holding of a commercial exhibition in Philadelphia has been made the occasion for the holding of a commercial congress at which the following recommendations were approved :—(1) That all nations should join a union for the registration of trade marks ; (2) that all Governments should establish a parcels post system ; (3) that uniform trade statistics should be prepared for all nations ; (4) that an international bureau for the collection and dissemination of agricultural reports should be established ; (5) that the Philadelphia Commercial Museum should be supported by all governments and chambers of commerce ; (6) that international arbitration should be established as far as possible ; (7) that an inter-oceanic canal should be constructed. Nos. 2 and 5 are peculiar recommendations. So far the United States stand as the only country which has not established parcels post. As the Philadelphia Commercial Museum is a purely American institution —in fact, a peculiarly American type of institution—it will strike outsiders as a cool suggestion that it should be made a recognised international centre of commercial organisation.

Cork—A protest signed by the majority of the leading business men in this city has been presented to the Corporation in reference to the proposed electric lighting arrangements. The signatories to the protest support the original proposals of the city engineer, which were adopted by the committee, but rejected by the Corporation. The matter will come up for consideration at the next meeting, on notice of motion to rescind the former resolution.

Douglas (Isle of Man).—In June, 1898, it will be remembered, Dr. J. A. Fleming addressed to the Electric Lighting committee of the Douglas Corporation an exhaustive report on the electric lighting of the town. After setting out a number of arguments in favour of municipal electric supply, Dr. Fleming pointed out that hardly any case could be cited where the revenue of a well-chosen electric lighting station, put up under competent advice, had not, after one year from the start, been sufficient to meet working expenses. In this report he recommended that the area of supply at Douglas should include the Sea Front, Victoria-street, Prospect Hill, Duke-street, Strand-street, Castle-street, Ridgway-street, Market Hall, an

Athol-street, to extend when required to Broadway and Bucks-road, as this district comprises all those portions of the town where hotels, restaurants, boarding-houses, shops, and public buildings are situate. Dr. Fleming further recommended that provision should be made in the initial scheme for a possible lamp connection of the equivalent of 6,000 8-c.p. each, and, in addition, for the public lighting of the sea front and parades round Douglas by arc lamps, of which 40 of 2,000-c.p. would be required for the parades on the sea front, and a further 20 for the principal streets set out above. The system of generation of supply then recommended for adoption was practically the Oxford system. The Wright maximum demand system of charging was advised, and a probable gross revenue of £2,400 from private lighting and £1,470 from public lighting (total £3,870 per annum) was anticipated The annual expenditure, omitting interest on loan and sinking fund contribution, was put at £2,350 for the generation of 187,000 units (working out at rather over 3d. per unit sold), or, allowing for interest on land and sinking and depreciation funds (£1,500), the total annual expenditure was put at £3,813. The estimated outlay for the initial scheme was rather over £25,000, made up as to £10,480 for generating plant; land and buildings, &c., £5,000; mains, £6,000; arc and incandescent lamps and standards for public lighting, £3,225; transformer chambers and main battery sheds, £300; to which was added charges for legal expenses, engineer's commission, superintendence during erection, and contingencies Dr. Fleming concluded by recommending that the Electric Lighting committee should visit Wolverhampton, Walsall, Shoreditch and Oxford. This report was discussed, but no decision was arrived at. Subsequently an offer to supply current in bulk was received by the Corporation from the Isle of Man Tramways Co. Upon the receipt of this offer it was decided to put the matter before Prof. Fleming, with a view to a further report. We briefly referred to this matter in our last issue, and now that the full report is before us, it shows that Prof. Fleming is convinced that the proposals contained in his original report form the true basis upon which the Douglas Corporation should proceed in regard to the electric lighting of the town. The Tramway Co.'s offer is to supply current on the three-wire system with 460 volts across the mains, the consumers' pressure being 230 volts.

The objection I have (says Dr. Fleming) to the high service pressure of 230 volts is that the consumer cannot easily employ small candle-power lamps. It is difficult, if not impossible, to get good lamps to work at 230 volts pressure of less than 16 c.p. Hence, the small consumer would be largely prevented from using 8 and 5 c.p. lamps, which he could do if the pressure of supply were, as I purposed it to be, 110 volts. It may be that this would exercise a retarding influence on the growth of the lighting. . . . On the other hand, the use of the high service pressure effects a distinct economy in the capital outlay on mains. Hence we may say that from the point of view of the suppliers the high service pressure is an advantage, but from the point of view of the consumer it is a disadvantage.

The report continues that as soon as the Corporation decide to light the area indicated in the 1898 report (as set out above) it would require to expend about £10,000 in mains and street arc lamps before electric energy can be taken from the company and delivered to the consumer. In addition, an electrical staff would have to be appointed to arrange and supervise the distribution, to look after the mains, read the meters, trim and repair the street arc lamps, &c. The salary for this staff is put at a minimum of £350 per annum. £600 a year would have to be set aside for interest and sinking fund, and a fund will also have to be provided for repairs to mains, arc lamps, and other portions of the distribution system. If this is put at £150 per annum, the Corporation will be committed to an annual outlay of £1,100 on a moderate computation merely to become purveyors of electric energy which is to be purchased in bulk from the Tramway Co. at from 3½d. to 3d. per unit. Prof. Fleming is therefore strongly opposed to the adoption of the Tramway Co.'s offer, and concludes with the following general statement:—

There are some towns where the Corporation purchase electricity in bulk from a public company for operating municipal electric tramcars, and do so successfully, but I do not know of any case in which the process is reversed and a Corporation buy electric energy in bulk from a tramway company to supply electric lighting. I feel that the final aspect of the whole question of purchase from the Tramway Co of electricity in bulk has something experimental about it. I leave out of account such questions as the uniformity and regularity of the supply. Even if we assume that this is entirely satisfactory, I feel that experience is wanting to show what the position of affairs will be five years hence, when the Corporation has gone on purchasing electric energy in bulk and retailing it, as it must do, at a constant price. The great success of the electric lighting industry in some towns, such as Brighton, has arisen solely from the fact that they have catered for the small consumer. It is beginning to be understood by the electric lighting companies and Corporations that the policy so successfully adopted by the railway companies of providing well and cheaply for the third class traffic is the policy which leads to success in dealing with the electric lighting industry. In order that an electric lighting enterprise may succeed, the electric light must become the poor man's light, and not simply the light of the well-to-do. With this aim, every effort must be made to encourage the small consumer to use the current, not only for light but for heat and power, and that can only be done by reduction of the price.

Dudley.—An inquiry was held on Tuesday into the application of the Corporation to borrow, amongst other sums, £33,000 for electricity supply purposes. The town clerk (Mr. H. C. Brettell) said the application was for a second loan under their 1897 electric lighting order. In 1898 the British Electric Traction Co. obtained possession of the Dudley-Stourbridge tramway, and the Corporation entered into an agreement with the company to supply current for working the tramway electrically. They had, therefore, erected a temporary generating station to supply the necessary energy, and were now erecting a permanent station for which this supplementary loan was required. The consulting engineer (Mr R. P. Wilson) submitted plans and technical details of the scheme, and said the streets through which the tramways worked would be lighted electrically by arc lamps placed on the tramway poles. Several applications for current had been received, and there were indications that the undertaking would be a financial success in the first year.

Dublin—The Palmerston Park Electric Tramway route was opened for traffic last week.

Dundee.—Owing to the delay in the delivery of plant for the electricity station extensions, the Gas Commissioners intimate that they cannot receive any applications for electric current until further notice.

Durham.—The proposals of the Electric Power Distribution Co. to establish electricity works and to construct an electric tramway from North-road to Brandon have been accepted by the Council and the Durham provisional order will be transferred to the Company.

Ealing.—In the annual statement of accounts recently issued by the Electricity department it was set out that various loans raised for electricity supply purposes amounted to £77,177. 9s., but of this sum £4,313. 10s. 7d. had been paid off. Last year the cost of generation, distribution, &c., amounted to £5,147. 11s. 8d., and the total revenue was £8,771. 18s. 5d. (£5,276. 7s. 8d. from private customers, and £3,213. 17s. 9d. for public lighting). After allowing for sinking fund, interest, &c., there was a net profit of £65. 16s. 11d. 502,491 units were generated, 445,241 sold, and 11,450 consumed on the works.

Eccles.—A proposal of the United Kingdom Tramways Syndicate to construct electric tramways from Eccles to Whitefield and Urmston has been endorsed by the Eccles Corporation.

Electricity Supply in the Midlands—The Midland Electric Corporation for Power Distribution (Limited) have acquired a plot of land, 14 acres in extent, at Ocker Hill, Tipton, as a site for electricity works for the supply of energy in various surrounding districts. The company have already obtained provisional orders for several of these districts, but in some cases special agreements have been made for a supply in bulk to the local authorities. The works will be capable of accommodating generating plant of 14,000-h.p. capacity.

Electric Traction in the Canary Islands.—A company, entitled the Société des Tramways Electriques de Teneriffe (Iles Canaries) et Extensions, has been formed in Brussels with a capital of £60,000, to construct and operate electric tramways in Teneriffe.

Erdington.—An application for a provisional order has been authorised by the District Council.

Exmouth.—As the result of an interview with their consulting engineer (Mr. Robert Hammond), the Council have decided to obtain powers for erecting electricity supply works at an estimated cost of about £16,000.

Fatality.—An inquest was opened at Eston Junction on Saturday last into the circumstances attending the death of David Evans, aged 14, who was killed by an electric shock at the Cleveland Steel Works. Deceased fell asleep, and on awaking yawned and stretched out his arms. One of his hands came in contact with the electric light wires, and he was immediately killed. The inquest was adjourned for the attendance of the factory inspector.

Glasgow.—The subject of the placing of the contract for electric cables, &c., which was to have come before the Council at its meeting yesterday (Thursday), was not reached.

Gomersal (Yorks.).—In connection with the British Electric Traction Co.'s scheme for the construction of an electric tramway from Dewsbury to Cleckheaton arrangements have been made for the construction of a branch line to Gomersal.

Guayaquil (Ecuador)—A recent report from this district states that an excellent opportunity exists for the introduction of electric lighting and electric tramway services in this city, which has a population of about 50,000. At present a very poor quality gas is used in lighting, which has the additional demerit of being very costly. It is stated that the finances of the city are in a flourishing condition, that fuel is scarce and expensive, and that extensive water power is readily available at some distance from the city. In 1896 electricity works were in progress, but a terrible fire destroyed the whole of the electrical plant, and the enterprise was abandoned.

Halifax.—At a special meeting of the Corporation on Tuesday the Council's Tramway Bill, under which powers are sought to construct new tramways of a total length of 38 miles, including lines to Brighouse, Hebden Bridge, Sowerby Bridge, Risworth, Elland, and other surrounding districts, was approved.

Hammersmith (London).—At present there are 374 customers (representing an equivalent of 22,768 8-c.p. lamps) connected, and applications in hand for nearly 5,500 additional lamps.

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Henley.—The Town Council have decided to obtain a report from a consulting engineer as to the advisability of establishing electricity supply works.

Hythe.—The overtures of the Folkestone Electricity Supply Co. in regard to electricity supply have been rejected by the council, who have decided, by a practically unanimous vote, to apply for a provisional order.

Ilford.—The Lighting and Tramways committee have appointed a sub-committee to visit various electricity works in England, and to report upon the system of electricity supply best adapted to this district.

Import Duties.—The following particulars relating to the re-arrangement of import duties are just published :—

Jamaica.—Under the new customs tariff, rolling stock, rails, locomotives, and all materials and appliances used exclusively in the construction, equipment, and operation of railways and tramways are admitted free of duty.

Zanzibar.—Machinery and materials used in the construction and maintenance of tramways or railways are admitted free of duty in the dominion of the Sultan of Zanzibar from 15th Sept. last.

Cyprus.—From 20th Aug. last street lamps and their fittings, imported by municipal councils in the island, to be used in street lighting, are admitted free of duty, as are also machinery and parts of machinery, and their fittings, connections and gear.

The *German* Government has placed asbestos paint, used in electric wire and cable factories for impregnating the cotton covering of wires, under the head of "painters' colours" for the purposes of duty, amounting to 200 marks per 100 kilos. This material is chiefly imported into Germany from the United Kingdom.

Insurance.—Foiled to a considerable extent in their attempts to bring into disrepute the Workmen's Compensation Act, 1897 (and evidently feeling that those industrial undertakings which are making provision for employers' liability risks outside the tariff offices are disposed to undertake also their own fire risks), what are known as the "tariff" insurance offices are, it is stated, making strenuous efforts to effect a rig in fire insurance by introducing into their arrangements with their brokers and agents conditions which may affect insurers adversely. In connection with workmen's compensation risks many large firms have saved thousands of pounds by either (*a*) providing a fund out of revenue and taking their own risks, or (*b*) making arrangements with members of Lloyd's, by which the rates for these risks have been very materially reduced. We strongly advise insurers, if there is any attempt on the part of the tariff offices either to increase their premium rates or to introduce conditions which are irksome or in restraint of freedom of action, not to lose sight of the fact that all classes of insurance can be effected by other means than through these offices and with quite equal security. The question of fire insurance, employers' liability, workmen's compensation, burglary, wilful damage, and other similar risks must on an early date come prominently before insurers generally and large employers of labour in particular, and it is important at this juncture that their hands should be free to adopt any system of insurance which, while consistent with safety and security, will lower the present excessive premium rates. For this reason it is essential that any device of the "tariff" offices to encumber their arrangements with insurance brokers and agents with vexatious conditions has an interest for insurers quite apart from its interest to the broker or agent, through whom the bulk of insurances are effected.

Ipswich.—The Council are promoting a Bill for powers to construct and equip a system of electric tramways in the district. This step has been taken after consultation with Mr. Waller (Messrs. Kincaid, Waller, and Manville).

King's Norton.—The Surveyor's department has been instructed to make a canvass of ratepayers to ascertain the probable demand for electric current.

Kingston-on-Thames.—The salary of the borough electrical engineer (J. E. Edgcome) has been increased from £300 to £350 per annum. The Local Government Board have sanctioned the borrowing of a further £15,000 for electric lighting purposes, on the understanding that no part of the money is to be expended in payments to salaried officers of the Corporation, or in defraying the cost of incandescent lamps ; also that the Corporation must accept the entire responsibility for the stability of the roofs of the sub-stations. The Board further state that before they consider any subsequent application for sanction to a loan, they would require to be furnished with statements showing how the sums included in the loans sanctioned for mains, services, meters, and public lighting had been expended, with plans showing where the mains had been laid and the lamps placed. The Council have now applied to the Public Works Loan Commissioners for the loan of £15,000.

The Corporation offer to supply electric current to the workhouse at 6d. per unit for the first hour's maximum demand and 3d. per unit after, provided the Guardians enter into a seven years agreement.

The Council have decided to proceed by way of a Bill for obtaining powers to construct and work electric tramways.

Particulars of the extensions to the electricity station required to enable current to be supplied to the proposed electric tramways were submitted by the borough electrical engineer at the last Council meeting, and negotiations are proceeding between the Electric Lighting and Tramway committees as to terms of supply.

Kirkcaldy (N.B.).—A committee of ratepayers is co-operating with the British Electric Traction Co. in formulating an electric lighting and tramway scheme for this district.

Lambeth (London).—The Lighting committee of the Vestry are about to invite tenders for the supply and erection of 25 arc lamps and lamp columns. Mr. F. A. Nixon, engineer to the South London Electric Supply Corporation, has prepared the specification and will superintend the work of erection.

Lancaster.—The Corporation have decided to equip the local electric tramways on the overhead trolley system, and, if possible, to acquire the line between Lancaster and Morecambe.

Leeds.—The Boar-lane–Headingly electric tramway route is approaching completion, and will be ready for traffic in about a fortnight. The Tramways committee have accepted a tender for the supply of 50 additional electric tramcars.

London County Council.—At Tuesday's meeting it was agreed to lend £25,000 to the Fulham Vestry and £14,620 to the Shoreditch Vestry for electric lighting purposes.

The question of the acquisition of property at Camberwell for a large generating station for working the tramways south of the Thames was again adjourned.

The Highways committee reported that the London United Tramways Co. had submitted drawings for the equipment for electric traction by the overhead trolley system of certain of the company's tramways in the Uxbridge-road, and by an underground system of the tramways from Young's Corner to Hammersmith Broadway and thence to King's-street West. The Hammersmith Vestry, had, however, strongly urged the adoption of the overhead system for a portion of the latter route, pointing out that several of the thoroughfares were narrow, and that considerable inconvenience would be caused to tradesmen and the public during the construction of an underground system, and further that there would be a difficulty in laying a conduit system as on a portion of the route, for a distance of 127 yards, a space of only between 9in. and 12in. lies between the top of the girders of the District Railway tunnel and the surface of the roads. The Highways committee have, however, been advised that the County Council has no power to agree to the proposals of the Hammersmith Vestry, and, as the Tramways Co. are prepared to adopt an underground system, notwithstanding the difficulties that may be met with in construction, the committee recommended that the Company's plans should be approved. The system to be adopted is similar to that in operation on the metropolitan tramways in New York, with certain improvements in detail to render the system better suited for the special local conditions under which these tramways are to be operated. The overhead system to be adopted will have no uninsulated return and "thus a great object to the system generally used with a rail return is removed." The plans submitted show that the overhead wires are to be placed only 22ft. above the level of the rails, although the Council's bye-laws stipulate for 35ft. No objection has been raised at this departure from the bye-law. The committee therefore recommended that the Company's plans and particulars should be approved, subject to the following conditions :—

"That the trolley wires be not attached to the electric lighting standards of the Vestry of Hammersmith; that the Company furnish to the Vestry detailed drawings of the inspection chambers and boxes proposed to be placed in the carriageways or footways; that the 'Bristol' designs for the side and centre traction-posts be used; that the cut-out circuits be of such length as shall be approved by the Council's chief engineer; and that the Company submit for the approval of the Council an amended design for the conduit."

The consideration of the recommendation was deferred.

Light Railways.—In connection with the extensive light (electric) railway scheme which is being promoted by the Middlesex County Council at an estimated cost of £800,000, Mr. C. H. Gadsby has been engaged as consulting engineer to prepare a report upon the scheme at a fee of £105.

The Light Railway Commissioners have settled the South Staffordshire light railway order, and the period of purchase by the Bilston and Willenhall Councils has been extended from 25 to 28 years.

The proposal of the British Electric Traction Co. to construct a light (electric) railway or tramway from Rothesay to Kilchattan Bay, via Scalpsie Bay, has been approved, and is being supported by the Rothesay Corporation.

A scheme has been submitted to the Pwllheli Town Council for the construction of a light (electric) railway from Pwllheli to Bevan.

On the invitation of the chairman of the Surrey County Council (Ald. E. J. Halsey), a conference of representatives of the local authorities interested in the scheme which is being promoted by the Surrey Council for the construction of light electric tramways was held last week at Kingston. Particulars of the scheme, which com-

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prise the construction of over 29 miles of light electric railway, were given in our last issue. No formal decision was come to, but the Kingston Corporation wish to be excluded from the scheme, as they are promoting a Bill for the construction of tramways.

On the recommendation of their Highways committee, the Herts County Council have decided to promote a scheme for the construction of light (electric) railways in such portion of the county as shall be shown to require light railway communication; and the Highways committee have been empowered to negotiate with the North Metropolitan Tramways Co. for the promotion, at an early date, of light railways in those portions of the county in which it shall be found that an immediate necessity exists for such communication, with power to make, or join in making, applications to the Light Railway Commissioners for orders in such cases as they shall consider desirable.

Limerick.—The question of the introduction of electric tramways has been agitating local circles for some time past. Nothwithstanding the hostile attitude of the car-drivers and of the labour members, the proposal to introduce electric tramways has been carried

Liverpool.—A stoppage on one of the lines of the electric tramways at Liverpool on Thursday last week was, of course, considerably exaggerated in the daily papers. All that happened was that the trolley pole of one of the cars left the line and fouled the guard wire. The latter fell on to the trolley wire, thus causing an earth and throwing the circuit breaker at the station. The fault was speedily removed, and the service was re-established within 40 minutes Only nine cars were affected by the incident. It is interesting to note that since the tramways were started, just 12 months ago, there has never until now been a single case of the current being interrupted, or at any time any untoward occurrence at the power-house.

The Walton electric tramway route was officially inspected by Sir F. Marindin and Mr. A. P. Trotter on Friday. The Stanley-road and the Aintree and Fazakerley sections are also nearly completed and will, it is expected, be ready for electric traction by Christmas.

Liversedge.—Mr. Gott, of Bradford, has been appointed consulting engineer to prepare a report on electric lighting.

Manchester.—Sir F. Marindin and Mr. A. P. Trotter will hold a Board of Trade inquiry on Wednesday next into the application of the Corporation to borrow £860,000 for electric tramway purposes. A special meeting of ratepayers will be held on Tuesday to consider the Corporation's proposed Tramway Bill.

Newark.—The Council have resolved to apply for a provisional order.

Newington (London).—The Vestry have asked the Electric Lighting committee to report upon the "frequent failure of street electric lighting."

Preston.—The report of the consulting engineers (Messrs. Lacey, Clirehugh and Sillar) on the electric tramway question was presented and approved at the Council meeting last week. It was decided to adopt a 4ft. gauge, to equip the lines on the overhead trolley system, and to apply for Parliamentary powers to reconstruct the existing and to construct additional lines, &c.

Provisional Order Notice.—The Prestwich Council give official notice of intention to apply for a provisional order.

Pwllheli.—By the casting vote of the mayor it has been decided to apply for a provisional electric lighting order.

Queensbury (Bradford).—The Council have approved the proposals of the Bradford and Halifax Corporations to construct and work electric tramways in the district.

Russian Poland.—A Foreign Office dispatch announces that the town of *Lodz*, in Russian Poland, with 400,000 inhabitants, offers an opening for electric lighting works. Electric tramways were started in this town last year, and are working admirably. The town of *Lublin* also offers an opening for the establishment of a tramway service, and is discussing the desirability of adopting electric traction. The town of *Radom* desires to adopt electric lighting, and the town of *Sosnowice* has also a lighting scheme under consideration. Electrolytic works were started in 1896 at Lombkowice, under Belgian auspices. The British consul-general at Warsaw, in the dispatch referred to, calls special attention to these excellent openings for British electrical enterprise.

St. George's, Hanover Square (London).— On the recommendation of their Motor Traction sub-committee, the Vestry have decided, as an experiment, to purchase a motor dust van.

St. Pancras (London).—The Electricity committee of the Vestry on Wednesday recommended that the freehold interest of property adjoining the King's-road station should be purchased for £7,500 for extension purposes. Dr. Wigg stated that the committee were inundated with demands for current, and it was essential to have room for extensions. The proposal was agreed to.

Salford.—The Corporation have decided to borrow £87,950 for the purchase of eight steam dynamos, boilers, &c., for their new Strawberry-road electricity station. The Cross-lane and Trafford-road tramway routes are to be constructed, and the Electric Light Committee have been requested to make arrangements for bonding the rails for election traction. Application is also to be made to the Board of Trade for sanction to borrow £53,450 for the purchase of 100 electric tramcars.

Shanghai.—In a recent report by the United States consul attention is called to the opening for the introduction of means of rapid transit in this district. Particular attention is called to the field for auto-motors, as it is stated that the Chinese take kindly to mechanical inventions when they are properly introduced. The city is growing rapidly, but as yet there are no street railways.

Sheffield.—An accident occurred on the Nether Edge tramway route on Thursday last when the boom ran off the trolley wire, and smashed against the cross pole, doing considerable damage and causing delay to the traffic. The curve at this point, being on a steep gradient, is not an easy one, and in his report to the Board of Trade, Mr. A. P. Trotter recommended that here a speed of four miles an hour should not be exceeded.

Shipley.—A report on electric lighting has been prepared for the Council by Mr. Robert C. Quin, recommending the establishment of electricity works at an estimated cost of about £14,500. Current for private lighting would be supplied at 7d. per unit for the first hour's maximum demand and 2d. after, and for street lighting at 2d. per unit. The report will come up for discussion at the next Council meeting.

Sierra Leone.—During 1899 preliminary arrangements have been made to establish a land telegraph service in connection with the railway, and the public offices are being connected up by telephone.

Singapore.—A report on the proposal to establish electricity works in this town has been submitted to the Municipal Commissioners by Mr. H. R. J. Burstall (Messrs. Burstall and Monkhouse). Owing to the peculiar formation of the town, Mr. Burstall is of opinion that the central area would be best supplied by a low-tension continuous-current system, the mains being laid underground; and that the external area would best be supplied by a high-tension alternating-current system, the mains being carried overhead, the plant for supplying the two districts being placed in one station. Such a combined system would be the most economical one for a town like Singapore. Current would be supplied at a pressure of 250 volts in the central area and the minor streets would be illuminated by 550 32-c.p. incandescent lamps placed at a distance of not more than 90 yards apart. The principal thoroughfares would be illuminated by 80 2,000-n.c.p. lamps. Plant capable of supplying current to the equivalent of 10,000 8-c.p. lamps should be installed for central area. Mr. Burstall advises the selection of three units of plant, each of 370 I.H.P. The estimate of cost for the central district scheme is put at £57,417 with high-speed plant, and £59,817 with low-speed plant. The annual expenditure would be about £5,770, the estimated annual income £10,620, leaving an estimated annual balance of £4,850 to meet interest, sinking fund, rent, rates, &c. For the whole district, central and external, the estimate of cost is £104,020 with high-speed plant, or £109,520 with low-speed plant. The total annual expenditure for the whole district is estimated at £9,166, and the estimated annual income at £20,280. A comparison of cost of underground and overhead mains is given as under:—Central district (low-tension), underground mains, £19,110; overhead mains, £11,400. External district (high-tension), underground mains, £25,550; overhead mains, £20,930.

Smoke Nuisance.—At the South Western Police Court on Friday last, before Mr. Lane, Q.C., the County of London Co. was summoned by the Wandsworth Board of Works and fined £45 for allowing smoke to issue from the chimney shaft at the Wandsworth works of the company.

Southborough.—The Council have refused the proposal of the Tunbridge Wells Corporation to extend, subject to consent of the Board of Trade, their electricity supply mains to Southborough.

Southwick (Sussex).—The Council have appointed a committee to meet representatives from the Shoreham and Portslade districts, to devise an electric lighting scheme for the three districts.

Stafford.—The Market Hall is to be lighted electrically, current being taken from the Corporation mains.

Sunderland and the Reservists.—Mr. John F. C. Snell, borough electrical engineer of Sunderland, has initiated a fund for the wives and families of the reserve men who have been called out to the Transvaal. The employés at the electricity works have unanimously decided to put aside a small percentage of their salaries towards this fund.

Telegraph and Telephone Combine.—According to Laffan, it is reported at Philadelphia that an organisation has been incorporated combining all the telephones, the land line telegraphs, and the five Atlantic cable companies in one big company. Amongst those engaged in the negotiations the names of Messrs. Morgan and Co., Mr. Geo. Gould, and Mr. John Jacob Astor are given. No confirmation of this report is obtainable on this side.

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Telephone Facilities in London.—The Holborn Board of Works has approved the proposal of the Kensington Vestry to hold a conference to discuss the question of granting or withholding the consent of the London local authorities to the application now being made by the Postmaster-General in connection with the opening up of the streets for laying underground telephone lines.

The Clerkenwell Vestry have declined for the present to grant the application of the National Telephone Co. to open certain streets for the purpose of laying underground telephone conduits. The subject is to be reconsidered when the Post Office authorities are opening up the roads for their telephone cables. The ground of refusal of the company's application was that the rental offered was insufficient.

Thirsk (Yorks.).—The application of the Northern Counties Electricity Supply Co. for a provisional order has been sanctioned by the District Council.

Walker.—Negotiations are proceeding between the Council and the Newcastle Electric Supply Co for supplying current for lighting and power purposes in the district.

Walthamstow.—The Council have decided to apply for a tramway provisional order. Mr. J. Enright has been appointed consulting engineer.

Warrington.—In response to an application by the Corporation to borrow £44,936 for electric lighting purposes, the Local Government Board have applied for the usual particulars, and have asked for an "estimate showing the expected revenue from the supply of current as ascertained by communication with intending consumers, whose premises and requirements should be specified in the estimate. They also wish to know whether a provisional agreement has been entered into for the purchase of the land required for the erection of the electricity generating station.

Wigan.—The free library is to be wired for the electric light.

Wolverhampton.—On Monday the Corporation authorised additional expenditure to the amount of £11,000 for electric lighting extension purposes.

Workhouse Lighting.—The Pontefract Guardians have decided to put down an electric lighting installation as recommended by their consulting engineer (Mr. G. R. Peers), at an estimated cost of £1,900 and an annual expenditure of £208. The workhouse will be illuminated by 470 incandescents.

The Lynn Guardians have appointed a committee to report upon the lighting of the workhouse electrically.

Works Lighting.—The Kittybrewster Granite Works of Mr. James Knowles have been provided with an electric lighting installation by Messrs. Shirras, Laing and Co.

PATENT RECORD.

The following list of Applications for Patents and Specifications published has been compiled for this journal by Messrs. J. C. Chapman and Co., *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs, and Trade Marks may be obtained.*

APPLICATIONS FOR PATENTS.

Note.—*The undermentioned Applications are not open to public inspection until after the acceptance of the complete Specification. The names within parentheses are those of communicators of inventions. When complete specification accompanies application, an asterisk is affixed.*

September 22, 1899.

19,065. R. F. Hall. Birmingham. Improvements in, and in the manufacture of the balance-weight fittings of electric lampe.

19,103. The Joint Stock Co. (styled K. Rheydt and J. Zappe and A. Hohnholz). London. Improvements in telephone conductors or cables.

19,105. P. A. Chalas. London. Improvements in secondary batteries

19,124. J. E. Spagnoletti. London. Improvements in electric thermostat.

September 23, 1899.

19,148. C. J. Cummins. Dublin. An electric pull switch.

19,189. Siemens Bros. and Co. (Limited). London. Means and apparatus for electrically working vacuum and air pressure railway brakes. (Siemens and Halske Actien Gesellschaft, Germany.)

September 25, 1899.

19,261. The British Thomson-Houston Co. (Limited) and F. Holden. London. Improvements in electrically-operated clocks.

September 26, 1899.

19,285. T. J. McTighe. Birmingham. Improvements in rail bonds for electric railways.*

19,354. I. Timar. London. Improved thermaphor with electric heating arrangements.*

19,384. J. G. Lorrain. London. Improvements in or connected with electric clock systems. (H. A. Macdonald, France.)

September 27, 1899.

19,440. M. Gehre. Liverpool. Improved apparatus for periodically producing electric current by means of irregular motive power.

19,445. A. Blondel, G. Weissmann and A. Wydts. London. Improvements relating to electric lighting systems.

September 28, 1899.

19,515. W. J. Crossley. Manchester. Improvements in electric igniters for internal combustion motors.

19,530. J. W. Fenn and A. R. F. Evershed. London. A new and improved adjustable reflector for electric and other lamps.

19,535. A. Blondel, G. Weismann and A. Wydts. London. An improved method of winding transformers for alternating electric currents.

19,537. R. J. Liebisch. Manchester. Improvements in switches and switch holders for incandescent electric lamps.

19,539. B. Hopkinson and E. Talbot. London. Improvements in automatic circuit breakers.

September 29, 1899.

19,595. B. McDermott. London. An improved electric telegraph hand transmitter for Morse code.

19,619. J. Burke. London. Improvement in laminated armatures for dynamo-electric machines.*

19,631. A. Soames. London. Improvements in electrical converters.

19,640. J. T. Armstrong and A. Orling. London. Improvements in electro-magnetic wave apparatus.

September 30, 1899.

19,646. W. Sunter. Glasgow. Appliance for generating electricity to be utilized in propelling machinery, and for other purposes.

19,672. T. Malkin and W. F. Malkin. Stoke-on-Trent. Improved insulator for supporting telegraph wires, telephone wires and (or) electrical mains.

19,678. H. W. Hedges. London. Improvements in lightning conductors.

October 2, 1899.

19,710. S. G. Brown. London. Improvements in wireless telegraphy.

19,758. A. B. MacGregor. London. Improvements in electric telephony.

19,781. S. A. Hunter. London. Improvements in or relating to electrical switches.

October 3, 1899.

19,785. The Vereinigte Elektricitäts-Actiengesellschaft and J. Klaudy. London. Electro-chemical process for cleaning metal surfaces.

19,787. W. Best. London. Improvements in means for electrically igniting miners' safety lamps.

19,793. B. J. Round and A. Round. Birmingham. Improvements in or relating to the electro-plating and burnishing of certain articles and in apparatus to be used therein.

19,818. R. O. Best. London. Improvements in the construction of wicks for oil lamps which are electrically lighted.

19,825. H. J. Sheldon. Harrow. Improvements for rendering moulds conducting in the electrolytic bath.

19,846. R. M. Thomas. London. A new and improved conduit terminal and junction box for electric wires.*

19,849. W. Friese-Greene. London. Means or apparatus for recording the electrical vibrations or undulations known as Hertzian waves.

19,854. P. Pinckley. Portsmouth. Improvements in electric railways and tramways on the surface contact system. (Post dated (April 21, 1899) and re-numbered 19,854, under Sec. 7 Patents, &c., Acts, 1883-8.)

19,863. W. Gray. London. Improvements in or connected with telephonic apparatus.*

October 4, 1899.

19,916. W. P. Thompson. Liverpool. An improved safety connecting bar or hanger for overhead electric wires carrying strong currents. (Petoch and Gürtler, Austria.)

October 5, 1899.

19,938. S. O. Cowper-Coles. London. An electrolytic method for drilling and slotting metals.

18,941. W. H. Pick. Bradford. Improvements in certain electric tramcars.

19,943. C. K. Everitt. Sheffield. Improvements in "trolleys" for electric tramcars.

20,002. A. Heyland. London. Improvements in electric motors.*

October 6, 1899.

20,045. W. Hooley. Windermere. An improved sliding electric light.

20,068. C. Beez. London. An improved ohmmeter or apparatus for directly indicating resistances.*

20,084. J. Cervera Baviera. Manchester. Improvements in the method of and means for transmitting and receiving electric waves for the production of signals, and for imparting motion to machines or apparatus.*

20,100. M. Roiling and J. H. Collings. London. Improvements in suspension fittings for electric lighting systems adapted to high voltage.*

20,110. F. Loppe, H. P. Morin, D. P. Martin, and G. J. A. Griner. London. Improvements in electrical accumulators. (Date applied for under Patents, &c., Act, 1883, Sec. 103, April 1, 1899, being date of application in France.)

20,114. L. E. Wilson. London. Improvements in electrophone apparatus.

20,121. F. Kappenberger. London. Process and apparatus for the production of insulators for electric wires.*

20,124. R. Haddan. London. Improvements relating to means for electrically controlling gas-cocks and lighting gas burners. (La Societé Anonyme "Lux Nora," Belgium.)

October 7, 1899.

20,129. C. B. Crawshaw, H. A. Jones, and J. W. Longley. Halifax. Improvements in the method of lubricating the bearings of commutators of alternate current dynamos.

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20,130. C. B. CRAWSHAW, H. A. JONES. and J. W. LONGLEY. Halifax. Improvements in motor starting and regulating switches.
20,145. W. SEVENOAKES. Middlesex. The improved combination electric light fittings.
20,151. A. WEBB. Manchester. Improvements in and connected with electric accumulator and battery boxes.
20,153. T. E. and E. T. GAMBRELL. London. Improvements in electrical resistances.
20,154. G. L. ANDREWS. London Improvements in, or connected with the controllers of electric tram-cars or electrically driven vehicles, machinery, or the like.
20,162. W. P. THOMPSON. Liverpool. Antiseptic appliance for sound-transmitter mouthpieces. (The Antiseptic Appliance Co., United States.)*

October 9, 1899.

20,180. G. PINNINGTON. Hull. Improvements in the means of connecting electric tramcars with overhead wires.
20,189. G. H. NISBETT. Liverpool. Improvements connected with indicating or recording and controlling the speed of electric railway cars or vehicles and other machinery.

COMPANIES' MEETINGS AND REPORTS.

Eastern Extension, Australasia, and China Telegraph Company (Limited).

The report of the directors of this company for the half-year ended June 30th last states that the gross receipts have amounted during that period to £324,361. 6s. 2d., against £277,282. 17s. 9d. for the corresponding half-year of 1898. The working expenses, including £28,177. 2s. for maintenance of cables, absorb £107,266. 10s. 1d., against £102,873. 18s. 4d., leaving £217,094. 16s. 1d. From this is deducted £4,400. 10s. for income tax, £31,895 for interest on debentures, debenture stock, and contribution to sinking fund, and £5,000 for the creation of a reserve fund in connection with the proposed removal of the head offices, leaving £175,799. 6s. 1d. as the net profit for the half-year. Two quarterly interim dividends of 1½ per cent. each, amounting to £62,500, have been paid for the half-year, leaving £113,299. 6s. 1d., from which £100,000 has been transferred to general reserve and the balance of £13,299. 6s. 1d. carried forward.

Further cable renewals and extensions have been carried out during the half-year under review, and the cost, amounting to £68,901. 1s. 10d., has been charged against reserve.

With a view to providing an efficient alternative service between Australia and this country, the directors, in conjunction with the Eastern Telegraph Co., have submitted to the Governments of Australasia a proposal for extending the new Cape cable to Perth and Adelaide without any subsidy or guarantee, and at once reducing the tariff between Great Britain and Australia to 4s. per word, to be followed by further reductions on a sliding scale down to 2s. 6d. per word as the traffic responds to the reductions. The only condition attached to the proposal is that the company shall be accorded the same freedom of dealing directly with the public in Australia as prevails in this country and elsewhere. The proposal has been very favourably received by the Press, Chambers of Commerce, and mercantile communities generally in Australia, and it is confidently anticipated that it will eventually be accepted.

The first quinquennial examination of the staff pension and superannuation funds has recently been made, with the result that the funds are reported by the actuary to be in a satisfactory condition; they do not, however, admit of the retiring age being reduced from 60 to 55 years, which experience proves would be most desirable, the existing limit being too high for tropical service. The actuary advises that in order to bring about this change the contributions by the staff and the company to the pension fund would have to be increased from 2½ per cent. to 4 per cent. respectively. It is believed that the staff will readily agree to assume this additional liability, and the shareholders are to be invited to authorise the directors to increase the company's contribution from Jan. 1 next to 4 per cent., and provide a sum sufficient to enable the trustees to pay the pensions which have already been purchased, and those which may be purchased prior to Dec. 31, 1899, at the age of 55 instead of 60 years. The shareholders will also be recommended to approve of an alteration in the superannuation trust deed, by which the age limit will be reduced to 55 years, the company guaranteeing to make up the loss (if any) that there might be in the fund on account of such reduction.

CITY AND SOUTH LONDON RAILWAY CO.—At a special meeting of this company, on Tuesday, it was resolved to convert the existing 2,500 Ordinary shares into Consolidated stock. The chairman (Mr. C. G. Mott) stated that the extension to Moorgate-street was in a forward state, and that the directors hoped to be able to open it to the public early in December. The Clapham extension was also well forward, the underground works being nearly finished: there was a service station to be finished, but the directors hoped to be able to open the extension soon—probably about March. The Islington extension was likewise proceeding rapidly towards completion.

THAMES IRONWORKS, SHIPBUILDING AND ENGINEERING CO. (LTD.).—The first ordinary general meeting of this company was held on Monday. The chairman (Mr. Arnold F. Hills) gave a sketch of the progress of the company since its reconstruction in July last. The engineering works of Messrs. John Penn and Sons, Greenwich and Deptford, had been finally taken over, and the new boiler-shops, machinery, and plant were now practically in working order. A complete system of electric driving and lighting had been introduced. The Admiralty had expressed satisfaction with the company's new arrangements, and had sent them orders for machinery. He could congratulate the shareholders upon the steady development of the company's business during the past three months.

NEW COMPANIES, STATUTORY RETURNS, &c.

ELECTRICAL LUMINISCRIPTOR CO. (LTD.).—This company was registered on Oct. 5, with a capital of £75,000, in £1 shares, to acquire and work Mr. W. Claypole's patent, No. 2,044 (1898), for improvements in apparatus for optical projection for advertising and other purposes, and to carry on the business of engineers, &c. The first subscribers, with one share each, are F. W. Jamieson, H. W. Hickson, S. A. Hickson, R. B. Fidler, W. F. Bosse, J. W. Mitchell, and H. R. Brownrigg. The first directors are Sir H. Wardlaw, Bart., W. H. Neil, S. A. Hickson, P. W. Willard, and F. W. Jamieson.

FLADBURY ELECTRIC LIGHT AND POWER CO. (LTD.).—This company was registered on Oct. 25, with a capital of £2,000 in £1 shares, to carry on at Fladbury, or elsewhere in England, the business of producers and suppliers of electricity for the purpose of light, heat, motive power, &c. The first directors are S. H. Deakin (chairman), L. H. Elkington, G. T. Stephens, and William Wagstaff.

F. J. JONES AND CO. (CHESTER) LTD.—This company was registered on Oct. 28, with a capital of £3,000 in £1 shares, to acquire the business carried on by Frederick J. Jones, and to carry on the business of electrical engineers, electricians, suppliers of electricity for the purpose of light, heat, motive power, &c. The first directors are F. J. Jones, T. Gaze, and R. Knowles.

PHODYNE ELECTRICAL CO. (LTD.).—This company was registered on Oct. 18, with a capital of £10,000 in £10 shares, to carry on the business of electrical engineers, electricians, engineers, contractors, suppliers of electricity and other power, manufacturers of and dealers in electrical and other plant and machinery, &c. The subscribers are J. C. M. Stanton, H. A. Stevens, M. R. Hamilton, A. Barrengen, M. E. Sheerboom, G. J. Tindall, and J. Renwit.

W. B. STARK AND CO. (LTD.).—This company was registered on Oct. 19, with a capital of £3,500 in £1 shares, to acquire the business carried on by Messrs. R. W. C. Barber, W. B. Stark, and A. Yeo, at Plymouth, and to carry on the business of engineers, electricians, &c.

THOMAS HARRISON (LTD.).—This company was registered on October 25, with a capital of £2,000 in £1 shares, to acquire the business formerly carried on by the late Thomas Harrison, and now by R. E. Hattersley, and to carry on the business of special tool makers, electrical and general engineers, &c. Mr. R. E. Hattersley is managing director.

UNITED STATES AND CANADIAN RHEA, RUBBER, AND INSULITE SYNDICATE (LTD.).—This company was registered on October 26, with a capital of £30,000 in £1 shares, to acquire certain inventions from W. J. Cordner, to manufacture, sell, and deal in a composition from rhea fibre suitable for electric insulation and other purposes. The first directors are H. B. Burnell, W. J. Cordner, R. Cordner, and J. Keefe.

EXCHANGE TELEGRAPH CO. (LTD.).—The annual return to Aug. 23 has been filed. The nominal capital is £246,250, in 8,125 "A" and 16,500 "B" shares, all of £10 each, of which 8,125 "A" and 16,200 "B" have been taken up; £9 has been called up on each of 6,000 "A" shares and £1 on each of 2,125 "A" shares, resulting in the receipt of £56,023, leaving £102 in arrears; £8 is considered paid on each of 2,125 "A" and £1 on each of 6,200 "B" shares—total £279,000; £816 has been paid on 102 forfeited shares.

HALIFAX AND BERMUDAS CABLE CO. (LTD.).—The annual return to Oct. 12 has been filed. The capital is £50.000, in 10,000 £5 shares, all of which have been taken up and paid for in full.

MINER'S LAMP ELECTRIC LIGHTING CO. (LTD.).—This company's annual return to Sept. 25 gives the nominal capital as £3,000, in 600 £5 shares, of which 301 have been taken up. £5 has been called up on each of 111 shares, and £950 is considered paid on 190 shares.

CITY NOTES.

MEMORANDA.—Bank rate 5 per cent. (since Oct. 5, 1899). Price of silver 26⅛d. per oz. (Nov. 2). Consols (2¾ per cent.) 103⅝—103⅞ for money, 103¾—104⅛ for account; 2½ per cent. 101–101½ (Nov. 2). Stock Exchange Settling Days: Consols, Nov. 3; Stocks and Shares Continuation Days, Nov. 13 and 28; Ticket Days, Nov. 14 and 29; Pay Days, Nov. 15 and 30; Mining Share Carry-over Days, Nov. 11 and 27.

ALLIANCE ELECTRICAL CO. (LTD.).—Subscriptions have been invited for 7,000 Five per Cent. Cumulative Preference shares of £10 each in the Alliance Electrical Co. (Ltd.), which has been formed to take over the installation department of Veritys (Limited). The company has a share capital of no less than £120,000. The company's business is to consist of electric light wiring and installation and the retailing of electric light fittings on the terms of a certain agreement. It is explained in the prospectus that there are two businesses—that which is now taken over by the Alliance Co. and the other which will continue to be known as Veritys (Limited). The transfer of the installation section of Veritys business was not completed till July, 1899, but the working arrangements for the transfer were commenced from Feb. 1, from which date the business has been taken over by the new company, which will, it is stated, acquire a business

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which has 5,000 customers' names on its books. The net profits of that portion of the business taken over by the new company are certified at £9,200 for the year ended July 31, 1897; £8,481 to July 31, 1898; and £8,691 to July 31, 1899. These profits are arrived at after deducting directors' fees, depreciation of leases, and due provision for bad and doubtful debts. The prospectus states "that under the new working arrangement goods bought from Veritys Limited of their manufacture are charged by them to the company on a different basis at a slightly increased cost." By a profit-sharing scheme which has now been arranged "the directors and leading members of the staff receive a percentage of the surplus profits in any year after the full Preference dividends have been paid, 8 per cent. on the Ordinary shares, and due provision for reserve fund." Veritys (Limited) have the right of appointing the chairman of the Alliance Co. "so long as they own £20,000 of Ordinary shares." The purchase price of the business has been fixed at £106,150, Veritys (Limited) or their nominees receiving £56,150 in £10 Five per Cent. Cumulative Preference shares entitled to rank for dividend from Jan. 1, 1899, and the whole of the 50,000 Ordinary shares, and "since the sales agreement was executed Veritys (Limited) have agreed to take cash with interest at 5 per cent. per annum from Feb. 1, 1899, in lieu of the Preference shares if so required by the Alliance Co." The £106,150 at which the purchase price has been fixed is made up as to £13,680 of leasehold property; stock in trade, &c., £13,088; value of work in progress, £10,459; surplus book debts over liabilities (guaranteed), £18,012; cash at bank and in hand, £911; goodwill and benefit of work and contracts in hand, valued by Veritys (Limited), £50,000. It will be seen from the extracts from the prospectus which we have selected that investors will be well advised to carefully study that document. The lists closed yesterday for town and will close at noon to-day (Friday) for the country.

BAKER STREET AND WATERLOO RAILWAY CO.—The half-yearly general meeting will be held at 43, Lothbury, E.C., on 16th inst.

BRAZILIAN SUBMARINE TELEGRAPH CO. (LTD.).—Notice is given that an extraordinary general meeting of this company will be held at Winchester House, London, E.C., on Friday, 10th inst., at 12.30, to confirm the resolutions respecting the agreements with the Western and Brazilian Telegraph Co., and certain amendments to the articles of association passed at the extraordinary general meeting held on the 25th ult. and reported in our issue of the 27th ult. A resolution to change the name of the joint companies to "The Western Telegraph Co. (Ltd.)," is also to be confirmed.

CALLENDER'S CABLE AND CONSTRUCTION CO. (LTD.).—The directors have paid an interim dividend on the original Ordinary shares of 5s. per share, equal to 10 per cent. per annum.

ELECTRICAL UNDERTAKINGS (LTD.).—A private meeting of this concern was held at Winchester House on Friday last. Reporters were refused admittance.

MEXICAN ELECTRIC WORKS.—A statement has appeared in some of the financial journals that a dividend of 6 per cent. has been declared on the shares of this company. We understand, however, that nothing has yet been decided as to the dividend, and as the shares are all in private hands, no directors' report will be published for the year ended Sept. 30, 1899.

SOUTH AFRICAN LIGHTING ASSOCIATION (LTD.).—The directors have declared an interim dividend of 4 per cent. (8 per cent. per annum), free of tax, for the half-year ended June 30.

STOCK EXCHANGE NOTICE.—The Stock Exchange Committee has appointed Tuesday, 14th inst., as a special settling day in 16,639 £5 (£3. 10s. paid) Five per Cent. Cumulative Preference shares (Nos. 1 to 16,639) of the *United River Plate Telephone Co. (Ltd.)*, and has ordered the same to be quoted in the official list.

WESTERN AND BRAZILIAN TELEGRAPH CO. (LTD.).—Notice is hereby given of an extraordinary general meeting of this company, at Winchester House, London, E.C., on Friday, 10th inst., at 12 o'clock, to confirm the resolutions passed at the meeting of shareholders on the 24th ult., reported in our issue of the 27th ult.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	1899	£	£		£	£
*Birmingham Tramways.	Oct. 28	4,290	+ 232	17	70,701	+ 7,575
Blackpool Corporation...	,, 26	209	+ 11	30	19,397	+ 4,299
Blackpool and Fleetwood	,, 28	238	- 24	17	18,871	+ 5,928
Bradford Corporation ...	,, 29	379	+ 116	63	20,915	...
Brisbane Trams	Sept. 13	1,550	+ 685	50	64,929	+19,050
*Bristol Trams & Carriage	Oct. 27	2,906	+ 87	17	53,066	+ 4,360
*Buenos Ayres & Belgrano	,, 1	1,822	+ 471	39	83,549	+38,901
City & South London Ry.	,, 30	1,045	+ 45	18	17,278	+ 3
Dover Corporation	,, 28	179	- 11	30	6,797	...
Dublin United	,, 27	2,641	+ 276	...	...	...
Dublin Southern Dist...	,, 27	740	- 110	...	...	...
*Glasgow Corporation ...	,, 28	9,150	+ 660	...	...	...
*Liverpool Corporation...	,, 21	7,043	+1,083	42	288,718	+32,974
Liverpool Overhead Rly.	,, 29	1,630	+ 223	18	29,266	+ 473
*Sheffield Tramways	,, 29	1,850	+ 745	43	60,253	+16,924
*South Staffs. Trams....	,, 27	625	- 40	43	28,658	+ 1,434

* Partly electrical.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Oct. 25.		Price Tuesday, Oct. 31.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Six Days Ending Oct. 31.	
			TELEGRAPHS.					£ s. d.		Highest	Lowest
£110,900	100	4%	*African Direct Telegraph 4% Mort. Deb. (red.)	100	104	100	104	3 16 11	January and July	...	...
25,000	10	...	Amazon Telegraph	3	4	3	4	...	June and December	...	...
£125,000	100	5%	Do. 5 per Cent. Debentures	85	90	85	90	5 11 1	...	...	...
£875,520	Stock	15/0	Anglo-American	64	67	65	68	4 8 3	Feb., May, Aug., Nov.	67	65½
£3,062,240	Stock	30/0	Do. Preferred	114½	115½	116½	117½	5 2 2	,, ,,	117¼	115¼
£3,062,240	Stock	18/0	Do. Deferred	16	16½	16½	17	5 5 10	...	16 15/16	16 7/8
205,983	10	3/0	Brazilian Submarine xd and bonus	15	15½	15	15½	4 10 4	Mar., June, Oct., Dec.	15⅝	15
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1900)	107	110	107	111	4 11 6	June and December	...	...
10,000,000	$100	$11	Commercial Cable Capital Stock	190	190	180	190	4 4 3	Jan., Apr., July, Oct.	...	...
£1,365,141	Stock	4%	* Do. 4 per Cent. Debenture Stock	102	104	103	105	3 16 6	,, ,,	105½	103¾
16,000	10	8/0	Cuba Submarine Ordinary xd and bonus	9	10	9	10	8 0 0	February and August	9⅛	...
6,000	10	10/0	Do. Preference 10 per Cent. xd	19	20	19	20	5 0 0	,, ,,	...	...
12,931	5	2/0	Direct Spanish Ordinary	4	5	4	5	4 0 0	April and October	...	...
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference	9	10	9	10	5 0 0	,, ,,	...	...
£30,000	50	4½%	Do. 4½ per Cent. Debentures	103⅞	107⅞	103⅞	107⅞	4 4 1	January and July	...	...
60,710	20	3/0	Direct United States Cable	11¼	12¼	11¼	12¼	5 14 3	Jan., Apr., July, Oct.	...	...
£120,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red.)	101	104	101	104	4 7 10	June and December	...	...
£4,000,000	Stock	5%	Eastern Ordinary	152	157	156	161	4 6 11	Jan., Apr., July, Oct.	159½	153½
£1,795,000	Stock	3½%	Do. 3½ per Cent. Preference Stock	99	102	99	102	3 8 8	,, ,,	101	99½
£1,432,268	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.) xd	118	123	117	122	3 5 7	May and November	119	118
250,000	10	2/6	Eastern Extension	14	14½	15	15½	4 10 4	Jan., Apr., July, Oct.	15⅝	14¼
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	117	122	119	123	3 5 7	February and August	120	...
£16,200	100	5%	* Do. 5% (Austln. Gov. Sub.) Deb., 1900 (reg.)	99	103	99	103	4 17 4	January and July	...	...
£64,400	100	5%	Do. (Bearer)	100	103	100	103	4 17 1	,, ,,	...	...
£17,400	100	5%	*Eastern and S. African 5% Mort. Deb., 1900 (reg.)	99	103	99	103	4 17 1	,, ,,	...	...
£24,500	100	5%	Do. (Bearer)	100	103	100	103	4 17 1	,, ,,	...	...
£300,000	100	4%	* Do. 4 per Cent. Mortgage Debentures, 1909	101	104	101	104	3 16 11	February and August	...	...
£200,000	25	4%	Do. 4 per Cent. Mauritius Sub. Debs. (red.)	102⅝	105⅝	102⅞	105⅞	3 15 2	May and November	...	...
180,227	10	1/9	Globe Telegraph and Trust xd	11	11½	11	11¼	4 11 4	Jan., Apr., July, Oct.	11⅞	...
180,042	10	3/0	Do. 6 per Cent. Preference xd	15¼	15¾	15½	16	3 15 0	,, ,,	15⅞	15½
150,000	10	5/0	Great Northern of Copenhagen	29	31	30	32	3 18 2	January and July	29¼	...
£89,500	100	4½%	Halifax & Bermuda Cable 4½ 1st Mort. Deb. (red.)	100	103	100	103	4 7 5	...	...	...
17,000	25	12/6	Indo-European xd	49	53	49	52	4 16 2	May and November	...	...
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904	106	109	106	109	5 10 1	March and September	...	...
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.)	103	106	103	106	3 15 6	June and December	...	...
11,839	8	4/0	Reuter's	7	8	7	8	5 0 0	April and October	...	...
3,391	£100 Cert.	6%	Submarine Cables Trust	128	133	129	133	4 10 3	,, ,,	...	...
15,609	10	...	West African Telegraph	2½	3½	2½	3½	4 9 3	December and July	...	...
£200,000	100	5%	* Do. 5 per Cent. Debentures (red.)	99	102	99	102	4 18 0	March and September	...	...
30,008	2½	...	West Coast of America	¼	1	½	1	..	...	...	...
£150,000	100	4%	* Do. 4 per Cent. Debentures	102	105	102	105	3 16 8	January and July	...	...
88,321	10	2/6	West India and Panama	1⅜	1⅝	1¼	1½	...	May and November	1 5/16	...
31,563	10	6/0	Do. 6 per Cent. 1st Preference	10½	10¾	10½	10¾	5 11 6	,, ,,	10⅜	...
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	8½	9½	8½	9½	6 6 3	,, ,,	...	...
£80,000	100	5%	* Do. 5 per Cent. Debentures	104	107	104	107	4 14 1	January and July	...	...
£399,731	Stock	4%	Western & Brazilian 4 per Cent. Debenture Stock	104	107	104	107	3 15 0	June and December	...	...
£158,100	100	6%	*Western Union 6 per Cent. Sterling Bonds (red.)	98	103	98	103	5 16 6	March and September	...	...

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Oct. 25.	Price Tuesday, Oct. 31.‡	Rate per Cent. Yielded.	Dividend Due.	Business Done During Six Days Ending Oct. 31. Highest	Lowest
			TELEPHONES.			£ s. d.			
44,000	£5	3/0	Chili Telephone (fully paid)	2 3	2 3	6 13 4	August	...	...
224,850	10s.	0/1½	Consolidated Telephone Const. & Manufacturing	¼ ¼	¼ ¼	4 15 3	July	...	...
71,000	1	0/6	Monte Video Telephone Ordinary ...xd	⅜ ⅜	⅜ ⅜	5 0 0	October	...	...
84,000	1	1 0	Do. 5 per Cent. Preference ...xd	¾ 1	¾ 1	5 0 0	...	...	...
490,000	5	3/0	National	5 5½	5⅛ 5⅜	5 11 7	February and August	5⅛	...
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Preference	13 14	13½ 14½	4 2 9	,, ,,	14⅜	...
15,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference	13 14	13½ 14½	4 2 9	,, ,,	...	...
250,000	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref.	5⅛ 5⅜	5½ 5⅝	4 10 11	,, ,,	5⅜	...
1,329,471	Stock	3½%	* Do. Debenture Stock 3½ per Cent. (red.)	99 102	100 102	3 8 8	June and December	100½	...
171,504	1	0/8	Oriental ...xd	¾ 1	¾ 1	5 0 0	April and October	...	...
58,000	5	6/0	United River Plate	4½ 5½	4½ 5½	5 14 3	July	...	...
£179,947	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	105 108	105 108	4 13 9	June and December	...	...
			ELECTRICITY SUPPLY COMPANIES.						
160,000	1	...	Bl'ckb'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (15s. pd.)	¾ 1	¾ 1	...	...	...	...
6,000	10	7/9⅗	Bournemouth and Poole Electricity Supply Ord.	13 13½	13 13½	2 18 5	...	...	...
6,000	10	4/6	Do. 4½ per Cent. Cumulative Preference	10 11	10 11	4 1 10	...	...	...
19,661	5	2/6	Brompton & Kensington Electricity Supply Ord.	7½ 8½	7½ 8	3 15 0	...	...	...
12,000	5	3/6	Do. 7 per Cent. Preference	9 10	9 10	3 10 0	March and September	...	...
20,000	5	...	Calcutta Elec. Supply Ordinary (£4 paid)	5½ 6½	5⅝ 6½	...	...	...	...
30,000	5	4/0	Charing Cross & Strand Electricity Supply Corp.	9⅜ 10⅛	9⅜ 10⅛	4 5 9	February & August	9⅜	9⅛
20,001	5	...	Do. (Nos. 3,001 to 50,000)	9⅛ 10⅛	9⅜ 10⅜	...	...	...	...
20,000	5	2/3	Do. 4½ per Cent. Preference	6 6½	6 6½	3 9 3	,, ,,	6⅝	...
34,000	5	2/6	Chelsea Electricity Supply Ordinary	7½ 8½	8 9	3 6 8	March	8¼	8⅛
£100,000	Stock	4½%	* Do. 4½ per Cent. Debenture Stock (red.)	110 112	110 112	4 1 1	June and December	111½	110⅛
$1,200,000	$1,000	5%	Chicago Edison 1st Mort. 5% 30 year Gold Bonds (red.)	100 110	100 110	4 10 11	April and October	...	...
60,000	10	7/0	City of London Electric Lighting Ordinary	11 12	11 12	5 0 0	February and August	11⅞	11½
40,000	10	6%	Do. 6 per Cent. Cumulative Preference	12½ 13½	12⅝ 13⅜	4 8 11	January and July	13⅛	...
£400,000	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	125 130	125 130	3 17 5	June and December	...	...
40,000	10	...	County of London and Brush Prov. Ordinary	10½ 11	10 11	...	...	10⅛	10⅜
20,000	10	6/0	Do. 6 per Cent. Cumulative Preference	13 14	13 14	4 5 9	March and September	13	...
£200,000	Stock	7/8	Do. 4½% Deb. Stock Certs. (all pd.) (red.)	81 84	111 114	...	...	...	...
15,000	5	10%	Kensington and Knightsbridge Ordinary	12½ 13½	12⅝ 13⅝	4 1 5	...	...	...
10,000	5	6%	Do. 6 per Cent. 1st Preference	7½ 7¾	7½ 7¾	3 17 5	January and July	...	...
110,000	3	..	London Electric Supply Ordinary	3⅜ 4	3⅜ 4	...	...	...	...
48,050	5	3/0	Do. 6 per Cent. Preference	6½ 6¾	6½ 6¾	4 8 11	...	...	...
£100,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures	104 106	104 106	3 16 4	Mar., June, Sept., Dec.	...	...
62,500	10	5/0	Metropolitan Elec. Supply Ord. (Nos. 1 to 62,500)	15 16	15 16	3 2 6	April and October	15 1/16	...
22,500	10	3/7½	Do. (Nos. 62,501 to 85,000)	14 15	14 15	3 5 10	...	...	...
£220,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage	117 119	117 119	3 15 7	June and December	...	...
6,452	10	6/0	Notting Hill Electric Ordinary	15 16	15½ 16½	3 15 0	March	...	...
10,000	5	5/0	Oxford Electric Ordinary	6½ 7½	6½ 7½	3 9 0	,,	...	...
300,000	1	8/	Rand Electric	⅜ ½	⅜ ½	10 13 4	...	...	...
£130,070	Stock	5%	River Plate El. Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb.	85 90	85 90	5 11 1	...	...	...
150,000	$100	$2	Royal Electric Company of Montreal Shares	160 180	160 180	4 8 11	...	...	...
£123,200	100	4½%	* Do. 4½ per Cent. 1st Mortgage Debentures	103 105	103 105	4 5 9	April and October	...	...
31,980	5	5/0	St. James's and Pall Mall Electric Ordinary	14½ 15½	15 16	4 10 8	February and August	15⅜	15
20,000	5	3/6	Do. 7 per Cent. Preference	9 9½	9 9½	3 13 8	,, ,,	...	...
65,000	5	...	South London Electric Supply Ordinary (£4 paid)	3⅜ 4	3⅜ 4	...	...	3 1/16	3⅜
79,900	5	5/0	Westminster Electric Supply Ordinary	14½ 15½	14⅜ 15⅜	3 17 5	March and September	14⅛	...
			ELECTRIC MANUFACTURING, &c., COMPANIES.						
125,000	1	...	Aron Electricity Meter 6 per Cent. Cum. Pref.	1 1/16 1 1/16	1 1/16 1 1/16	...	...	...	...
40,000	5	5/0	British Insulated Wire Ordinary	11 12	11 12	4 3 4	...	...	...
27,500	5	3/0	Do. Preference	6½ 6¾	6½ 6¾	4 8 11	...	...	...
90,000	2	2/0	Brush Electrical Engineering	1⅜ 2⅛	1⅜ 2⅛	4 14 1	September	1 15/16	...
90,000	2	1/2½	Do. 6 per Cent. Pref. Non-Cumulative	2⅛ 2⅜	2⅛ 2⅜	4 16 0	,,	2 1/16	2⅛
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Deb. Stock	109 113	109 113	3 19 10	February and August	...	...
£50,000	Stock	4½%	* Do. 2nd Debenture Stock (red.)	104 107	104 107	4 4 11	June and December	105	104½
20,000	5	5/0	Callender's Cable Construction Ordinary ...xd	13½ 14½	13 14	5 7 2	,, ,,	13⅛	13
20,000	5	...	Do. 5 per Cent. Cumulative Preference	5½ 6	5⅛ 6	...	...	5⅛	5⅛
£90,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb. (red.)	112 115	113 116	3 19 7	November and May	...	...
300,000	1	0/9½	Castner-Kellner Alkali Co. (fully paid) ...xd	1⅛ 1⅜	1⅛ 1⅜	5 16 5	...	1 1/16	...
60,000	1	0/7½	Chadburn's Ship Telegraph Ordinary	1 1½	1 1½	...	...	...	...
60,000	1	0/7½	Do. 6 per Cent. Cumulative Preference	1 1½	1 1½	4 16 0	...	...	...
32,098	3	2/1⅗	Crompton and Co. (Nos. 1 to 32,098)	3½ 4	3½ 4	4 10 9	January and July	3⅛	3 1/16
£100,000	100	5%	* Do. 5 per Cent. First Mortgage Deb. (red.)	100 103	100 103	4 17 10	,, ,,	...	...
60,000	1	0/3	Davis and Timmins 6 per Cent. Cum. Pref.	¾ 1	¾ 1	...	...	...	...
99,261	5	1/9⅗	Edison and Swan United ("A" Shares) (£3 paid)	2 2⅛	2 2⅛	7 4 0	February and August	2⅛	...
17,139	5	2/9⅗	Do. (£5 paid)	4 5	4 5	6 0 0	,, ,,	...	...
£350,000	Stock	4%	Do. 4 per Cent. Mortgage Deb. Stock (red.)	95 97	95 97	4 2 6	June and December	...	...
26,100	5	5/11⅕	Edmundson's Electric Corporation Ord. (fully pd.)	5 5⅛	5 5⅛	5 9 1	Half-yearly	...	...
112,100	2	1/2⅗	Electric Construction Co. (Limited)	2⅛ 2⅜	2 2⅛	5 2 3	January and July	...	...
25,000	2	2/9⅗	Do. 7 per Cent. Cumulative Preference	3 3⅛	3 3⅛	4 0 0	July	...	...
182,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	104 105	103 106	3 16 0	January and July	...	...
91,195	1	...	Elmore's Patent Copper Depositing	¼ ⅜	¼ ⅜	...	...	...	...
15,900	10	8/0	Henley's Telegraph Works Ordinary	... ...	... ...	...	February and August	...	...
3,000	10	9/4	Do. 7 per Cent. Preference	... ...	... ...	...	,, ,,	...	...
£50,000	Stock	4½%	Do. 4½ per Cent. Mortgage Deb. Stock (red.)	111 114	111 114	3 19 6	,, ,,	...	...
50,000	10	5/0	India Rubber, Gutta Percha, &c., Works	21 22	21 22	4 8 11	,, ,,	21⅛	21⅛
£300,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	100 104	100 104	3 16 11	March and September	...	...
37,350	12	12/0	Telegraph Construction and Maintenance	37 41	37 41	4 8 3	March and July	37⅛	...
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909	103 106	103 106	3 15 6	...	...	...
20,000	5	4/5⅗	Do. Manufacturing Ordinary	9½ 9⅞	9½ 9⅞	4 2 1	...	...	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5½ 6	5½ 6	4 3 4	...	...	...
30,000	5	5/0	Willans and Robinson Ordinary	10½ 11	10½ 11	4 1 10	April and October	10⅞	...
30,000	5	3/0	Do. 6 per Cent. Cumulative Preference	7 7½	7 7½	4 0 0	,, ,,	...	...
£100,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Debentures	106 108	106 108	3 18 8	May and November	...	...
			ELECTRIC RAILWAYS, TRAMWAYS, &c.						
12,000	10	6/0	Blackpool and Fleetwood Tramways	19 21	19 21	3 16 2	...	...	...
£167,800	100	5%	Brisbane Tramway 5 per Cent. Debentures	104 106	104 106	4 14 4	...	...	...
50,000	10	7%	Bristol Tramways and Carriage Ordinary	23 24	23 24	2 17 2	February and August	...	...
25,000	10	...	Do. Cumulative Preference (£4 paid)	4⅜ 4⅝	4⅜ 4⅝	...	...	...	...
£100,000	Stock	4%	Do. 4 per Cent. Debentures	118 119	118 119	3 7 3	...	...	...
30,000	10	9/0	British Electric Traction Ordinary	16½ 17½	16⅜ 17⅛	6 0 0	...	17⅛	...
30,000	10	6/0	Do. 6% Cum. Pref. (Nos. 30,001 to 60,000)	13⅛ 14	13⅜ 14	4 5 9	...	14	13⅞
£200,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures	125 128	126 129	3 17 10	...	...	...
40,000	5	1/9	Buenos Ayres & Belgrano 6% "A" Cum. Pref.	5⅛ 5⅜	5⅛ 5⅜	5 9 1	...	5 1/16	...
27,500	5	...	Do. "B"	5⅛ 5⅜	5⅛ 5⅜	...	...	...	...
265,585	Stock	5%	Do. 5 per Cent. Debentures	108 111	108 111	4 10 1	...	109⅜	...
35,250	10	3/0	Central London Ordinary	10 10½	10⅛ 10⅜	2 15 10	June and December	10⅛	10⅛
178,303	10	2/4 1/10	Do.	... ...	... ...	...	,, ,,	...	...
£630,000	Stock	2½%	City and South London Railway Com. Ordinary	63 66	63 66	3 4 6	January and July	63⅛	63
22,500	10	...	Do. Ordinary (Nos. 1 to 22,500) (fully paid)	6½ 6¾	6½ 6¾	...	...	...	...
37,500	10	...	Do. (Nos. 22,501 to 60,000) (£4. 10s. paid)	3⅜ 4⅛	3⅜ 4⅛	...	...	...	...
15,000	10	5%	Do. 5 per Cent. Perpetual Preference (1891)	14 15	14 15	3 6 8	January and July	...	...
20,000	10	5%	Do. (1896)	13½ 14½	13½ 14½	...	...	...	...
£187,701	Stock	4%	Do. 4 per Cent. Perpetual Debenture ...xd	132 134	132 134	2 19 9	May and November	133⅛	...
20,000	10	7½%	†Imperial Tramways Ordinary	... ...	23 24	...	March and September	...	...
10,000	10	6%	† Do. 6 per Cent. Preference	15½ 15¾	15½ 15¾	3 13 10	,, ,,	...	...
£200,000	Stock	4½%	† Do. 4½ per Cent. Debenture	114 115	114 115	3 18 6	January and July	...	...
37,500	10	2½%	Liverpool Overhead Railway Ordinary	8 3/16 8 5/16	9⅛ 9⅜	3 6 8	February and August	...	...
10,000	10	5%	Do. 5 per Cent. Preference	13½ 13¾	13½ 13¾	3 12 9	,, ,,	...	...
125,000	Stock	4%	Do. 4 per Cent. Debenture	104 105	104 106	3 16 5	January and July	...	...
24,000	5	...	New General Traction Ordinary	3¾ 4⅛	3¾ 4⅛	...	...	...	...
30,000	5	6/0	Do. 6 per Cent. Cumulative Preference	5 5½	5 5⅛	5 9 1	May	...	...
13,334	10	...	Potteries Electric Traction Ordinary	13 14	13 14	...	...	...	...
20,000	10	5/10	Do. 5 per Cent. Cumulative Preference	10½ 11	10½ 11	4 10 11	...	...	...
£540,000	Stock	3%	Waterloo and City Ordinary	101 104	101 104	2 18 0	June and December	101	...

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

† The London Stock Exchange Committee refuses to quote these.

‡ Stock Exchange closed on Wednesday.

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THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED. First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,121. [Vol. No. 3. XLIV.] FRIDAY, NOVEMBER 10, 1899. PRICE SIXPENCE (by post, 6½d.), Abroad, 8d., or 16 cents. or 80/r., or 70xf.

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NOTES.

THE censorship of messages from South Africa during the present military operations has been freely discussed and criticised during the past week. If it be true that a telegram was seen at Rotterdam recounting the British reverse at Ladysmith many hours before the news reached our War Office, it may be safely asserted that it did not come through "in plain," but was possibly the translation of a foreign Government cipher message. Under the International Telegraph Convention it is provided that "Each Government reserves to itself the power to suspend the service of international telegraphs for an indefinite period if it deem necessary," but that, if the service be not suspended, "Government and service telegrams may be sent on all occasions in secret language." This, of course, applies only to non-belligerent Governments and their recognised agents. No commercial messages in code and no telegrams of any kind to or from the Transvaal Government or its known agents are allowed to pass during these hostilities. Obviously, therefore, it is possible that communications in cipher from South Africa to a foreign Government might pass the censors—but it would be a distinct breach of neutrality for information which might be of use to the enemy to be sent in such a way. If such a breach were detected, a repetition of the act could no doubt be prevented by an entire suspension of the service.

THERE is no instance on record of a cable being cut in the interest or at the desire of the British Government, and it may be taken as certain that this country, at all events, had no hand in the recent severance of the Delagoa Bay cable. At the time of the Jameson Raid, the stoppage of telegraphic communication with South Africa by one cable, an hour or so before the repair of a cable on the other coast of Africa, was regarded by some of the newspapers as having been purposely done; but there was never any ground for this suspicion, although no doubt the land lines were purposely interrupted on that occasion. Cable companies exist for the purpose of carrying messages, and it is absurd to expect them to lend themselves to the interruption of their lines except under the orders of, and with the promise of compensation from, their own Government. It may be added that under existing arrangements commercial messages "in plain" are allowed to pass both to and from the Transvaal.

ANOTHER accident has occurred on the Sheffield tramways, owing to insufficient use of the brakes with which the cars are fitted. This time a car caught up another and collided with it on a down gradient, although fortunately nobody was seriously injured. It is impardonable that such an accident should happen to a car fitted with an electro-magnetic brake, an ordinary wheel brake, a slipper brake, and a reversing switch. If the Sheffield Corporation are unable to drill their motor men in the use of the already too numerous brakes with which their cars are fitted, let them simplify the arrangements. Frequent accidents such as those at Sheffield will bring electric traction into disrepute.

MR. TROTTER'S report, published in another column, on the recent accidents at Dublin, will be read with interest by those interested in electric traction. The moral of the report is threefold. Brackets should be used in place of span wires whenever possible; secondly, a stop should be employed to prevent the trolley head from rising beyond a certain limit when it leaves the wire, otherwise guard wires should be abolished. It is not clear, however, whether Mr. TROTTER favours this latter. Thirdly, Mr. TOWLE'S easily detachable trolley head (see *The Electrician*, Vol. XLIII., p. 695), with the addition of a chain to prevent it from falling, is a good thing.

THE world's output of gutta-percha is still extremely small, and although at present there is no fear of the extermination of the gutta-percha tree, an abnormal consumption of the gum

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—whether caused by the laying of a Pacific cable or the introduction of golf into the South African Republics—would result in at least a temporary scarcity and a corresponding increase in its price. A suitable substitute would therefore be welcomed. A rubber substitute is not so urgently needed, however, for the supply of india-rubber has not so great a difficulty in keeping pace with the demand. Hitherto so-called rubber substitutes have not been eminently successful. None has been found equal to replacing pure india-rubber for a fraction of the purposes to which it is applied; and it must be remembered that the prices of the various vulcanised and unvulcanised "compound" india-rubbers are considerably lower than that of the pure gum. Thus, in the majority of manufactured articles india-rubber has held its own against substitutes. It is true that for the dielectric of cables india-rubber has been largely superseded by other materials; but no rubber substitute, in the true sense of the word, has been found, for two independent materials must be used in combination to replace its insulating, waterproof and mechanical properties.

THOSE who have looked to "Velvril" as a possible substitute for gutta-percha will not, we fear, be gratified—at all events, in the near future. In a Paper on this material, read by Mr. W. F. REID before the Society of Chemical Industry last Monday, the suitability of "Velvril" material for belting, portmanteaus, waterproofing cloth and canvas, varnish, "patent leather" boots, fishing lines, paints, hose, corks, &c., was ably demonstrated, but no data were given as to its electrical properties. This combination of nitrated linseed or castor oil (nitro-linolein or nitro-ricinolein) with nitro-cellulose has not, to judge from the samples exhibited, the same mechanical properties as gutta-percha. It appears to lack the strength and elasticity required for a golf ball, as well as the flexibility necessary to the core of a submarine cable. The specimens shown by Mr. REID were plastic at ordinary temperatures rather than resilient. Moreover, its objectionable smell will probably preclude its employment to any great extent for surgical instruments. Mr. REID is engaged in the perfection of machinery which will subject the material to great pressures, and, he hopes, render it suitable for insulating wire and cable. Until these sanguine hopes are realised, however, gutta-percha will continue to hold its own in the three chief uses to which it is put; and it is at present doubtful whether an improvement in "Velvril" manufacture or a modification in the rules of golf will be the first to reduce the cost of our most expensive cable insulator.

THE National Telephone Co. has always suffered under the disadvantage of having no power to break up streets for laying its lines; but under the Telegraph Act, 1892, framed mainly for the purpose of empowering the POSTMASTER-GENERAL to raise funds for taking over and extending the telephone trunk system throughout the country, it has in an indirect manner, attained this object in certain cases. The POSTMASTER-GENERAL is therein authorised to delegate to his licensees the same powers of laying wires which he himself has under the Telegraph Acts, but subject to consent in London of the County Council, and elsewhere of the local authority or County Council, according to circumstances. Encouraged by its success in Manchester, Liverpool, Leeds, and other large towns, the company has been endeavouring to improve its London system by burying its wires; but although successful in obtaining the consent of the local authorities in a few districts, it has met with rebuffs in the greater part of the metropolitan area. Not only this, but, to judge by the circular lately addressed to the London Vestries, and printed in another column, it would appear that the company has, even where its wires are underground in the metropolis, neglected to obtain the necessary sanction of the POSTMASTER-GENERAL. The circular warns the London Vestries, therefore, that these negotiations are premature, since the granting of the POSTMASTER'S authority to the company is an essential preliminary to anything being done in the matter. Although the Government has been so anxious to ensure fair competition in the provinces, it seems that competition between its own department and the National Telephone Co. in London is not to be on equal terms.

THE insurance offices are making another attack on electrical interests. Not content with issuing a new set of wiring rules at the very moment when the Institution of Electrical Engineers was taking the opinion of its members before making a fresh endeavour to secure uniformity, the Royal Insurance Co. of Liverpool has now sent out a circular to their policy holders instructing them how their lines should be connected. If there is an electric tramway in the town equipped on the overhead trolley system there is, of course, a certain small risk of crosses between the two services of wires; but surely it is to the interest of the telephone company itself to see that sufficient precautions are taken within the house, while the Board of Trade issue regulations with a view to ensuring protection outside. The circular in question recommends the following precautions:—If an earth connection is employed it should be outside the building and not made to a gas pipe. Wires insulated as for electric lighting should be used, the circuit inside the house being metallic with both wires equally well insulated, and not fixed with metal staples. Fuses with long break, lightning arrestors, metal-cased telephone instruments, &c., are also recommended, and outside lines, it is said, should be kept at least 2ft. clear of gutters. We do not wish to deprecate reasonable precautions being taken against accidents, but the list of precautions is in this case unreasonable. The addition to telephone sets already fixed of an efficient lightning protector and fuse, possibly combined, as is done in American and Continental practice—and we believe already to some extent in this country—when there is danger from lightning or trolley wires, would assuredly afford sufficient safeguard in any case. The users of telephone as well as the telephone companies will do well to oppose strenuously any attempt at interference with methods of wiring which have hitherto proved satisfactory.

Cable Interruptions.

Latakia—Cyprus	June 21, 1899
Cayenne—Pinhieros	Oct. 11, 1899
Zanzibar—Mombassa	Oct. 27, 1899
Lorenzo Marques—Mozambique	Oct. 31, 1899

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Electric Traction on the Erie Canal.—The note bearing this title, published in our last issue, was taken from the *Electrical Review* of New York.

International Congress of Physics, 1900.—M. Guillaume has been appointed foreign secretary of the International Congress of Physics, to be held in Paris in 1900.

Long-Distance Telephony.—An American contemporary announces that telephonic connection has been completed between Detroit and Houston (Texas), a distance of 1,700 miles. The line is said to work clearly and satisfactorily.

Lectures to Science Teachers.—The West Riding Technical Instruction Committee has made arrangements with Prof. Oliver Lodge to give a short course of lectures to science teachers shortly after Christmas, at a convenient centre in Yorkshire. The subject will probably be electrical vibrations.

Royal Institution.—At a general monthly meeting, held on Monday last, the special thanks of the members were returned to to "a lady member" for her donation of £100, and to Mr. George Matthey for his donation of a similar sum, to the fund for the promotion of experimental research at low temperatures.

A Correction.—Our correspondent, "A Municipal Engineer," in his letter on the Shoreditch combined lighting station and refuse destructor, by a clerical error wrote 2·98 pence instead of 2·98 shillings as his estimated cost per ton of destroying the refuse at Shoreditch. The error will have been fairly apparent by the context.

Surface Contact Tramways.—At the meeting of the Wolverhampton Corporation on Wednesday the Tramways committee recommended that an electric tramway line, on the surface-contact system, be laid on the Wednesfield-road, from Sun-street to Railway-street, at an estimated cost of £3,300. This report was considered by the council yesterday, and has been referred back to the Committee.

Victoria University, Manchester.—The following appointments to vacant examinerships were made, among others, at a council meeting on October 26th:—External examiner in mathematics, Major P. A. MacMahon, R.A., F.R.S.; external examiner in engineering, Prof. J. Perry, D.Sc., F.R.S.; external examiner in physics, W. L. Shaw, M.A., F.R.S.; external examiner in chemistry, J. Norman Collie, F.R.S.

Wireless Telegraphy in Cuba.—The *Electrical World* of New York understands that the Government is negotiating with Mr. Marconi for the adoption of his system of wireless telegraphy between Key West and Havana. It is also proposed, says our contemporary, to establish communication in like manner between the eastern end of Cuba and the western end of Hayti. Lieut. G. Squiers, of the Signal Corps, has charge of the matter under the United States Government, and is now in consultation with Mr. Marconi.

Society of Arts.—The Society of Arts commences its 146th session on the 15th inst. with an address from the chairman of the council, Sir John Wolfe Barry. In it it is probable that he will develop the subject of his address last year, "London Communications," and will make some suggestions as to the practical means of carrying his proposals into effect. There are no Papers on electrical subjects before Christmas, but after Christmas Mr. Charles H. Gadsby is down for a Paper on "Electric Traction," and Prof. C. A. Carus-Wilson for a Paper on "The Electrical Induction Motor on Mountain Railways." In May Major Cardew will deliver a series of three Cantor lectures on "The Control, Regulation, and Measurement of the Supply of Electrical Energy."

Obituary.—It is with deep regret that we announce the death of Mr. William Ernest Mather, the elder son of Mr. William Mather, of the firm of Mather and Platt. Mr. W. E. Mather, although only 22 years of age, was also a director of the firm of which his father is the chairman, and was a favourite with all at the Salford Ironworks. Soon after his arrival there the workmen presented him with an illuminated address of welcome and good wishes. Before entering the firm, he was educated at Harrow and Trinity College, Cambridge, where he took his B.A. degree last June. He also spent some months at Bonn. The cause of his death was a fall from horseback. We offer our profound sympathy to Mr. William Mather and his firm for the loss they have sustained.

Royal Society.—At the anniversary meeting of the Royal Society, on November 30, the following Fellows will be recommended by the President and council of the Royal Society for election into the council for the year 1900. The names of new members are printed in italics:—President: Lord Lister. Treasurer: Alfred Bray Kempe. Secretaries: Sir Michael Foster, K.C.B., Prof. Arthur William Rücker. Foreign secretary: *Dr. Thomas Edward Thorpe.* Other members of the council: *Horace T. Brown*, Captain Ettrick William Creak, R.N., Prof. James Dewar, *Prof. Edwin Bailey Elliott, Dr. Hans Friedrich Gadow*, Prof. William Dobinson Halliburton, Prof. William Abbott Herdman, *Sir John Murray, K.C.B.*, Sir Andrew Noble, K.C.B., *Prof. Arnold William Reinold*, Dr. George Johnstone Stoney, *George James Symons, J. J. H. Teall*, Prof. Joseph John Thomson, *Prof. Edward Burnett Tylor, Sir Samuel Wilks, Bart.*

The Late Major Wrottesley.—Captain C. W. Davy, R.E., points out some inaccuracies in the obituary note published in our last issue. The deceased officer was not a son of Lord Wrottesley, but a cousin. His regimental rank was that of Major, the grade of Lieutenant-Colonel being a local rank only, which he never lived to assume. He occupied the post of superintending engineer of the Southern District Postal Telegraphs, and was also in command of the military unit known as the Telegraph Battalion. On mobilisation, however, he merely proceeded to Aldershot in common with the remainder of the officers and men selected for the telegraph division going out with the Army Corps. He was drowned on the 26th and not the 27th ult. Captain Davy, who until recently served under Major Wrottlesley's command, was his personal friend, and succeeded him in the post of superintending engineer, testifies to the extreme regret felt among all his comrades at his early death.

An Excess Current Cut-out for Consumers.—A device has been installed on the premises of consumers taking current from the mains of the Mount Whitney (California) transmission plant, its object being to prevent the consumer using more than a specified maximum current. A properly-gauged fuse or magnetic cut-out might effect this, but either would have the disadvantage of requiring replacement, and would leave the house in darkness. The device in question, which is said only to consume about half a watt per lamp, causes a flickering in the lights as soon as the maximum current is exceeded. A series solenoid overcomes the pull of an adjustable counterweight, and breaks the circuit through the medium of a relay. The counterweight then pulls back into place, and the circuit is again closed for an instant, and this process is repeated 120 times in the minute. As soon as the current is sufficiently reduced this action stops. The *Electrical World* of New York, commenting on this appliance, points out that its chief disadvantage is that the contacts must eventually be burnt away by repeated working, especially if the number of lights connected is large. A plan is suggested similar to that adopted in the Long-Schattner prepayment meter, of warning the consumer by inserting a resistance to dim the lamps.

Institution of Civil Engineers.—Among the 26 medals and premiums awarded by the Institution of Civil Engineers during the last session, and presented on Tuesday, only one is for a Paper on an electrical subject, and that a Millar Prize for a student's Paper on "The Electrical Driving of Engineering Workshops," by Mr. William Middleton. Among the premiums awarded for Papers on subjects allied to electrical engineering we may mention a George Stephenson Medal and a Telford Premium to Robert Abbott Hadfield (member) for his Paper on "Alloys of Iron and Nickel," and a Telford Premium to William George Kirkaldy (associate member) for his Paper on the "Effects of Wear upon Steel Rails," both of these being read at ordinary meetings. The following are among the premiums awarded for Papers printed in the *Proceedings*, and not read at ordinary meetings: A George Stephenson Medal and a Telford Premium to George Watson (associate member) for his Paper on "Refuse Furnaces," and Telford Premiums to Floris Osmond for his Paper on "Experiments on Alloys of Iron and Nickel," Thomas Ernest Stanton, D.Sc. (associate member), for his Paper on "The Efficiency and Design of Surface-Condensers," and

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William George Hibbins for his Paper, "Experiments upon the Action of Engine-Governors."

Skin Effect in Aluminium Wires.—Owing to the fact that the apparent increase in resistance of alternating currents, due to the skin effect, increases with the diameter, fears have been entertained by some engineers that this effect would seriously reduce the efficiency of long-distance aluminium transmission lines. The *American Electrician* points out the fallacy of this. The skin effect, expressed as a ratio of the apparent resistance under alternating currents to that of the same conductor with continuous currents, depends both upon the specific resistance of the material and upon the diameter of the wire or cable. An increase in diameter tends to cause a greater density of current at the surface of the wire. If, however, the specific resistance of the conductor is greater, this greater resistance tends to prevent the unequal distribution of the current. The two elements vary in such a way that if the diameter of the material having a greater specific resistance be made sufficiently large to give the same resistance in a given length to the flow of a direct current, then the tendency to skin effect, due to increased diameter, is just counterbalanced by the increased specific resistance. The skin effect, therefore, in a copper wire is just the same as it is in an aluminium wire, if the diameter of the aluminium wire is increased so that it has the same ohmic resistance as the copper wire.

The Cripple Creek Gold Mining District.—In commemoration of its having started a new electric power station at Goldfield, Cripple Creek, La Bella Mill Water and Power Co. have issued an attractive "souvenir" giving a description of the works, prefaced by a history of the company. Electric power is supplied in the towns of the district for industrial purposes, and to the mines for hoisting, pumping, and ore crushing. Facilities are also provided for operating electrically a local service of tramways, as well as tramways in the mines and tunnels. Ordinary slack coal is burnt in the furnaces of Babcock-Willcox boilers, fitted with chain-grate automatic stokers. These consist of an endless chain moved forward by a worm gear driven by an adjustable ratchet. Coal is delivered on the upper surface, and as the grate moves inward the coal is burnt. As the chain grate turns over the ashes are dumped into an ash hopper, from which they are taken to a car on the railway siding by means of a motor-driven travelling chain conveyer. In this way the ashes are not handled in the boiler-room, and the motion of the coal is continuous and automatic from the time it leaves the car. The steam pressure is 150lb. per square inch. Three McIntosh and Seymour cross-compound engines running condensing are directly coupled to 750-kw., 6,600-volt three-phase General Electric dynamos, with revolving fields, which are excited by one steam-driven and one motor-driven exciter. There is also an air compressor, for the compressed air power service in the mines.

Seventy-fifth Anniversary of the Franklin Institute.—The Franklin Institute of Philadelphia commemorated its seventy-fifth anniversary by a series of public meetings of its sections at the National Export Exposition, which is now being held in Philadelphia under the joint auspices of the Philadelphia Commercial Museums and the Franklin Institute. Prof. E. J. Houston read a Paper on "The Seventy-fifth Anniversary of the Franklin Institute from an Electrical Standpoint." He spoke of the work accomplished by the Institute in the general advancement of science, and pointed out that nearly all the discoveries and inventions in electricity have been made during the last century and a half. The last century, he said, included by far the most important of these discoveries and inventions, the last half century the most valuable and useful, and the last decade and a half the period of their most extended commercial applications. The Franklin Institute had assisted in this development by the encouragement of mutual work and the enthusiasm begotten of comradeship; for the association of men of similar interests not only resulted in the better carrying out of their work as a whole, but also ensured more earnest and intelligent work on the part of the individual workers. The speaker dwelt especially on the fact that the highest type of scientific knowledge finds its expression in the production of actual working machines or processes. In order to trace the influence exerted by the Franklin Institute on electrical science and its allied useful industries, as they exist to-day, Dr. Houston made a somewhat extended *résumé* of electric progress from the earliest time down to to-day. He pointed out that electrical progress was by no means uniformly distributed throughout the past. Periods of comparative inactivity were followed by periods of marked activity, era-making discoveries and inventions, removing obstacles to further progress, and exciting attention to electric science and gave greater incentive to further progress. Some of these era-working inventions were the discovery of the Leyden jar, by Von Kleist, in 1745; Franklin's discovery as to the identity of lightning and electricity, and his invention of the lightning rod, about 1752; Volta's invention of the voltaic pile in 1799; Davy's immortal discovery of the compound nature of the alkaline earths in 1807; Oersted's discovery of the relation between electricity and magnetism in 1820; Faraday's immortal discovery of magneto-electric induction, or the production of electricity from magnetism, in 1831, and his early form of dynamo-electric machine, and the production, almost immediately afterwards, of the early dynamos and electric motors; the production of the electro-magnet, by Sturgeon in 1825 and by Henry in 1838; of the invention by Daniell of his constant voltaic cell in 1836, and the marvellous growth in electro-telegraphic systems by Morse in America, Steinheil in Munich, and Wheatstone and Cooke in England, culminating, as they did, in the laying of the first telegraphic cable by Field in 1858. Dr. Houston concluded by pointing out that the last quarter of the nineteenth century, which was a period of marvellous activity in electric science, showed unusual activity during the 15 years that followed the holding of the Franklin Institute International Exhibition of 1884. Mr. Ralph W. Pope, secretary of the American Institute of Electrical Engineers, followed Dr. Houston with a Paper on "The Influence of Technical Societies in Promoting the Progress of Electrical Arts." Mr. Pope, among other things, pointed out the fact that a most valuable characteristic of a society like the Franklin Institute was the continuity of its work. The individual members were mortal, but the organisation lived and its work persisted. Mr. Pope referred to another exceedingly important duty, voluntarily undertaken by such societies, which he said was of immense economic value. This was the introduction of standard practice in the industries. Among the examples that he cited was the "Standard Rail Section," by the American Society of Civil Engineers; "Standard Boiler Tests," by the American Society of Mechanical Engineers; and within the present year the "The Standardisation of Electric Generators, Motors, and Transformers," by the American Institute of Electrical Engineers. There were other addresses of similar character in the various sections, and the celebrations lasted for four days.

MEETINGS OF SCIENTIFIC AND ENGINEERING SOCIETIES, &c.

(To-day) FRIDAY, November 10th.

PHYSICAL SOCIETY.

5 p.m. Meeting in the Physical Laboratory of the Central Technical College, Exhibition-road, South Kensington. Papers to be read: (1) "Contact Electricity," by F. S. Spiers; (2) "On the Heat of Formation of Alloys," by J. B. Tayler.

TUESDAY, November 14th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Papers to be read: (1) "The Waterloo and City Railway," by H. H. Dalrymple-Hay; (2) "The Electrical Equipment of the Waterloo and City Railway," by B. M. Jenkin.

WEDNESDAY, November 15th.

SOCIETY OF ARTS.

8 p.m. First Ordinary Meeting of the 146th Session. Opening Address by Sir John Wolfe Barry, F.R.S.

THURSDAY, November 16th.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. First Ordinary General Meeting of the Session. Prof. S. P. Thompson, F.R.S., will deliver his Inaugural Address, and the premiums for the Session 1898-9 will be presented.

SATURDAY, November 18th.

INSTITUTION OF JUNIOR ENGINEERS.

3:30 p.m. Visit to the City and South London Railway Depôt at Stockwell.

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CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

Analysis of Spark Discharges.—The mutograph, or mutoscope camera, has been utilised by J. H. West for obtaining some capital records of sparks yielded by a Wehnelt interrupter. As ordinarily used, the mutograph film is arrested in its motion during the short interval required to take the picture. The author, however, let the film move at a uniform rate, and so obtained a large number of successive spark pictures. Some of them have a thicker track than others, but the author believes that the thicker ones are composed of a large number of separate sparks nearly superimposed. In some cases such multiple sparks could be seen to consist of several distinct tracks. That these were successive and not simultaneous was proved by the fact that the distance between the nearest points of the tracks would vary with the direction of the track, being smallest where the track most nearly coincided with the direction of motion of the film. The irregularity of the action of the Wehnelt interrupter is proved by the variations in the intervals between successive sparks, but it is already made evident to the ear by the absence of a musical note of constant pitch. The author estimates the thickness of a spark as varying between 0·2mm. and 2mm. He also proves that sparks lasting only one-millionth of a second are capable of producing a visual sensation.

[J. H. West, *Elektrotechn. Zschr.*, October 26, 1899.]

Physiological Effects of the Current.—J. L. Prevost and F. Battelli have found that the fatal effects of the electric discharge are proportional, not to the quantity of electricity discharged, but to its energy. The fatal effects of a certain combination of instruments are, below a certain limit, proportional to the sparking distance. Above that limit (about 15mm.) the effect increases with the capacity of the condenser, but is not affected by the sparking distance. Generally speaking, the energy required for killing a given animal increases in proportion to its weight. Respiration is arrested by an energy of about 400 joules in a guinea-pig weighing 1lb., whereas it requires only 250 joules to produce the same effect in a guinea-pig weighing 10oz. Age also has a certain influence, young animals being more sensitive to electric shock, weight for weight, than adult animals. The authors distinguish five stages of effects produced by the shock, characterised respectively by muscular contraction, clonic convulsions, tonic convulsion with momentary stoppage of respiration, general inhibition of respiration and the nervous system, but without convulsion, and lastly, complete stoppage of the heart's action.

[Prevost and Battelli, *Comptes Rendus*, October 23, 1899.]

Disintegration of Incandescent Wires.—That incandescent wires are gradually disintegrated has been proved, among other methods, by Lodge's experiment which shows that air freed from dust recovers its cloud-forming capacity after glowing a wire in it. In hydrogen such a wire does not disintegrate. Nahrwold supposed that oxygen is required for the disintegration of platinum or palladium. W. Stewart has confirmed this by a number of experiments made at various pressures, and has incidentally found that the disintegration decreases as the glowing is continued. Thus, in one set of experiments the same platinum wire was used six times consecutively, each experiment lasting two hours and the temperature of the wire being the same in each. The loss of weight gradually decreased from 0·68 per cent. to 0·11 per cent. of the weight. For palladium the same rule was found to hold good. The amount of disintegration was the same whether the air was moist or dry. On exhausting the space in which the wires glowed, the disintegration of platinum decreased, while that of palladium increased. We have therefore not to deal with an ordinary process of combustion, though Kaufmann has shown that disintegration is more rapid in pure oxygen. The actual process going on cannot as yet be said to be very clear.

[W. Stewart, *Phil. Mag.*, November, 1899.]

Dispersion of Cathode Rays.—When a narrow beam of cathode rays is deflected by a magnetic field, some of the rays are more deflected than others. Birkeland, using an induction coil for producing the rays, observed that the deflected rays produced several successive phosphorescent patches, which he described as a magnetic spectrum. Since the deflection of the particles composing the rays depends upon the velocity with which they are projected, and also upon the ratio e/m of the electric charge to the mass, it is interesting to determine which of these factors it is that varies from one part of the spectrum to the other. Some light is shed on this subject by an important observation made by R. J. Strutt, that in the same vacuum tube a magnetic spectrum may be produced with an induction coil, whereas all the rays are deflected to the same extent on substituting a high-potential battery for the induction coil. The single patch remains a single patch, and is, if anything, more sharply defined than before. This indicates that it is probably the velocity of the particles which changes, and not the ratio e/m. The velocity depends upon the difference of potential, and that is constantly changing when a coil is used. The author supposes that there are certain maxima and minima of velocity produced in rapid succession, and that the simultaneous observation yields the "magnetic spectrum."

[R. J. Strutt, *Phil. Mag.*, November, 1899.]

Range of Observable Phenomena.—A highly suggestive contribution to the general survey of physical science has been made by G. Johnstone Stoney. He classifies the various measurable distances under four groups, as stellar distances, planetary intervals, laboratory measures, and molecular quantities respectively. Each of these stands to the next in the ratio of 10^{10} to 1. The uttermost region of the visible universe accessible to our telescopes is probably 10^{21}m. away. Light takes some 100,000 years to reach us from there, and, when the white spot flared up in the nebula of Andromeda some time ago, we were probably witnessing an occurrence which happened during the neolithic period. Light, by its wonderful speed, brings these enormous distances within our grasp. It also brings us into touch with extremely minute intervals by the smallness of its wave-lengths. The smallest distances with which we can even theoretically deal are larger than 10^{-12}m., and comprise the intervals concerned in events within atoms. A further subdivision is, to us, meaningless. The known universe, then, is comprised between the limits of ultra-stellar remoteness and infra-molecular proximity. Large as the range is, it might be infinitely larger in both directions. Mapped out as it is by the author, it resembles nothing so much as an absorption band in a spectrum, representing that portion of the material universe which happens to be accessible to human faculties.

[G. J. Stoney, *Phil. Mag.*, November, 1899.]

Effect of Heat on Sparking Distances.—A striking experiment in this connection is described by F. J. Jervis-Smith. The pointed conductors of the secondary wire of a 10in. induction coil, by Apps, were separated till a spark would not pass and only a faint brush was visible : on bringing the flame of a spirit lamp near one of the points, a torrent of sparks instantly bridged over the space between the points. When the flame was removed the sparks ceased, and they were restored each time the flame was brought back. But this was not the case when the flame was brought into a similar position with respect to the other point. The application of the flame did not cause the sparking to bridge across the space between the points, but on reversing the direction of the primary current the sparks crossed as before. The nature of the discharge was then tested by applying an X-ray tube, and the point affected by the flame was found to be the cathode pole. The effect was only obtained with an electrolytic break in the primary circuit, and with points instead of balls as spark terminals. This is probably the first case observed in which heat has a well-marked differential effect upon the two poles. The author supposes that heated particles are projected from the cathode and form a bridge across the gap, whereas no such particles are projected from the anode pole.

[F. J. Jervis-Smith, *Phil. Mag.*, November, 1899.]

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THE THEORY OF THE POWER FACTOR.

BY ALEXANDER RUSSELL, M.A.

(*Concluded from page 50.*)

Numerical Examples.—In order to simplify the calculation, we will consider that the current wave is a sine curve, and find the power factor between it and the P.D. waves given below. To make the diagram more instructive we have drawn all the curves so that each would give the same effective voltage. The absolute value of the volts has, however, nothing to do with the power factor, which depends only on the class of the curve and its position relatively to the current curve.

Let the equation to the current be

$$(1)\ i = I \sin \frac{2\pi}{T} t \text{ and } (2)\ i = I \sin \left(\frac{2\pi}{T} t - \alpha\right).$$

where I = the maximum value of the current
= its effective value multiplied by $\sqrt{2}$.
$= A\sqrt{2}$.

and T = the period of a complete cycle.

Let the equations to the E.M.F. be

(*a*) *Rectangle*

$e = V$ from t equal to 0 to $\frac{T}{2}$.

$= -V$ from t equal to $\frac{T}{2}$ to T, &c.

(*b*) *Parabola*

$$e = \frac{4\sqrt{30}}{T^2} V \left(\frac{T}{2} t - t^2\right) \text{ from } t \text{ equal to 0 to } \frac{T}{2}, \text{ &c.}$$

(*c*) *Sine Curve.*

$$e = \sqrt{2} V \sin \frac{2\pi}{T} t.$$

(*d*) *Triangle.*

$$e = 4\sqrt{3} V \frac{t}{T} \text{ from } t \text{ equal to 0 to } \frac{T}{4}, \text{ &c.}$$

$$= 4\sqrt{3} V \frac{\frac{T}{2} - t}{T} \text{ from } t \text{ equal to } \frac{T}{4} \text{ to } \frac{3T}{4}, \text{ &c.}$$

(*e*) *Inverted Parabolas.*

$$e = 16\sqrt{5} V \left(\frac{t}{T}\right)^2 \text{ from } t \text{ equal to 0 to } \frac{T}{4},$$

$$= 16\sqrt{5} V \left(\frac{\frac{T}{2} - t}{T}\right)^2 \text{ from } t \text{ equal to } \frac{T}{4} \text{ to } \frac{T}{2}, \text{ &c.}$$

(*f*) *Inverted Cubics.*

$$e = 64\sqrt{7} V \left(\frac{t}{T}\right)^3 \text{ from } t \text{ equal to 0 to } \frac{T}{4},$$

$$= 64\sqrt{7} V \left(\frac{\frac{T}{2} - t}{T}\right)^3 \text{ from } t \text{ equal to } \frac{T}{4} \text{ to } \frac{T}{2}, \text{ &c.}$$

All the curves (*a*), (*b*), &c., have the same effective voltage.

Curve.	Maximum value of e.	Height of C.G,	Cos ϕ with I sin x.	ϕ in degrees.	Cos ϕ with I sin $(x - \alpha)$.
(*a*)	V	0·5 V	0·9003	25·8	0·9003 cos α
(*b*)	1·370 V	0·5476 V	0·9995	2·2	0·9995 cos α
(*c*)	1·414 V	0·5552 V	1·0000	0	cos α
(*d*)	1·732 V	0·5773 V	0·9928	6·75	0·9928 cos α
(*e*)	2·236 V	0·6708 V	0·9322	21·2	0·9322 cos α
(*f*)	2·646 V	0·7560 V	0·8628	30·4	0·8628 cos α

We might also have calculated the phase difference between any of the curves shown in the figure. For example, the phase difference ϕ between the rectangle (*a*) and the very peaky curve (*f*) is 48·6 deg., and the power factor (cos ϕ) is 0·6613.

These results illustrate, amongst other things, that with similar curves the power factor is unity, and that the more unlike the curves are to one another the smaller will be the power factor. They also illustrate the importance of distinguishing between the angle of phase difference and the angle of time lag or lead. By the time lag of two periodic functions of the same frequency we mean the interval that elapses between the instants when they pass through their zero values in the positive direction.

In the above curves (Fig. 3), if ϕ_0 be the phase difference when the time lag is zero and α the angle of lag of the current, then

$$\cos \phi = \cos \phi_0 \cos \alpha. \quad \ldots\ldots \quad \text{(iv.)}$$

If OAB and OBC be two planes at right angles to one another, and if the angle AOB equals ϕ_0 and the angle BOC equals α, then the angle AOC will be ϕ.

To prove this, draw BC perpendicular to OC and join AC.

Then $OA^2 = OB^2 + AB^2$,
$= OC^2 + CB^2 + AB^2$,
$= OC^2 + AC^2$.

Therefore the angle OCA is a right angle.

Now, $OC = OA \cos AOC$,

and $OC = OB \cos \alpha$,
$= OA \cos \phi_0 \cos \alpha$,

$\therefore \cos AOC = \cos \phi_0 \cos \alpha$,

$\therefore$ by (iv.) the angle AOC is the phase difference.

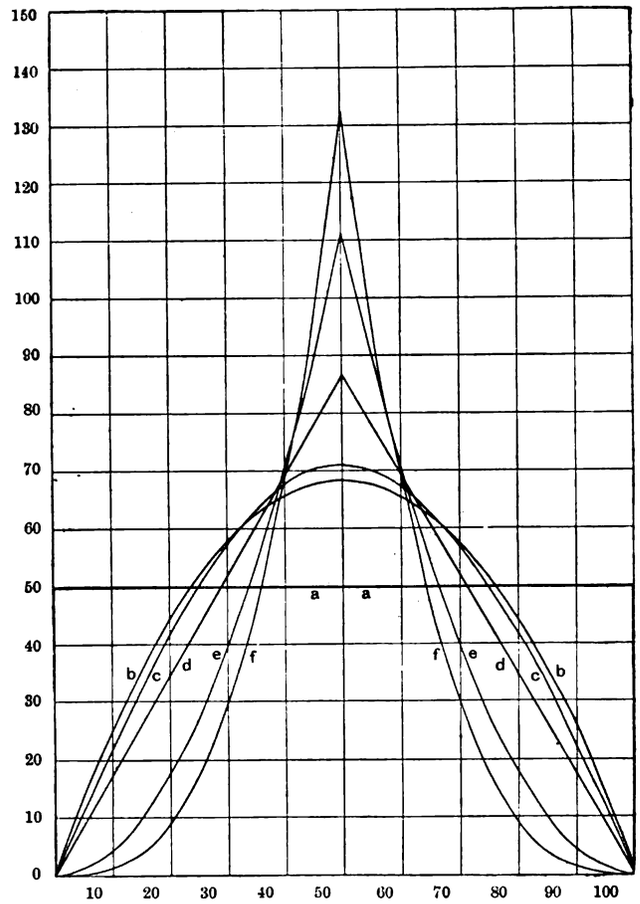

FIG. 3.

Voltage Curves, each of which has an effective value of 50.
(*a*) Rectangle. (*b*) Parabola. (*c*) Sine Curve. (*d*) Triangle. (*e*) Inverted Parabolas. (*f*) Cubic Curves.

This construction shows us how the phase difference increases as the angle of lag increases. It is generally true for finding the phase difference between a symmetrical curve and a sine curve. By a symmetrical curve we mean one in which the ordinates equidistant from the zero points are numerically equal.

To prove this let

$$e = f(t)$$

be the equation to the P.D. Since the curve is symmetrical,

$$f(t) = f\left(\frac{T}{2} - t\right). \quad \ldots\ldots \quad (a)$$

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we have

$$\int_0^{\frac{T}{2}} f(t) \sin\left(\frac{2\pi t}{T} - a\right) dt = \int_0^{\frac{T}{2}} f(t) \sin\frac{2\pi t}{T} dt \cos a,$$

$$- \int_0^{\frac{T}{2}} f(t) \cos\frac{2\pi t}{T} dt \sin a \quad . \quad (b)$$

Putting $t = \frac{T}{2} - x$, we see that

$$\int_0^{\frac{T}{2}} f(t) \cos\frac{2\pi t}{T} dt = \int_{\frac{T}{2}}^{0} f\left(\frac{T}{2} - x\right) \cos\frac{2\pi x}{T} dx.$$

$$= - \int_0^{\frac{T}{2}} f(x) \cos\frac{2\pi x}{T} dx. \qquad \text{from } (a)$$

$$= - \int_0^{\frac{T}{2}} f(t) \cos\frac{2\pi t}{T} dt.$$

Therefore the value of this integral is zero, and hence from (b)

$$\cos\phi = \cos\phi_0 \cos a.$$

In practice it is the exception to have both curves symmetrical. Suppose that the current is a sine curve, and

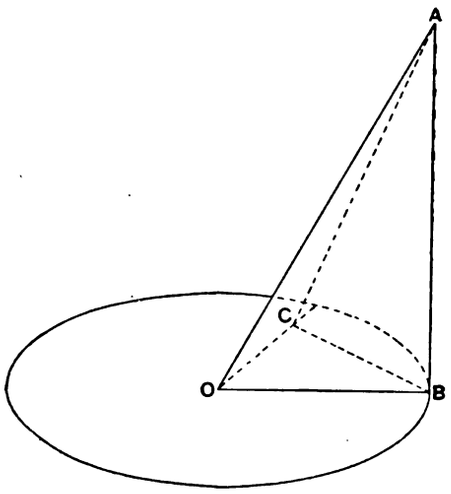

FIG. 4.

that there is no time lag between it and the P.D. curve. Then a little consideration will show that the power factor is a maximum when the peak of the wave occurs at the quarter period.* Suppose now that the current is lagging, and that the P.D. wave has its maximum value before the quarter

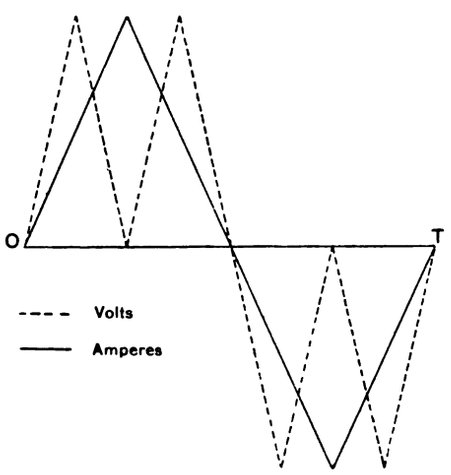

FIG. 5.

period; then it is easy to see, by drawing curves, that the power factor will be less than if the P.D. wave were symmetrical. The maximum value of the power factor in this case occurs when the peak of the P.D. wave is in the second quarter.

* All the P.D. waves considered are supposed to have the same maximum value, as well as the same effective value. They have also the same area.

Again, during the half-wave the ordinate may pass through several maxima and minima values. Suppose, for example, the P.D. and current were given by the curves in Fig. 5. In this case the power factor would be 0·75, and the phase difference 41·4deg. It is fairly obvious that if the P.D. have a minimum value when the current has its maximum value, then the power factor will be low and the phase difference large, even if there be no time lag between the current and the P.D.

In conclusion, we will recapitulate the main points proved in this Paper:—

1. If the power factor of a circuit be unity, then the P.D. and current waves are similar curves—*i.e.*, the value of the volts divided by the value of the amperes at any instant is constant.

2. If the P.D. wave be flat and the current wave peaky, or *vice versa*, then the power factor may be small, even if there be no time lag between them.

3. It is convenient for graphical purposes to define the phase difference between two periodic functions $f(t)$ and $F(t)$ as an angle (ϕ) given by the equation

$$\cos\phi = \frac{\int_0^T f(t) F(t) dt}{\left[\int_0^T \{f(t)\}^2 dt \int_0^T \{F(t)\}^2 dt\right]^{\frac{1}{2}}}.$$

4. If either the current or P.D. wave is a sine curve, and the other is a symmetrical curve, then the power factor equals $\cos\phi_0 \cos a$ where $\cos\phi_0$ is the power factor between them when there is no time lag and a is the angle of time lag.

THE GENERATION AND ELECTRICAL DISTRIBUTION OF MOTIVE POWER.*

BY JOHN S. RAWORTH, M.INST.C.E., M.INST.E.E.

(Concluded from page 44.)

APPENDIX A.—*Power required to Drive Shafting and Various Types of Machines.*

Table I.—*Prof. Benjamin's Figures for the Losses in Shafting, based upon an Investigation of the Conditions existing in 12 different Shops in U.S.A.*†

Total line shaft (ft.)	Diameters of line shafts (inches).	No. of belts.	Av. width of belts.	No. of machines.	No. of men.	Total H.P.	H.P. to drive machines.	H.P. to drive shafting.	Useful H.P. per machine.
130	$\left\{\begin{matrix}2\frac{1}{2}\\4\end{matrix}\right.$ $\left.\begin{matrix}2\frac{3}{4}\\6\end{matrix}\right\}$	89	4	...	...	400	243	157	...
580	3 $3\frac{1}{2}$	28	6	18	78	74	17	57	...
530	$2\frac{1}{2}$ 3	53	$5\frac{1}{2}$	43	152	38·6	13·3	25·3	0·310
1,460	$2\frac{1}{2}$ 3 4	92	$4\frac{1}{2}$	69	80	59·2	11·3	47·9	0·164
1,120	3	141	4	68	300	112	48	64	0·707
1,065	2 3 4	192	4	123	225	168	77	91	0·627
748	$\left\{\begin{matrix}1\frac{1}{2}\\2\end{matrix}\right.$ $\left.\begin{matrix}1\frac{3}{4}\\3\end{matrix}\right\}$	217	3	250	200	40·4	19·7	20·7	0·790
500	2 3	335	3	313	226	74·3	34·3	40	0·109
990	$1\frac{3}{4}$ $2\frac{1}{2}$	217	3	258	100	47·2	22·7	24·5	0·881
2,490	2 6	521	3	454	400	190	82	108	0·180
1,472	2 3 4	484	3	179	350	107	32·5	74·5	0·181
1,800	$\left\{\begin{matrix}2\\2\frac{1}{2}\end{matrix}\right.$ $\left.\begin{matrix}2\frac{1}{4}\\3\end{matrix}\right\}$	486	3	428	320	241	127	114	0·296

Table II.—*Power Absorbed in Driving Main Shaft, Counter Shafting, Belting, and Lathes (both light and when working). Main Shaft 98ft. 4in. long, 2in. diameter, having 12 bearings each $4\frac{3}{8}$in. long, and ordinarily driving 19 belts.*

[From Mr. W. E. Langdon's Paper before the Institution of Mechanical Engineers, September, 1898.‡]

Table III.—*Tests of $9\frac{1}{2}$in. Screw-cutting Lathe Driven through Shafting and Belting, and Driven Direct by Small Lundell Electric Motor of $\frac{1}{2}$ H.P.*

[From Mr. W. E. Langdon's Paper before the Institution of Mechanical Engineers, September, 1898.§]

* Paper read before the Manchester Association of Engineers, Oct. 28.
† From *Machinery* of New York.—ED. *E.*
‡ See *The Electrician*, Vol. XLI., p. 756.—ED. *E.*
§ See *The Electrician*, Vol. XLI., p. 757.—ED. *E.*

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Table IV.—*Details of Power Required by, and Cost of Working, an Electric Warehouse Crane.*

[From Mr. A. H. Gibbings' articles in *The Electrician*, 1898.*]

Table V.—*Details of Power required to drive a 24in. Saw Frame.*

Tests made at Messrs. Bennett's Works, Manchester, by Messrs. Lacey, Clirehugh and Sillar.

Date. 1898.	No. of trial.	No. of log.	No. of saws.	Size and character of each log.	B.T.U. for each log.	Time cutting each log. Minutes.	H.P. for each log.
Oct. 4	1	1	12	20″ × 16″ deep. Birch	14·8	63	19·0
„ 4	1	2	12	17′ 6″ × 16″ „ „	13·7	50	22·21
„ 5	1	1	12	27′ 6″ × 16″ „ „	11·1	51	17·6
„ 5	1	2	12	21′ 3″ × 16″ „ „	13·3	49	21·8
„ 5	1	3	11	15′ 0″ × 14″ „ „	8·8	35	20·4
„ 5	2	1	13	10′ 3″ × 18″ „ „	4·77	22	17·4
„ 5	2	2	13	9′ 3″ × 17″ „ „	4·3	19	18·3
„ 5	3	1	21	20′ 0″ × 17½″ „ Pitch pine	13·6	42	26·2
„ 6	1	1	14	31′ 3″ × 17″ „ Am. ash	15·1	63	19·3
„ 6	1	2	14	24′ 3″ × 15″ „ „	10·5	41	20·7
„ 6	1	3	15	17′ 0″ × 16″ „ „	8·1	32	20·6
„ 6	1	4	15	17′ 3″ × 16″ „ „	7·7	29	21·1
„ 7	1	1	28	16′ 0″ × 22″ „ Yellow pine	xx	...	27·4
„ 7	1	2	28	16′ 6″ × 23″ „ „	17·6	49	29·1
„ 7	1	3	28	16′ 0″ × 23″ „ „	16·4	48	27·4
„ 7	1	4	28	13′ 8″ × 22″ „ „	20·6	58	28·6

Power required to start machine = 23 H.P. Machine running light = 9·75 H.P.

Table VI.—*Details of Power required by Ship-yard and other Machine Tools when running under Light and Heavy Loads.*

From Mr. D. Selby Bigge's Paper before the Cleveland Institute of Engineers, November, 1897.

	E.H.P.
Double Punch—Running light	2·0
Punching both ends, 1in. hole, ⅞in. plate, 28 punches per minute at each end	5·0
Punch and Shear—Running light	2·0
Punching hole as above and shearing ⅞in. plate, 5½in. cut, 28 strokes per minute	6·5
Large Plate Bending Rolls—Running light	5·5
Rolling plate $\frac{9}{16}$in. thick by 4ft. 4in. wide by 16ft. 6in. long, endways on (4ft. 4in.)	6·9
Sideways on (16ft. 6in.)	12·2
Plate ½½in. by 4ft. 8½in. by 21ft. long, sideways on	19·3
Same Rolls Lifting and Lowering Top Roll—Lifting	8·5
Lowering	7·0
Forcing ½½in. plate down	10·0
Forge Fan—For 24 fires	10·5
Angle Squeezer—Running light	0·8
Squeezing	2·5
Wood-working Machinery—Small plane	0·8
Tenoning machine	0·8
Band saw	1·5
Cross-cut saw	2·5
Small circular saw, cutting 6in. pitch pine, hand fed	6·4
Circular saw 18in., sawing 18in. teak (6ft. 6in.) per minute	24·0
Sawing 4½ teak, 25ft. per minute	17·7
Countersinking Machine—Actual power taken in countersinking	3·5
Riveting Machine—Running light	1·6
Riveting	3·0
Wall Planer—Taking ⅜in. cut cast-iron	5·0
Radial Drill—Drilling 1½in. hole cast-iron	1·59
Plate Planing Machine—Running light	0·6
Reversing light	1·8
Cutting 1in. × 14ft. plate	3·1
Stern Frame Boring—Cutting	1·75
Shafting Lathe, 18in. centre—Running light	0·5
One tool cutting ½½in. square cut	1·8
Two „ „	2·5
Lathe, 9in. centre—$\frac{3}{16}$in. cut	0·6
Angle Cutting Machine—Running light	1·6
Cutting angle 6in. × 3½in. × ½in.	3·5
Winch—Lifting 28 cwt. single purchase, 50ft. per minute	6·5
Ending Machine—Running light	1·9
Cutting girder, 18in. by 7in.	4 to 4·8
Cold Saw—Running light 24in. saw	2·0
Cutting 4in. by 4in. angle	4 to 4·5
Air Compressor—10in. by 14in. cylinder, 50lb. pressure	15 to 25·5
Portable Drill—When drilling 1in. hole	1·5
Hydraulic Pump—Three rams 3⅜in. diameter; 4½in. stroke, 60 strokes per minutes. Pressure 870lbs. Power taken	38·0
Joiner's Shop Motor—Normal load	14·8 to 22
Machines being driven from this motor—One 20in. plane, one circular saw 24in., one 30in. planing and sandpaper machine.	
Electric Winch—Running light	1·2
Lifting 24 cwt. 16ft. per minute	5·6

* See *The Electrician*, Vol. XLI. p. 749.—Ed. *E.*

Table VII.—*Losses Observed at the Works of the Bristol Waggon Co.*

[From Mr. W. Geipel's Paper before Section G, British Association, Bristol Meeting, 1898.*]

Table VIII.—*Power required by various Tools at the Bristol Waggon Company's Works.*

[From Mr. W. Geipel's Paper before Section G, British Association, Bristol Meeting, 1898.*]

The following two extracts from Mr. Wm. Geipel's Paper upon "Electric Power and its Application on the Three-Phase System to the Bristol Waggon and Carriage Works," read at the British Association, Bristol meeting, 1898, summarise much of the information given in the above-mentioned tables:—

(1) "*Loss in Shafting and Gearing.*—The loss under this head varies greatly, according to the conditions of each case. Prof. Kennedy stated, in his address to the Institution of Mechanical Engineers in 1894, that for 100 H.P. of useful work it required 145 I.H.P. at the engine; that is to say, there was a loss of 45 H.P., of which say 13 H.P. would be lost in the engine, leaving 32 H.P. or 22 per cent. as the loss in the shafting. Mr. Crompton gives the loss in shafting as 32 per cent. Sir T. Richardson found the loss to vary from 25 per cent. to 70 per cent.; the average was 43 per cent. At Messrs. Furness, Westgarth and Co.'s engine works, Middlesbrough, the loss in one shop, in which two long lines of shafting and a comparatively small number of tools were used, was 75·6 per cent. In two other shops it was 59 and 42 per cent.; or about a general average of 50 per cent. for the whole works. In several different factories in Cleveland, Ohio, Mr. C. H. Benjamin found the loss to vary from 50 to 80 per cent. At the Bristol Waggon Works the loss varies from 22 to 57 per cent.; it is more often nearer to the latter figure."

(2) "Moreover, it is found with a constant speed that a higher speed may be adopted for the tools, which results in a still further output of work. At Messrs. Richardson's works, for example, where electric driving was adopted, the speed of the tools was increased by an average of 20 per cent., with a corresponding increase of output. In a rail rolling mill in the United States, where electric motors have been adopted, it is stated that the work hitherto done by 6,000 hands with separate engines is now accomplished by 4,000 with electric power."

APPENDIX B.—*Firms using Electrically-Driven Machines.*

Table. I.—*Printing Firms.*

[From Mr. A. H. Gibbings' articles in *The Electrician*, 1898.†]

Table II.—*Shipbuilding and other Firms on N.E. Coast.*

From Mr. D. Selby Bigge's Paper before the Cleveland Institute of Engineers, November, 1897.

Name of firm.	Locality.
Messrs. Dorman, Long and Co. (Ltd.)	Britannia Iron Works and West Marsh Works, Middlesbrough.
Messrs. Chas. Dorman and Co.	Bedson Wire Works, Middlesbrough.
Messrs. Bell Bros. (Ltd.)	Clarence Iron Works, Middlesbrough.
Carlin How Mines Co.	Carlin How.
Lumpsey Mines Co.	Brotton.
Messrs. Sir Raylton Dixon & Co. (Ltd.)	Shipyard, Middlesbrough.
Messrs. R. Craggs and Sons	Tees-side Shipyard, Middlesbrough.
Messrs. The Anderston Foundry Co. Ltd.	Port Clarence, Middlesbrough.
Messrs. Sir Chris. Furness, Westgarth and Co. (Ltd.)	Tees-side Engine Works, Middlesbrough.
Messrs. The North-Eastern Steel Co. (Ltd.)	Steel Works, Middlesbrough.
Messrs. Skinningrove Iron Co. (Ltd.)	Skinningrove Iron Works, Carlin How
Messrs. Furness, Withy and Co. (Ltd.)	Middleton Shipyard, Hartlepool.
Messrs. Wm. Gray and Co. (Ltd.)	Central Shipyard, North and South Shipyards, West Hartlepool.
Messrs. Thos. Richardson & Sons (Ld.)	Hartlepool Engine Works, Hartlepool
Messrs. Irvine's Shipbuilding and Dry Docks Co. (Ltd.)	Harbour Dockyard, West Hartlepool.
Messrs. Short Bros.	Pallion, Sunderland.
Messrs. R. and W. Hawthorn, Leslie and Co. (Ltd.)	Hebburn Shipyard, Hebburn-on-Tyne.
Messrs. The Tees-side Bridge and Engineering Co. (Ltd.)	Middlesbrough.
Messrs. Palmer's Shipbuilding and Iron Co. (Ltd.)	Jarrow.
Messrs. C. S. Swan & Hunter (Ltd.)	Wallsend.
Messrs. The North-Eastern Marine Engineering Co. (Ltd.)	
Messrs. The Sunderland Forge Co. (Ld.) &c., &c.	

The above list is representative only of what has been done on the North-East Coast, and does not refer to the numerous installations which have been started in other parts of the country. It will, however, clearly indicate the rapid development which has taken place in this particular district.

* See *The Electrician*, Vol. XLI., p. 743.—Ed. *E.*
† See *The Electrician*, Vol. XLI., p. 748.—Ed. *E.*

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Table III.—*Printing and other Firms.*
(Details from various sources.)

Name of firm.	Locality.	No.	H.P.
Linotype Co.	Manchester	7	66
C. Tinling and Co.	Liverpool	4	56
Kennick and Jefferson	West Bromwich	8	28
The Morning Post	London	1	35
Alex. Baird and Son	Glasgow	5	16
Johns, Son and Watts	London	3	12
Hazell, Watson and Viney	London	2	12
M. P. McCoy	London	3	9
Chorley and Pickersgill	Leeds	2	8
G. G. Walker	Bradford	1	6
Wm. Byles and Sons	Bradford	3	7
Armitage and Ibbetson	Bradford	1	10
The Ulster Newspaper	Belfast	1	4
Cassell and Co.	London	...	...
Salvation Army Printing Works	London	...	...

APPENDIX C.—*Efficiency Tests of Various Motors.*

I.—*Worcester Waterworks Motors.*

Two 30-H.P. non-synchronous Brown motors, built by the Oerlikon Company of Zürich, and each driving, by means of belt and gearing, a three-throw pump.

The following figures were taken during one of the ordinary daily runs, and do not represent the best that have been attained, as the attendant said they were taking more current than usual. This might have been due to several causes—say, tight glands on the pump, mud, &c.

10,000 gals. were raised 300ft. in one hour; this is equivalent to 15·15 H.P. 18 units were consumed, which equals 24·4 E.H.P. The combined efficiency of the whole system (motor, belt, gearing and pump) was therefore equal to 15·1/24·4, or 62 per cent.

As the pumps are hardly the best of their kind, it is probable that the efficiency of the motors alone is about 85 per cent.

The above motor took a current of about 12 amperes at 2,000 volts during this period, so that the power factor is 18,000/24,000 = 75 per cent. Starting on a loose pulley with a condenser and resistance which is gradually cut out, they take for a few seconds a current of from 16 to 18 primary amperes, which drops to 7 or 8 when up to speed, and increases to 12 when pumping.

II.—*Oerlikon Motor, Nominal Capacity* 12 H.P.

The above motor was sent on approval for a customer, and thoroughly tested by the Electricity Department of the Worcester Corporation, with results as follows :—

Power factor ..... = 75 per cent.
Efficiency full load ..... = 78 per cent.
Efficiency half load ..... = 70 per cent.
Efficiency, quarter load ..... = 60 per cent.

III.—*Oerlikon Motor, Nominal Capacity* 9 H.P.

The above motor has been driving shafting in works in Worcester for the past two years, and has given no trouble. The following test was taken by the General Electric Company, and checked by the Worcester Electricity Department :—

—	Duration of test in hours.	Revolutions per minute.	Volts.	Amperes per phase.
Without load ...	¼	1,550	100	83
8·8 h.p.	1	1,438	105	178
6·5 h.p.	1	1,455	102	148
Nominal	1	1,440	110	180

Careful tests have since been taken, which show that this 9-H.P. Oerlikon single-phase motor runs at 1,440 revolutions per minute (supply from 100-volt mains), has a 9in. diameter pulley, is fitted with starting box and fast and loose pulley, self-oiling bearings (Lyon's liquid resistance, which is seldom used), and consumes one unit per horse-power per hour, the current being measured on a T.-H. wattmeter.

IV.—*Oerlikon Motor, Nominal Capacity,* 1½ H.P.

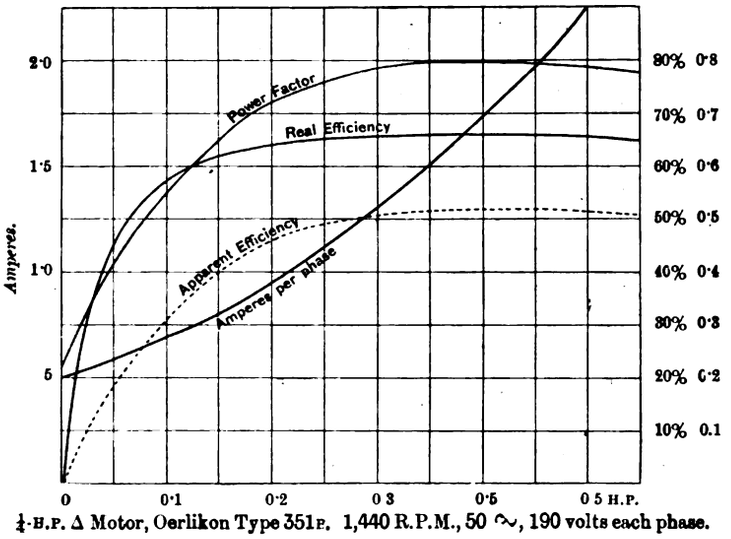
The above small motor is running shafting at the Upholstery Works, Worcester, and takes

35 amperes at 100 volts starting.
25 amperes at 100 volts running loose.
37 amperes at 100 volts fully loaded.

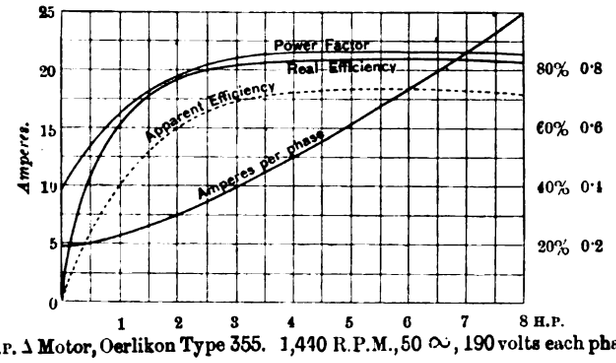
Table I.—*Efficiencies of Various Sizes and Makes of Direct-Current Motors.*

From manufacturers' price lists, &c.

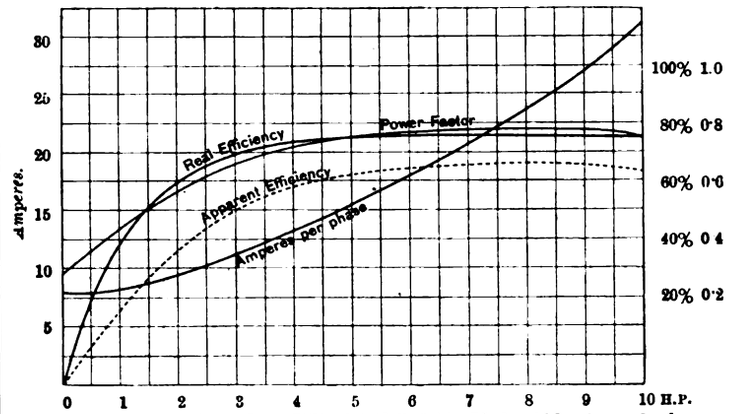
Type of motor.	Horse-power.																	
	1/20	1/12	1/10	1/6	1/4	1/3	1/2	1	1½	2	2½	3	4	5	6	7½	10	12	15	30
	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
Crocker Wheeler	...	28	...	61	73	...	75	81	...	82	...	84	...	85	...	86	...	87	...	...
Fuller-Wenström	...	...	...	...	...	64	72½	...	...	...	76	...	...	...	...	...	...	...	...	...
Lundell (Holmes)	53	...	53	...	68	...	71	74	...	80	...	83	84	85	...	86	87	...	...	...
Lundell (Verity)	...	...	...	...	55	...	65	76	...	78	...	84	...	...	...	...	...	...	...	...
Oerlikon	...	...	...	...	...	...	...	...	...	63	...	70	...	...	77	...	...	78	...	85
Slow-speed Crocker Wheeler	...	...	...	...	...	...	...	69	...	74	...	75	...	...	...	...	...	...	...	...



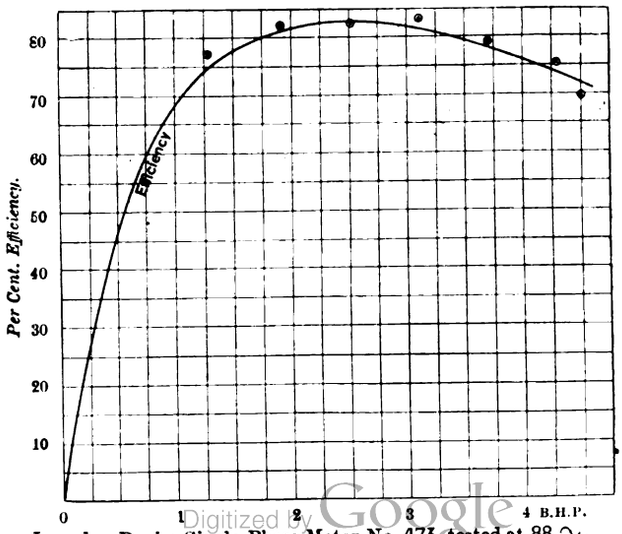
¼-H.P. Δ Motor, Oerlikon Type 351P. 1,440 R.P.M., 50 ∿, 190 volts each phase.



4-H.P. Δ Motor, Oerlikon Type 355. 1,440 R.P.M., 50 ∿, 190 volts each phase.



6-H.P. Δ Motor, Oerlikon Type 357. 1,440 R.P.M., 50 ∿, 190 volts each phase.



Langdon-Davies Single-Phase Motor No. 473, tested at 88 ∿.

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Table II.—*Efficiency Tests of Fuller-Wenström Motors.*

By Dr. Mullineux Walmsley, Northampton Institute, London, E.C.

A.—½-H.P. Continuous-Current Motor.

Load B.H.P.	Full load per cent.	Efficiency per cent.	Fall of speed per cent.
0·125	25	40	...
0·25	50	63	28·3
0·375	75	60	9·4
0·5	Full load.	72.5	...

B.—½-H.P. Alternating Current Motor,

Load B.H.P.	Full load per cent.	Efficiency per cent.	Fall of speed per cent.
1/8	25	29	1·0
¼	50	49	0·5
¾	75	59.5	0·2
½	Full load.	64	...

Table III.—*Efficiency Tests of Various Sizes of Lundell Motors.*
From figures supplied by Messrs. J. H. Holmes and Co., Newcastle.

Nominal H.P.	Volts.	Revs.	Brake H.P.	Actual efficiency (%).	Remarks.
¼	220	1,512	0·223	67·5	...
½	115	1,336	0·565	70·6	Tested cold.
½	115	1,780	...	74 to 75	Tested as a generator.
2	105	1,250	1·87	72	Not fully loaded.
4	100	1,150	4·29	86	Over loaded. Tested cold.
7½	115	1,015	7·5	87	Full load test.
7½	115	1,020	3·75	83·5	Half load test.

BOOKS RECEIVED.

(Copies of any of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price.)

"*Transactions* of the American Institute of Electrical Engineers." Nos. 8 and 9. Vol. XVI. (New York: Ralph Pope.) 50c.

"Science Abstracts." No. 23. Vol. II. (London: E. and F. N. Spon.) 2s.

"Chimney Design and Theory." By W. W. Christie. (London: E. and F. N. Spon.) 12s. 6d.

"The Elements of Alternating Currents." By W. S. Franklin and R. B. Williamson. (London: Macmillan and Co.)

ELECTRICITY WORKS ACCOUNTS.

Cheltenham Municipal Electric Supply Works.

The Cheltenham electric supply undertaking is interesting by reason of the relatively large street lighting load on the station. For the year ended at March 31, 1899, the output for the public lamps reached no less than 51·8 per cent. of the total output sold. The relation of the maximum demand to the output resulted in a load factor of 11·9 per cent., as compared with one of 10·6 per cent. in 1897-8. These load factors are, if anything, slightly above the average.

During the year the plant capacity has been increased by 385 kilowatts, the total being now 800 kilowatts, while the capital expenditure has increased from £55,690 to £75,125, representing £93·8 per kilowatt installed.

The financial results of the year's working, although they show a substantial improvement over those of 1897-8, are still disappointing. The net result is a deficit of £1,118 for the year after satisfying capital charges to the total extent of 4·99 per cent. of the capital. The costs in total are not to blame, standing as they do at a figure which is quite satisfactory considering the conditions and the output. An examination of the revenue items shows that the average price obtained per unit for the supply to private consumers was 4·98d., while the average price paid for the public lighting was barely 2·75d. per unit. This latter price appears below the lowest possible cost of the public lighting at the total output which obtains at Cheltenham, and it is clear that the ordinary consumers are paying the department more than their fair share of the total revenue. In the foregoing table we give particulars which are interesting as showing the progress which the undertaking has made.

Year.	No. of consumers.	Lamp connections.	No. of arc lamps.	Output. Total sold.	Output. Arc lighting.	Plant capacity kw.	Max. demand kw.	Total costs. Total.	Total costs. Per unit sold.	Total revenue Total.	Total revenue Public lighting.
1896-7	179	10,2.0	37	100,515	18,300	280	157	£1,891	4·52d.	£1,945	£148
1897-8	246	16,500	68	248,516	107,898	415	267	2,748	2·65d.	4,011	1,111
189?-9	302	22,200	134	375,834	192,712	800	366	3,860	2·46d.	6,009	2,204

Southampton Municipal Electric Supply Works.

In our second table we deal with the accounts of the working during the year ended at March 31st last of the Southampton municipal undertaking. It is satisfactory to find that the business is going ahead well, although it is not yet self-supporting. During the year we are noticing the output, at 263,465 units sold, shows an increase of about 38 per cent. over that of 1897-8, and was productive of a total revenue of £5,999, or at the rate of 5·49d per unit.

With one exception the items of works costs and the collective management and property charges show diminished expenditure; and in spite of the still rather high fuel item, generating works and total costs are well within the average at the output. The working profit for the year amounted to £2,894, representing 5·88 per cent. of the mean capital. After a payment of £1,454 as interest and £2,080 to the sinking fund, the resulting deficit is £641. Supply at Southampton was commenced about the end of 1891 by the Southampton Electric Light and Power Co. (Limited). In September, 1896, the undertaking was acquired by the Corporation for the sum of £21,100. In the following table we give a summary of the progress made since the commencement:—

	Year ending Dec. 31.	Units sold.	Equiv. lamp connections.	Average price obtained per unit.	Total cost per unit sold.	Working profit Total.	Working profit % to capital	Max. supply demanded kw.
Under local company.	1892	35,537	2,200	7·28d.	8·27d.	nil	...	...
	1893	53,848	3,162	6·87d.	4·32d.	£485	...	...
	1894	85,501	5,396	6·78d.	4·41d.	814	...	...
	1895	100,473	6,887	6·65d.	4·52d.	966	...	...
	Year ending March 31—							
Under Corporation.	1897	131,843	8,948	6·21d.	3·68d.	1,472	5·18	187
	1898	191,868	11,845	5·35d.	3·10d.	1,913	6·45	262
	1899	265,081	22,000	5·30d.	2·81d.	2,894	5·88	330

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

Aberdeen (Municipal)	Jan. 6, 1899	Kingston-upon-Hull (Mun.)	June 9, 1899
Ayr (Municipal)	Sept. 22, ,,	Kingston-on-Thames (Mun.)	April 21, ,,
Bedford (Municipal)	May 19, ,,	Lancaster (Municipal)	Oct. 21, 1898
Belfast (Municipal)	Sept. 15, ,,	Leeds (Company)	Mar. 3, 1899
Birmingham (Company)	Sept. 15, ,,	Leicester (Municipal)	Jan. 20, ,,
Blackpool (Municipal)	Sept. 29, ,,	Leyton (Municipal)	Sept. 9, ,,
Bournemouth (Company)	April 28, ,,	Liverpool (Municipal)	June 9, ,,
Bolton (Municipal)	Dec. 9, 1898	Manchester (Municipal)	Aug. 11, ,,
Bradford (Municipal)	April 14, 1899	Newcastle and District (Co.)	Oct. 6, ,,
Brighton (Municipal)	May 12, ,,	Newcastle-upon-Tyne (Co.)	April 14, ,,
Bristol (Municipal)	July 14, ,,	Northampton (Company)	Oct. 20, ,,
Burnley (Municipal)	Aug. 25, ,,	Norwich (Company)	Dec. 2, 1898
Burton-upon-Trent (Mun.)	April 21, ,,	Notting Hill (Company)	Mar. 17, 1899
Bury (Municipal)	Sept. 22, ,,	Nottingham (Municipal)	July 21, ,,
Cambridge (Company)	Mar. 10, ,,	Oldham (Municipal)	Nov. 18, 1898
Cardiff (Municipal)	Jan. 6, ,,	Oxford (Company)	May 19, 1899
Charing Cross (Company)	Mar. 17, ,,	Pontypool (Company)	May 5, ,,
Chelsea (Company)	Mar. 31, ,,	Portsmouth (Municipal)	July 14, ,,
Cheltenham (Municipal)	Oct. 7, 1898	Preston (Company)	Sept. 29, ,,
Chester (Municipal)	June 23, 1899	Reading (Company)	Oct. 13, ,,
City of London (Company)	May 12, ,,	Richmond (Company)	Oct. 13, ,,
Clerkenwell (Company)	Aug. 18, ,,	Scarborough (Company)	Nov. 3, ,,
Derby (Municipal)	Dec. 9, 1898	St. James' & Pall Mall (Co.)	Feb. 24, ,,
Dewsbury (Municipal)	Nov. 25, ,,	St. Pancras (Vestry)	May 26, ,,
Dover (Company)	June 2, 1899	Sheffield (Company)	Dec. 16, 1898
Dundee (Municipal)	Nov. 4, 1898	Shoreditch (Vestry)	Oct. 27, 1899
Eastbourne (Company)	July 22, ,,	Southampton (Municipal)	June 9, 1899
Edinburgh (Municipal)	Oct. 14, ,,	Southport (Municipal)	July 7, 1899
Exeter (Municipal)	Aug. 5, ,,	South Shields (Municipal)	July 7, ,,
Glasgow (Municipal)	Sept. 1, 1899	Stafford (Municipal)	Oct. 21, 1898
Guildford (Company)	May 5, ,,	Sunderland (Municipal)	July 28, 1899
Halifax (Municipal)	July 21, ,,	Taunton (Municipal)	June 16, ,,
Hammersmith (Vestry)	May 26, ,,	Tunbridge Wells (Mun.)	Sept. 1, ,,
Hampstead (Vestry)	Aug. 25, ,,	Walsall (Municipal)	June 23, ,,
Hanley (Municipal)	April 28, ,,	Wandsworth (Company)	Aug. 18, ,,
Harrogate (Municipal)	Oct. 20, ,,	Westminster (Company)	Feb. 24, ,,
Harrow (Company)	June 16, ,,	Whitehaven (Municipal)	July 28, ,,
Hast'gs & St. Leonards (Co.)	April 29, 1898	Windsor (Company)	Dec. 30, 1898
H'use-to-H'use Co. (K'ns'gt'n)	Mar. 31, 1899	Wolverhampton (Municipal)	June 30, 1899
Hove (Company)	Mar. 10, ,,	Woolwich (Company)	Jan. 18, ,,
Huddersfield (Municipal)	Oct. 6, ,,	Worcester (Municipal)	April 7, ,,
Islington (Vestry)	Oct. 27, ,,	Yarmouth (Municipal)	Nov. 3, ,,
Kensington & Knightsbr' (Co.)	Mar. 3, ,,		

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	CHELTENHAM.		SOUTHAMPTON.	
Undertaking Worked by	Cheltenham Corporation.		Southampton Corporation.	
Date of Commencement of Supply	May, 1895.		1891.	
System of Supply	Alternate-current transformer sub-stations.		Three-wire, with batteries.	
Chief Engineer	Hamilton Kilgour.		F. H. Chaplin.	
YEAR ENDED	MAR. 31, **1898.**	MAR. 31, **1899.**	MAR. 31, **1898.**	MAR. 31, **1899.**
QUANTITIES—				
Units generated	344,010	507,830	228,227	331,458
„ SOLD (TOTAL)	248,516	375,834	191,868	265,081
„ sold to consumers	140,618	183,122	191,868	263,465
„ sold for public lighting, &c.	107,898	192,712	—	1,616
„ used on works	33,383[a]	31,698[g]	5,223	44,059
UNITS SOLD PER 8 C.P. LAMP CAPACITY	19·1	15·0	20·6	10·6
Maximum supply demanded	267 kilowatts	360 kilowatts	262 kilowatts	330 kilowatts
Number of public lamps	68	134 arc, 13 glow	—	24
Number of consumers	246	302	180	320[i]
Connections to mains in 8-c.p. lamps	16,500[b]	22,200[f]	11,845[a]	22,000[i]
CAPACITY OF PLANT IN 8-C.P. LAMPS	13,000	25,000	9,300	25,000
CAPACITY OF PLANT IN KILOWATTS	415	800	300	800
CAPITAL—	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.
AUTHORISED (TOTAL)	— —	— —	£56,064 £187	£56,064 £70·1
Share	— —	— —	— —	— —
Loan (including Debenture charges)	— —	— —	56,064 187	56,064 70·1
RECEIVED (TOTAL)	£47,485 £114	£67,685 £84·6	56,064 187	56,064 70·1
Share	— —	— —	— —	— —
Loan (including Debenture charges)	47,485 114	67,685 84·6	56,064 187	56,064 70·1
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	— —	— —	— —	— —
Share (unissued)	— —	— —	— —	— —
Share (uncalled)	— —	— —	— —	— —
Loan (including Debentures)	— —	— —	— —	— —
REPAID (TOTAL)	— —	— —	— —	— —
RESERVE OR SINKING FUND	2,012 4·84	3,397 4·25	2,543 8·48	4,692 5·86
DEPRECIATION FUND	— —	— —	— —	— —
EXPENDED (TOTAL)	55,690 134	75,125 93·8	30,918[b] 103	67,503[b] 84·4
Lands and buildings	— —	— —	— —	— —
Plant	— —	— —	— —	— —
Mains	— —	— —	— —	— —
Miscellaneous	— —	— —	— —	— —
BALANCE OF CAPITAL ACCOUNT	−8,206[c] −19·8	−7,440[c] −9·3	+25,146 83·8	−11,439[f] −14·3
REVENUE—	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.
TOTAL	£4,011 3·875d.	£6,009 3·835d.	£4,392 5·49d.	£5,999 5·434d.
Revenue from supply	2,867 2·770d.	3,803 2·427d.	4,276 5·35d.	5,845 5·295d.
„ meters, &c.	2 0·002d.	2 0·001d.	86 0·110d.	108 0·098d.
„ public lighting	1,111 1·072d.	2,204 1·406d.	— —	20 0·018d.
„ sale of lamps, &c.	31 0·030d.	— —	— —	— —
„ miscellaneous sources	— —	— —	29 0·036d.	26 0·024d.
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	£2,748 2·653d.	£3,860 2·464d.	£2,479 3·10d.	£3,105 2·812d.
WORKS COSTS	2,306 2·227d.	3,332 2·127d.	1,700 2·13d.	2,194 1·988d.
Generation of electricity	*1,818 1·755d.*	*2,652 1·693d.*	*1,558 1·95d.*	*2,061 1·866d.*
Fuel (including cartage, &c.)	704 0·680d.	1,322 0·844d.	956 1·20d.	1,293 1·171d.
Oil, waste, water, stores	185 0·179d.	239 0·153d.	110 0·138d.	139 0·126d.
Wages at station	829 0·801d.	975 0·622d.	411 0·514d.	477 0·432d.
Repairs and maintenance at station	99 0·096d.	86 0·055d.	81 0·101d.	152 0·138d.
Distribution of electricity	*162 0·156d.*	*232 0·148d.*	*142 0·178d.*	*130 0·118d.*
Wages, &c.	71 0·069d.	50 0·032d.	98 0·123d.	88 0·080d.
Repairs, renewals of mains, &c.	91 0·088d.	182 0·116d.	44 0·055d.	42 0·038d.
Public lighting	*326 0·315d.*	*448 0·286d.*	— —	*3 0·003d.*
Attendance	236 0·228d.	276 0·176d.	— —	3 0·003d.
Renewals	89 0·086d.	172 0·110d.	— —	
MANAGEMENT AND PROPERTY CHARGES	443 0·428d.	528 0·337d.	779 0·974d.	911 0·825d.
Royalties	— —	— —	— —	— —
Rent, rates, taxes	*93 0·090d.*	*143 0·091d.*	*100 0·125d.*	*127 0·115d.*
Management	*350 0·338d.*	*386 0·246d.*	*679 0·850d.*	*784 0·710d.*
Salaries	208 0·201d.	236 0·151d.	476 0·596d.	516 0·467d.
Stationery, &c.	68 0·066d.	64 0·041d.	53 0·066d.	61 0·055d.
Establishment charges	50 0·048d.	71 0·045d.	47 0·059d.	91 0·082d.
Law charges, &c.	24[d] 0·023d.	15[h] 0·010d.	103[e] 0·129d.	116[g] 0·105d.
FINANCIAL RESULTS—	Total. / % to mean cap. exp'nded.	Total. / % to mean cap. exp'nded.	Total. / % to mean cap. exp'nded.	Total. / % to mean cap. exp'nded.
WORKING PROFIT FOR YEAR	£1,262 2·74%	£2,148 3·29%	£1,913 6·45%	£2,894 5·88%
Sum carried to Depreciation Fund	— —	— —	— —	— —
Sum carried to Reserve or Sinking Fund	1,606 3·48%	1,616 2·47%	1,208 4·07%	2,080 4·23%
Net interest on loans (incl. Debenture charges)	1,074 2·33%	1,650 2·52%	726 2·45%	1,454 2·96%
BALANCE FROM LAST ACCOUNT	−2,950 −6·41%	−4,368 −6·68%	21 0·071%	— —
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	— —	— —	— —	— —
Deficit	*4,368 9·49%*	*5,487 8·39%*	*19[d] 0·064%*	*641[h] 1·30%*
ORDINARY DIVIDEND PAID	— —	— —	— —	— —
PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE	68·5%	64·3%	56·5%	51·8%
Expenditure per kilowatt capacity	£6. 12s. 5d.	£4. 16s. 7d.	£8. 5s. 2d.	£3. 17s. 7d.
REVENUE PER KILOWATT CAPACITY	£9. 13s. 4d.	£7. 10s. 2d.	£14. 12s. 7d.	£7. 10s. 0d.
Expenditure per 8-c. lamp capacity	4s. 2¾d.	3s. 1d.	5s. 4d.	2s. 5¾d.
REVENUE PER 8-C.P. LAMP CAPACITY	6s. 2d.	4s. 9¾d.	9s. 5½d.	4s. 9½d.
REVENUE PER 8-C.P. LAMP CONNECTED	4s. 10d.	5s. 5d.	7s. 5d.	5s. 5½d.
Price charged for lighting, per unit	6d. to 3d.[e]	6d. to 3d.[i]	7d.[e]	6d. to 4½d.[j]
Price charged for power, per unit		[ann.		3d.
Price charged for public lighting	£19. 10s. per arc lamp.	£19. 10s. per arc lp. per.	—	£20 per arc per ann.

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Editorial, Publishing and Printing Offices,

1, 2 & 3, SALISBURY COURT, FLEET ST., LONDON,

Telephone: 949 Holborn. *Telegrams:* "ELECTRICIAN NEWSPAPER LONDON."

All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher "THE ELECTRICIAN," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN" *Printing and Publishing Company, Limited, and be crossed "Coutts and Co."*

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FINALITY IN ELECTRICAL ENGINEERING.

As the present century draws towards its close we may expect to have, in speech and literature, and in gradually increasing numbers, reviews of the scientific and engineering achievements of the past hundred years, and speculations on the developments that may be looked for in the century about to commence. Of such a nature as these was Sir DOUGLAS FOX's presidential address to the Institution of Civil Engineers on Tuesday evening; and, while the scope of that address naturally covered the entire domain of civil engineering, no small portion of it was devoted to its latest branch—namely, that with which electrical engineers are directly associated. Civil engineering of a systematic description, as distinct from military engineering, is of very ancient date; its origin is lost in the mythological ages of early Egyptian and Chaldean civilisation. On the other hand, electrical engineering is of such brand-new and modern character, that not only is its history scarcely sufficient to cover the waning century, but the vast majority of the scientific facts and laws, or principles, upon which it is based are no older than that self-same epoch. A hundred years ago the scientist or the civil engineer, looking forward, as Sir DOUGLAS FOX did on Tuesday, to a coming century, could at best behold through a misty veil the dim outlines of an electrical science, far less picture the ramifications of an electrical branch of engineering. Thus, developed with a rapidity of which its own lightning flash is not an ill-fitting symbol, electricity has attained to a marvellous degree of progress towards scientific and technical perfection. An interesting question is suggested by the concluding remarks of Sir DOUGLAS FOX's address, as to whether the perfection, or completion, towards which there has been such rapid movement, is actually attainable; or whether, on the other hand, the coming century will witness new discoveries and inventions piled upon those of the present age with a rate of progress unslackened from the almost breathless pace of to-day.

Sir DOUGLAS clearly indicates his belief that there is no finality; that the young engineer need not be discouraged by the mistaken notion that everything has been already accomplished, that the mine of new ideas has been worked out, and that the new century will find him "no work to do." Even

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the oldest branches of civil engineering have not yet arrived at finality, either in regard to improvement in methods or to extensions in practice. Canals, bridges, roads, railways, are always being improved in their mode of construction, as well as extended in increasing numbers over the face of the earth. The civil engineer need have no fear that his profession, taken as a whole, will become exhausted.

Nevertheless, it is not impossible that, while civil engineering on the whole maintains its onward march, an isolated branch of it may attain absolute finality, and, perhaps in consequence thereof, may decline and ultimately cease to be. It will be remembered that just such a fate as this was promised the gas industry by the early exponents of electrical engineering. How completely these ill-judged prophecies failed, as an example of the decay we are presuming to be possible, the data given in our abstract of Sir Douglas Fox's address abundantly make clear. The gas industry and electrical supply have progressed hand in hand, and in all probability will continue to do so as long as they both exist. But will there, in the next century, arise prophets who shall predict of electrical engineering what early electrical engineers ventured to predict of gas supply? Probably such will indeed arise; but whether their prophecies will be vain or not must depend upon the ability of electrical engineers to prevent practice from lapsing into finality. If, while material civilisation advances, electrical practice should ever fail to meet new demands and to adapt itself to a more exacting environment, stagnation and decay would be inevitable.

Fortunately, there is not the least indication that applied electricity will fall into this unhappy plight; on the contrary, it has always shown remarkable ease in adapting itself to altered conditions. Every year witnesses important improvements in *matériel* and methods. Nor need there be any alarm because, in some branches of electrical engineering, progress has resulted in greater complexity in the machinery and other appliances. Healthy and genuine evolution, be it remembered, is from what Herbert Spencer termed "undifferentiated homogeneity" to what he termed "highly differentiated heterogeneity"; in other words, from simple to complex. Contrast the structure of a modern marine engine with that of the early steamboats, and it will be seen how true this is of progress in machinery. The electric supply works of to-day are a much more elaborate affair than the plant which supplied electric current to the Thames Embankment in the early days of electric lighting.

Occasionally, however, it happens that the invention which is looked for from maternal necessity fails to put in an appearance. This phenomenon, indeed, is not unknown in electrical invention, and in some instances the lack of ready adaptation to the needs of the time has somewhat retarded progress in certain directions. As an example of this we may mention the necessity which exists for a storage battery suitable for light motor vehicles, the absence of which invention in a perfected form has allowed of considerable development in oil-driven and even steam-driven motor cars. We may also refer to the long-standing need for a system of electric traction which shall combine the cheapness and flexibility in working of the trolley system with the æsthetic advantages of the conduit system. Broadly speaking, however, electrical engineering has not only been able to "hold its own" wherever it has taken the field, but has also exhibited a high degree of mobility in seeking fresh fields and pastures new. Such has been its character during the period of its existence, and such we may reasonably expect will be its character in the century close at hand.

SIR DOUGLAS FOX'S PRESIDENTIAL ADDRESS TO THE INSTITUTION OF CIVIL ENGINEERS.*

The following is an abstract of those portions of Sir Douglas Fox's address of greatest interest to electrical engineers. After acknowledging the honour conferred upon him in being chosen as President, Sir Douglas Fox referred to the progress of the Institution of Civil Engineers from the year 1818 to the present day, when it numbers 20 honorary members, 1,995 members, 3,971 associate members, with 336 associates and 904 students, making a total of 7,216, widely distributed throughout the world. Referring to the introduction of a system of examination for studentship and associate membership, he said that the last-mentioned departure might be expected to raise in a useful degree the standard of theoretical knowledge, though it must not be allowed to interfere with or to supersede the qualification of sound practical experience, which had always been required for admission to the higher ranks of our profession. Not only at Cambridge, where a special "tripos" had been instituted in mechanical science, but at most of the leading universities of the Empire, degrees in engineering science had of late years been established, and the requirements of our profession were receiving special attention in connection with the new "University of London." It appeared to him to be of importance to cultivate still further the relations between the investigators of physical science, who were establishing and enlarging our principles, and the civil engineers, who carried those principles into practice; and he hoped that means might be found to bring these important bodies of co-workers into closer touch and sympathy with one another. Continuing, he said:—

Only a few years since, Great Britain, the birthplace of the electric telegraph, of railways, and of ocean steamships, was the workshop of the world and the educator of all the nations in mechanical science. This was the time when European nations sought our aid; but the well-matured and State-aided scientific education of the Continent has changed all that, and we have now much to learn from foreign engineers, notably from those of France, Germany, Italy, and Switzerland, as well as from our cousins in America. For the encouragement of our younger members, it must be remembered that our sphere is widening daily with the expansion of the Empire and with the growth of wealth and enterprise amongst its citizens. They must be well equipped, and will then find ample openings for practice.

The century now drawing to a close has witnessed the greatest strides in human knowledge, as regards both the theories of the scientist and the practical applications of the civil engineer, that the world has ever known. At its commencement there were living some of the pioneers in both departments, and these have been followed by an ever-increasing body of trained and earnest men. It was in an early year of the century that William Murdoch exhibited in a practical form the lighting of rooms and streets by coal gas. A leading philosopher of the day sounded the note of prejudice and depreciation, which has so often since that time heralded the introduction of great inventions. He trusted that "no one would rely upon so foolish and unlucky a thing as gas," and anticipated that its inventor would soon be asking for the dome of St. Paul's as a gasholder. He little thought that, within the century, gasholders would be erected greatly exceeding in diameter and cubical contents that noble building.

Through the kindness of our member, Mr. Henry E. Jones, I am enabled to give the following facts in connection with the gas industry:—Peckston, an engineer, writing in 1841, stated that about 1837 the sale of gas in London, Westminster, and Southwark required the production of 1,460 million cubic feet of gas; and in the same work demonstrated the comparative economy of gas and other means of lighting in tables based on the price of gas of 9s. per thousand, tallow candles 8d. per pound, wax candles 2s. 6d. per pound, and sperm oil at 9s. per gallon. Gas is at the present day being sold by the South Metropolitan at 2s. 2d. per thousand, and the best petroleum lamp-oil is sold at about 5d. per gallon. According to the latest available returns issued by the Board of Trade in November, 1898, the sale of gas, by both companies and local authorities throughout the United Kingdom, in the year 1897 aggregated 122,219,000,000 cubic feet, involving the carbonisation of 12,000,000 tons of coal, consumed by 3,000,000 consumers scattered over 25,000 miles of gas mains, involving a total capital expenditure of £78,000,000. Of the total sale of gas above stated, so much as 33,495,810,000 cubic feet, or over 25 per cent., was sold within the metropolis as included under the London County Council. It is interesting to note that gas-making in horizontal retorts, purifying by lime, storing in holders, and distributing by mains of cast-iron with wrought-iron service pipes, are in operation now with very much the same plant (although improved in detail) as was in use in 1840.

In spite of the charms of its younger sister, electricity, coal gas still holds its own; and, in consequence of the rivalry between the

* Delivered November 7th.

two systems of lighting, improvements in both are rapidly being made. The introduction of the "mantle" system, at one time so very near failure, has proved to be a great step towards a more powerful light; and the mantle, used under forced draught, results in a gas light of intense power and of very low cost, which is proving to be no mean competitor with the electric light, and promises to restore gas to its former position as an illuminant. At the same time, gas is more and more asserting itself as a most useful, if not the most important, agent for cooking and heating, and, were it to be generally adopted, it would go a very long way towards solving the great problem of London fogs. It is needless to point out the heavy loss, both in health and in pocket, caused by these fogs heavily laden with carbon. Were they to be satisfactorily abolished, London would not only be far cleaner, but would vie with other capitals of Europe in their charm of pure atmosphere and clear skies.

One of the most unsatisfactory features in the history of British civil engineering has been the slow progress made, in this country, with the introduction of electricity for its three great applications of lighting, traction, and transmission of power. Hampered by restrictive legislation, opposed by vested interest, and encumbered by the by-laws and regulations of official bodies without number, the electricians, who form so important a branch of our profession, have been unable to do justice to their skill. A few railways, specially designed for city traffic, and a comparatively insignificant length of electrical street tramways, have struggled into existence. Some rather better progress has been made with lighting in the chief towns, but it is discouraging to compare the present position of electrical industries with that of similar undertakings in the United States, Germany, Switzerland, Japan, and even in our own Colonies. No powers have yet been obtained for the transmission of energy to a distance, whilst the electrical tramway, hailed as a boon by the inhabitants of almost every town abroad, is still quite exceptional here, and the extension of the system seems doomed to still encounter serious delay. The Metropolitan and Metropolitan District Railway Companies of London have only now commenced to experiment upon a question which has been long since practically decided in the United States—that of the electrical haulage of heavy trains, combined with rapid acceleration on starting. Upon this latter important point our American cousins have arrived at the limit of actual safety to passengers.

On the "Baltimore Belt" Railway electrical locomotives, weighing 95 tons, haul through a tunnel, on a gradient of 1 in 125, ordinary passenger trains at a speed of 50 miles per hour, the steam locomotive being included in the load, and goods trains, in some cases weighing 1,800 tons, at a speed of 12 miles per hour. High speeds are attained and heavy loads hauled by similar locomotives, but of less weight, on other American railways. The drivers are found to much prefer the electrical to the steam locomotives. The tunnels of the two metropolitan companies, were they to be properly cleaned and whitened, provided with a pure atmosphere, and traversed by comfortable, well-lighted electrical trains, starting rapidly, running at high speed, and capable of stopping quickly without shock, would assuredly be patronised by vastly-increased numbers of passengers, and would thus yield improved dividends to the shareholders and greatly enhanced comfort to the travelling public.

Sir John Wolfe Barry has lately dealt very fully with the question of congestion of traffic in London. I would emphasise his conclusion that relief by way of new and wider thoroughfares is imperative; but perhaps even a better result could be attained by making short connections between back streets, and thus converting them also into thoroughfares. It would appear to me equally important to remove the injurious mud and dust from the streets and the smoke from the atmosphere, at present seriously affecting the well-being of the inhabitants. May we not look forward to a time when horses shall have given way, at least in towns, to mechanical traction, avoiding offensive smell, reducing noise and wear and tear, and enabling asphalte pavement to be used throughout with cleanliness and safety; when the cooking and heating of the town shall be effected, if not electrically, at least from gasworks situated in the neighbourhood of the collieries, and ceasing to add, as at present, their by no means unimportant quota to the volume of smoke loading the atmosphere; when the fog-producing marshes of the east shall be thoroughly drained and dried up; and when an efficient ventilation of sewers shall prevent the escape into the thoroughfares, especially in the higher parts of towns, of the foul gaseous emanations of the mighty sewage flow beneath? It would be interesting, as well as most useful, if a careful comparison were made between the different kinds of paving for our public streets. The question of durability is of the greatest importance, even more so than first cost, the public inconvenience and the great delays caused to traffic by constant repairs being so serious.

The telephonic service of this country is at present much behind that of other nations. Metallic returns, possibly automatic exchanges, and far more numerous trunk lines, are called for; and it is to be hoped that ere long the telephone and telegraphic wires, with gas, water, and hydraulic mains, will be relegated to proper subways, admitting of easy inspection and repair, and thus reducing to a minimum the present constant interference with street surfaces.

A commencement has been made in the metropolis with improved electric railways running through specially designed tunnels, but this development is not by any means keeping pace with the increase of the population and of the traffic, it having been found difficult to raise capital for such undertakings. The increase of the capital cost of main lines of railways in this country is becoming every day more serious, and indirectly affects the power of Great Britain to hold her own in the markets of the world. Efforts are being made to reduce the first cost of secondary or light railways, chiefly by steepening gradients and sharpening curves, but in some cases by reducing the gauge. Whether the enhanced cost of working and maintenance will counterbalance the seeming advantage remains to be proved by the test of lengthy experiment under ordinary traffic conditions. Far more economy will result: from omitting fencing except where absolutely necessary; from reducing the width of formation of the earthworks; from substituting level crossings without lodges or gates for public and private bridges; from reducing the weight of rail, and the depth and width of ballast; from modifying the station arrangements, and doing away with raised platforms and complicated signalling; and from arranging for lighter locomotives and reduced speeds.

The Light Railways Act has now been put in force to a considerable extent. No definition of a light railway has, however, been settled, and proposals of very varying character have been brought under the notice of the Commissioners. The recent decision, practically prohibiting applications under this Act where existing railway companies allege competition, must largely interfere with its application and reduce its advantages over an ordinary application to Parliament. If amended in this respect, the new procedure might be increasingly useful.

In connection with water supply to towns, and the transmission of power from waterfalls by electricity, very curious questions have arisen in this country with reference to the right to carry water from one watershed to another, and the compensations to be paid for necessary easements. In the meantime, vast installations are being rapidly established in Germany, Switzerland, and the United States, where difficulties of this kind are rapidly swept away if found to impede industrial progress.

As regards electricity, from the experiments by Prof. Wheatstone in 1837 to those of Signor Marconi there has been a steady march of discovery and practical application. In the former the scientists of this country have fully held their own; but the British engineer has been greatly hampered, and the results attained have been small as compared with those in some other countries. Vested rights are difficult to overcome. The multifarious requirements of Acts of Parliament, framed to prevent the creation of monopolies, have been followed by Board of Trade regulations, and by clauses imposed by county, district, and even parish councils; and to such over-legislation much of the backward condition of British enterprise in connection with electric lighting and traction must be attributed. The three railways of short length and the few miles of electric tramway already referred to have to be compared with the wonderful progress made in the United States, where no suburb is considered suitable for residence without its tramway, and almost every small town has its combined system of electric lighting and traction. Wherever electric tramways have been introduced the public have shown a decided preference for them. In the case of New York and Brooklyn, representing about two millions of inhabitants, the only decreases in traffic are on the overhead steam railways, whilst in 1897 no less than 880 millions of people are said to have travelled, and it is estimated that the annual number is fast approaching 1,000 millions.

British engineers have two chief bodies of competitors to reckon with—the engineers of the great and growing empire of Germany and those of the United States, who have been thoroughly trained in theory and practice, and are proving their ability and courage by the vast works they originate and carry out. German and other Continental engineers are greatly assisted in many ways by paternal Governments, whose officers they generally are, and who lay down valuable regulations and in many instances establish standards of quality and design. American engineers are encouraged by the vast demands of a comparatively new country, in which nature exists on a magnificent scale only equalled by Switzerland and India, and of a rapidly rising civilisation calling loudly for the most recent improvements in locomotion, in building, in lighting, in telephonic and telegraphic communication.

An important matter, demanding careful consideration by civil engineers, if not by the Institution itself, is whether competition in the world's race could be facilitated by the establishment, upon sufficient authority, of standard specifications for such materials as steel and cement, and the introduction of standard types for bridgework, roofing, and other structures frequently occurring in practice, and for locomotives and rolling stock. Care must be taken not to stereotype the details of design so thoroughly as to throw difficulties in the way of improvements; but the experience with the Atbara

bridge shows how important it is, when early delivery is a necessity, to be prepared with type designs based upon ordinary merchant sections of steel. This, however, is already carried out by British engineers engaged upon railway extension in the Colonies, India, and elsewhere abroad. It is hardly practicable in thickly settled countries, where local circumstances involve variation in almost every span. In the case of the Liverpool Overhead Railway every effort was made to duplicate as far as possible, yet for some 660 spans over 1,000 drawings were found to be necessary.

The question of the adoption of the metric system has been ably dealt with by others. I therefore only desire to record my opinion that it is of the utmost importance to the engineers and traders of this Empire that this simple and effective mode of measurement, already in force in almost every other civilised nation, should be introduced here. Having had occasion for many years to work under both systems, I can bear testimony to the great saving of time and of labour effected by the use of the metrical weights and measures, and to the ease with which the system is acquired even by those trained to use our antiquated and complicated standards. I am strongly of opinion that the two great Anglo-Saxon nations, Great Britain and the United States, must fall into line with the rest of the world in this matter; and it would be a notable and interesting mark of our entry into a new century if, as has already been suggested to our Government, the metric system could be made compulsory as from A D. 1900. One great obstacle to British designs and manufactures finding their way upon equal terms through the Continent of Europe, and into the vast empire of China, Japan, and elsewhere, would thus be removed, and engineers throughout the world would be thinking and designing upon a basis of like dimensions.

Mechanical traction upon public roads has been, and still is, most seriously hampered by restrictive legislation in this country of ours, which, with all its enterprise, is very slow to adopt improvements involving any change in the ordinary course of life. Whilst American and foreign engineers have been able to build and run motor cars for a long time past, it is only quite recently that such carriages have been allowed to travel here, except with a red flag in front and at a foot's pace. Even under the new Act, which has given impetus to this important industry, the limitation of the weight to 3 tons, instead of 4 tons, prevents many valuable improvements from being adopted; and, by rendering necessary the introduction of aluminium and other costly materials, has kept the price of such carriages at a prohibitive figure for general use. In America the street railway trains run at 20 miles per hour even in suburbs, and at much higher rates on country roads; affording thereby greatly increased facilities of inter-communication, apparently without serious risk to the public. It must not be forgotten that many remarkable attempts were made, in the early part of the century, and before the introduction of railways and tramways, to establish mechanical traction, of which one notable example has been already mentioned. In fact, these innovations were considered so dangerous that an effectual legal bridle was put upon the ambitious inventors, not to be removed for the best part of a century.

At present a fourfold competition is taking place for the control of the roads between steam, gas, compressed air, and electricity. Where continuous rails and conductors are permitted, the last-named power is far in advance of the others. The overhead trolley is at present in much favour, but it is to be hoped that before long the conduit system may be brought into practical and economical use, thus avoiding much that is unsightly and dangerous.

There is no department of engineering which has benefited more by the inventive genius of the century than that of mining. Improved methods of sinking deep shafts, tubbing back water, and winding at high speeds from great depths, have enabled much coal to be opened up. Electricity has been impressed into the service with most beneficial results, not only of economy, but of safety and improved sanitation, and is now largely used for underground haulage, for lighting, for pumping at the face, and, in the shape of telephones, for communication.

Conclusion.

As we engineers look back over the century, we are encouraged by the array of well-known and highly-respected names of those who have preceded us, and who have laid the foundations of our professional history in sound principles, correct practice, earnest and consistent hard work, and high professional honour and integrity. We find ourselves now surrounded by an ever-increasing phalanx of highly-educated gentlemen, entering our profession for the love of the work, upholding our social status, and enabling us thus far to fairly hold our own amongst the engineers of the world.

And here I desire to call the special attention of my brother members to the position of the benevolent fund connected with our Institution, which has proved of the utmost value to many most deserving cases. Through the liberality of some of our older members a considerable sum has been invested as capital; but only the interest of this is available. Considering the benefits that members derive from our profession, I think the least that we can expect is that every member of the different grades should endeavour to contribute, and thus enable the committee, who give much time and attention to the consideration of the cases, to adequately assist those who, from misfortune or from sickness, are in need. From personal knowledge of the work of the committee, I can testify that in many cases of misfortune or ill-health the help afforded is of the greatest possible benefit.

Upon our younger brethren will it devolve to carry on our traditions, so far as they are worthy ones, to steadily improve upon them wherever possible, and to deal with the vast practical problems which already surround us or loom in the near distance, that the still hidden powers of nature, created and maintained by the Ruler of the universe for the use and happiness of man, may be more and more developed, controlled, and combined into one harmonious and useful whole.

> See through this air, this ocean, and this earth,
> All matter quick and bursting into birth.

So writes Pope, and again another says—

> Every discovery of to-day brings us an appreciable distance nearer to the final mystery of the nature of things. Every discovery helps man to make earth his servant. Yet is there still infinite room to advance.

The problems now opening up to the civil engineer are of surpassing importance. Trunk railways through Russia, China, Persia, Africa; irrigation works to supply the wants of growing populations; harbours large enough to receive the vessels of the future (already eclipsing the "Great Eastern," of which the chief shortcoming was that she was before her time); central installations to furnish lighting, power, traction, and heating to whole counties; the extension of the telephonic communication—with and without wires; the abolition of the smoke and smell of cities; the replacement of horses by mechanical power in the streets; the increase of the speed of trains to 100 miles per hour; the erection of buildings of great height, where land is valuable; the utilisation of waste products, especially the refuse of cities; the improvement of the water supply; the reclamation of land; the profitable working of deep seams of coal.

These are but some of the branches in which engineering progress in the twentieth century may be expected to develop. They will call with increasing force for engineers sanguine for the future, educated upon a basis of sound scientific attainment, trained in experimental research, and qualified by practical experience—obtained, I trust, by means of that regular course of pupilage under members of the Institution which, under the less favourable circumstances of the past, has nevertheless produced the engineers who have achieved the results to which I have referred.

> The Alps have been bored (as we are told), the earth encircled with cables, and a thousand other marvellous results of energy achieved, solely for the reason that energy was enkindled by the conviction that the results were possible.

It will be essential for our successors to maintain a high standard of professional loyalty and cohesion, a strong sympathy between chief and assistant, an absolute integrity as regards the interests of clients, and rigid impartiality in the administration of contracts or the settlement of disputes. Our aim as a profession must ever be to leave behind us works of efficiency and stability, combined with economy of first cost and, maintenance and at the same time structures which shall as far as possible conform to true æsthetic taste and feeling.

I am one of those who believe that destiny, whether it be of a nation or of an individual, depends upon character. Most earnestly then must we strive to hand down from generation to generation the tradition that to be a civil engineer implies the possession of high qualities, not only of intellect, but of character and heart.

THE ELECTROLYTIC TREATMENT OF COMPLEX SULPHIDE ORES.*

BY SHERARD COWPER-COLES.

Introduction.

The author approached the difficult subject of this Paper about four years ago. During the last two years he has been intimately connected with a number of experiments carried out on a practical scale with complex sulphide ores. The Paper is limited to wet extraction process. A number of electrolytic processes are briefly touched upon.

In the present concentration system adopted at Broken Hill an argentiferous lead concentrate is first produced, sufficiently low in zinc to make it available for the ordinary lead furnace. If a further elimination of zinc is attempted, it means finer crushings and the production of slimes. Only about 25 per cent. of the original ore is obtained as zinc middlings, 5 to 15 per cent. as slimes, and the remainder as worthless tailings, containing only a small percentage of the metals. The lead concentrates assay 55 to 70 per cent. of lead, 8 to 14 per cent. of zinc, and 20 to 30 oz. of silver to the ton; while the zinc middlings assay 8 to 20 per cent. of lead, 25 to 40 per

* Abstract of a Paper read before the Society of Engineers, Nov. 6.

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cent. of zinc, and 5 to 18 oz. of silver to the ton. The slimes assay 25 to 35 per cent. of lead, 15 to 20 per cent of zinc, and 20 to 25 oz. of silver to the ton. Only a small proportion of the total contents are recovered, namely, one-half of the lead, one-third of the silver, and no serviceable portion of the zinc. A sample of Broken Hill ore, when concentrated on a Luhrig vanner, gave the following results :—

—	Lead. Per cent.	Silver. Oz. per ton.
Tailings	18·5	11¾
Second middlings	17·4	...
Heads	23½	Not assayed for silver.
First middlings	20¾	...
Coarse	16½	...

Cost of Distillation Process.

The present method of zinc distillation is a costly and crude process, and is not applicable to the removal of zinc from ores containing lead or zinc silicates ; the lead rapidly attacks and destroys the retorts. Mr. J. W. Swan mentioned, in his presidential address to the Institution of Electrical Engineers, that the method in common use for reducing the native sulphide or the carbonate of zinc to the state of oxide by calcination, by mixing with non-bituminous coal and distilling in clay retorts at an extremely high temperature, is absolutely barbaric in its primitiveness and its wastefulness.* The quantity of coal consumed in the smelting of zinc is more than five times the weight of the metal produced. The cost of smelting involved in the production of a single ton of zinc, including coal, labour, pottery, and stores, is generally not less than 80s. ; and as about 16 per cent. of the metal contained in the ore is unextracted, the loss of this at the then present value of zinc ore (zinc being £21 per ton) makes an addition of 56s. to the cost of production, and a total of about £7. 16s. for smelting one ton of zinc. These figures are variable with the market value of zinc ore, also with the locality of the smelting works, and are based on the current value of zinc ore and the current cost of material and labour in England.

Watt's Process.

One of the first electrolytic attempts to deal with the zinc difficulty appears to have been made by Alexander Watt, and the experiments are of considerable interest. The process he employed consisted of dissolving out the zinc from the ore with dilute sulphuric and acetic acid, and depositing the zinc electrolytically from this mixed solution, using anodes of carbon. The ore was agitated with the leaching solution, and the liquid then allowed to stand until quite clear of sedimentary matter, whilst the stream of acid liquor from the tanks was turned into a second stirring vat, the operation requiring about 12 hours. The actual weight of zinc obtained, as compared with the theoretical, by this process is said to have been from 86 to 96 per cent. From 2 to 3 amperes per square foot was found to give a good deposit of zinc. This process was tried on some quantities of ore, but never came to any commercial result.

Diffenbach's Process.

A process patented by Prof. Diffenbach is now at work at Duisburg in Germany, where 600 H.P. is utilised in producing zinc. The ore used is a zinciferous iron pyrites, which contains 8 per cent. of zinc before roasting and 15 per cent. after. The ore is submitted to a chlorodising roasting, and is then leached with a zinc chloride solution, or with the effluent from the depositing vats. The solution of zinc obtained in this way is electrolysed in specially-designed vats. The author is informed that this plant is producing over 50 tons of zinc per month. Prof. Diffenbach has also devised an ingenious method of producing zinc from an alkaline solution of zinc and sulphate of soda.

Ashcroft's Process.

The original process of Mr. Ashcroft consisted of leaching out the zinc with a solution of ferric chloride and ferric sulphate, but these have since been abandoned for a zinc sulphate solution. The original process was very costly and complicated, and the works which were erected for the trial of the process on a large scale have been closed. A strong point claimed for this process is keeping the solution in a basic state, by the presence of oxy salts of zinc, which is alleged to prevent the formation of zinc sponge. The chief causes of failure appear to have been due to : (1) Inability to make the process truly cyclic, owing to the accumulation of manganese and gelatinous silica. (2) The complex nature of the process, which necessitates 13 separate operations. (3) The high voltage required, and consequently the large expenditure in fuel. (4) The indifferent zinc extraction and the troubles experienced from the accumulation of iron in the electrolyte.

The Siemens-Halske Process.

The Siemens-Halske process resembles the Ashcroft process in general principles, a solution of sulphuric acid or an acid zinc sulphate solution being used for leaching the crushed and roasted ore. The resultant zinc sulphate solution is electrolysed in vats divided into anode and cathode compartments by imperfect wooden partitions which act as substitutes for diaphragms. Lead anodes and zinc cathodes are used. When the free acid exceeds the desired percentage, the solution is returned to the leaching vats. Circulation is maintained by means of injector air jets. The process is much simpler than the Ashcroft process ; its chief weakness lies in the acidity of the electrolyte, which causes an increasing back electromotive force in the depositing vats. Difficulties have also been experienced in producing zinc free from sponge. It was estimated that a ton of zinc would be produced by this process for £3. 12s. : this estimate included a charge for labour, supervision, and fuel, but did not include the cost of the ore and the cost of extracting the sulphate of zinc from it. Messrs. Siemens and Halske have also proposed to leach the roasted ore with ferric sulphate, with the formation of a zinco-ferrous sulphate solution, which is electrolysed to deposit the zinc.

Hoepfner's Process.

Hoepfner has erected experimental works at Juhrfuhrt on the Lahn. A chloride solution is used as electrolyte, and for the recovery of the chlorine porous cells are arranged between the cathodes. He uses discoidal rotating cathodes made of zinc or iron partly immersed in the electrolyte. A high current density is used to ensure the chlorine being evolved at the anode, which would otherwise become diffused in the electrolyte and again combine with the zinc. A special triangular form of cell is provided for the circulation of the anolyte and catholyte, rubbing contacts being used to collect the current from the cathodes.

Mohr's Process.

Dr. Mohr has suggested fusing or boiling calcined sulphide ores with acid sodium sulphate ($NaHSO_4$) for the leaching out of the zinc, the proportion being 10cwt. to 15cwt. of sodium sulphate to the ton of ore. The process has been tried on a laboratory scale, it is said, with satisfactory results. The author has experimented with an acid sodium sulphate solution, and found it to offer no advantages over sulphuric acid leaching, the iron and manganese going readily into solution, and a gelatinous silica being formed which practically prohibits any filtration process being employed.

Swinburne's Process.

This process consists of stirring the crude ore into a bath of molten zinc chloride contained in a cauldron heated from beneath. A small quantity of molten lead in the bottom of the cauldron alloys with, and entirely removes, the silver and gold from the ore, dissolving a small portion of the lead as chloride in its place. The rich lead is then withdrawn, and the mixture of sulphides and chlorides of lead and zinc is subjected to the action of an electric current. The lead is first deposited as molten metal, and collects in the bottom of the cauldron. No chloride is given off from the fused mass, but sulphur in the form of vapour escapes. The action of the current is continued until all the lead chloride is decomposed and the zinc chloride begins to be acted upon. By interrupting the process at this stage the lead may be withdrawn. If electrolysis is continued further, the zinc is then deposited, also in a molten state, and collected in a similar manner. The gangue and decomposed matter, remaining after all the zinc sulphide has been decomposed by the electric current, is raked out ; and this residue is heated in a retort, which drives off the whole of the zinc chloride remaining, leaving nothing behind but worthless residue. The zinc chloride so distilled is allowed to run in a molten state back into the electrolysing cell. For convenience of working, the process is preferably divided into three operations. It is much cheaper to deposit lead electrolytically than it is to deposit zinc electrolytically ; therefore, should the composition of any class of ore render it desirable, it will be possible to stop the process short of the recovery of the zinc. The cost of operating the process in Australia, it is said, should not exceed 38s. per ton of ore for complete recovery of the lead and zinc, or 25s. per ton, omitting the recovery of zinc.

This process differs from others, inasmuch as it extracts the precious metals first, and then the lead, and finally the zinc. It directly splits sulphides into sulphur and metal without any intermediate oxidation of the ore. The electrolytic process applied to the recovery of lead is a comparatively simple matter, the same electrical energy required to deposit one ton of zinc being capable of depositing upwards of three tons of lead. Moreover, in electrolysing fused chlorides very high current densities are possible, so that the apparatus employed becomes small in comparison with that which is required for depositing metals in the wet way.

Ganelin has worked out a process which is based on the reaction, that when lead sulphide or galena is brought in contact with a molten mass of a halogen salt of such a metal as zinc or manganese, a double decomposition takes place, the lead of the galena combining with the halogen radical of the molten salt, the metal of the latter combining with the sulphur of the galena according to the following equations :—

$$PbS + ZnCl_2 = PbCl_2 + ZnS.$$
$$3\,PbS + Al_2Fl_6 = 3\,PbFl_2 + Al_2S_3.$$

* See *The Electrician*, Vol. XL., p. 416.

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Lorenz has also observed that silver chloride dissolves in zinc and lead chloride, and on subjecting the mixture to electrolysis the silver is deposited first. The addition of lead chloride to zinc chloride greatly increases the ease with which the fused salt is dehydrated by heat alone, and magnesium and cadmium chloride produce the same effect. When such mixtures of fused metallic chlorides are electrolysed, the metals are deposited one after the other, and can be obtained pure by fractional electrolysis. As a result of the experiments, Mr. Lorenz has worked out a practical method for winning zinc and lead from their ores.

A process has been patented in America for treating mixed ores containing lead and zinc. The ore is crushed, concentrated and dead roasted, and then agitated in a vessel containing 20 per cent. of caustic alkali, heated to 210°F., so as to dissolve the zinc and lead the iron, copper, and silver remaining intact. The solution is then conveyed to a series of electrolytic vats, the first of which are worked at a voltage of 1·8, which deposits the lead and not the zinc. The solution is then decomposed by a current of 2·1 volts, which brings down the zinc. In the lead depositing tanks carbon anodes are used, which are placed in cells of asbestos or earthenware containing a pure alkaline solution, so that the ore solution may not come in contact with them and thus produce lead peroxide.

(To be continued.)

PRESIDENTIAL ADDRESS TO THE INSTITUTION OF JUNIOR ENGINEERS.*

BY THE HON. CHARLES A. PARSONS, F.R.S.

The definition of the aims of the engineer, as formulated in the charter of 1828 to our parent society, the Institution of Civil Engineers, as "the art of directing the great sources of power in nature for the use and convenience of man," was at that date an accurate and concise description of those aims which are still ours to day and may be similarly described.

In the present state of our solar system there are three chief sources from which motive power may be obtained, though only one of the three has so far been used for practical purposes. Firstly, there is the energy of the tides produced by the energy of rotation of the earth under the attraction of the sun and moon: this energy is drawn almost entirely from the earth, whose speed of rotation is being gradually diminished, and the energy is expended in fluid friction and heating of the ocean; but the great cost of utilising some of this power by impounding the water has so far precluded its useful application. Secondly, there is the heat of the earth, whose temperature normally increases by about 1°F. for every 80 feet of depth below the surface, but in volcanic regions the heat is much more readily available. The great difficulty, however, to be met with is the low conductibility and specific heat of rock or molten lava. Thirdly, there is the group of sources primarily derived from the heat of the sun, which constitute at the present time practically all the available sources of power.

The vast mass of the sun, at an estimated temperature above 6,000°F., radiates light and heat in all directions into space. This great flow consists of transverse vibrations in the ether and takes place in straight lines: of the whole, only about one-two-thousand-millionth falls on the earth's surface. Of this quantity of heat received nearly the whole is radiated away again from the earth's surface into space, but, from it, in its course, we derive our motive power. The character of this flow of heat from a very hot source like the sun to a much cooler recipient like the earth, and its final rejection by the latter into space, is analogous to a waterfall from a high lake flowing to one of lower level, and is also analogous to the conditions under which all heat engines are placed, for were it possible to place a boiler at the sun, and lead a steam pipe to the earth, and condense in the ocean, we should have a steam engine without fuel; in fact, could we only cause some of the vast flow of heat to pass through a heat engine on the earth, we should secure a vast source of power; but this has not yet been done on a practical scale.

However, indirectly it produces some power in other ways. For instance, the atmosphere of the earth is unequally heated by the sun's rays causing convection currents, the chief sources of winds. The ocean is evaporated near the equator and the vapour condenses nearer the poles, causing rainfall, rivers, and water power. Again, some of the heat stream is caught by vegetation, in which it expends its energy by causing dissociation of the chemical constituents of the leaves and the carbonic acid gas drawn from the atmosphere, producing carbon and hydrocarbons, and setting free the oxygen, and so forming wood, coal, or fuel. When the fuel is burnt it unites with the oxygen of the air, giving out some of the heat that had been originally absorbed from the sun.

Perhaps, with the exception of petroleum, whose origin is not fully determined as to whether it is the product of the sun's heat on vegetation, or of the heat of the earth itself acting on carbonates in the presence of water, the heat of all fuel may be said to have been derived from the sun's radiant heat. It is a very remarkable fact, however, what an infinitesimal portion of the sun's heat which falls on the surface of the earth is converted into an available form from which may be derived mechanical energy, whether in the winds, waterfalls, or the production of fuel.

An engine may eventually be discovered that will be actuated directly by the rays of the sun, and should its principle of action be based on the second law of thermo-dynamics, its *modus operandi* will be the absorption of the heat from the sun in the day, the production of mechanical energy and the rejection of the residuum of heat to some equaliser or dissipater of heat, such as the ocean. Engines of this description have often been proposed, and, to enable us to realise that it is not very far removed from the region of practical possibilities, let us consider the experiment of a parabolic reflector of 24in. diameter placed in the sun on a bright summer's day. A thin piece of sheet iron placed in the focus is almost instantly melted, and if a toy steam engine be placed with the focus of the mirror on the boiler, it will raise steam in a few minutes, and enough steam will be generated to work it continuously. Even in this crude form the problem does not seem hopeless, but is rather a question of first cost and cost of maintenance.

Calculating from figures given by Prof. Ball, we find that on 1 sq. ft. of earth's surface in Egypt 150 cubic ft. of ice would be melted annually, which is equivalent to 1,278,000 thermal units, or equal to the production of 1,100lb. of steam at 250lb. pressure; on the assumption of 16lb. of steam per horse-power hour in a good condensing engine, it is equal to about 68 H.P. hours. All this work is done in daylight on an average of 12 hours per day, therefore 1 sq. ft. will provide 5·66 H.P. days, or 64·4 sq. ft. will provide on the average 1 H.P. for 12 working hours during the year. If we seek to concentrate the sun's heat on a boiler by a concave mirror, we find that, after allowing 50 per cent. for the losses in absorption in the atmosphere and reflection, a mirror 13ft. in diameter mounted like a heliostadt and reflecting the sun's heat on to a small boiler and working a condensing steam engine of the best make, the condenser being cooled by sea or lake water at 80°F., will produce 1 H.P.

But, again, the good steam engine which we have assumed as a practical example converts only about $\frac{1}{8}$th of the total heat given to the boiler into mechanical power. If, however, an engine were discovered to convert one-half the total heat received into mechanical work, a mirror of only 6ft. 6in. diameter would be required to produce 1 H.P. on the same basis, and it does not seem unreasonable to expect that such a motor may eventually be constructed.

All heat engines at present in use work under the second law of thermo-dynamics—that is to say, they take in heat from a source at a high temperature and discharge most of it at a lower temperature, the disappearance of heat in the process being the equivalent of work done by the engine.

The chief types of heat engine are:—

1. *Steam engines* of the turbine or reciprocating type, which under favourable conditions generate one effective horse-power hour with 1¼lb. of good coal, and whose complete weight with boiler in working order has been reduced to 20lb. per horse-power, and in some cases for flying machines to 8lb. per horse-power.

2. *Gas engines*, which in the larger sizes consume 1⅓lb. of anthracite coal or 17 cubic ft. of illuminating gas per effective horse-power hour.

3. *Oil engines*, which consume in some cases 0·82lb. of oil per effective horse-power hour, and whose weight for motor car propulsion has been reduced to 39½lb. per horse-power hour.

4. *Hot air engines*, consuming from 2lb. to 8lb. of coal per effective horse-power hour.

5. *Gunpowder engines* or cannon, consuming in moderate sizes 4·1lb. of cordite (having the same calorific value as 0·7lb. of coal) per horse-power hour in the shot, the weight of a 6in. quick-firing gun (without mounting) being 10lb. per average effective horse-power in the shot at six rounds per minute. In the Maxim gun the weight is about 1lb. per effective horse-power.

Primary batteries constitute a form of engine or producer of electrical energy that consumes fuel of a special kind, prepared in a form suitable for assimilation: they do not work under the second law of thermo-dynamics, and the efficiency is high, but the great cost of their special fuel has restricted their use to very small powers.

The earliest records of heat engines are found in the "Pneumatics" of Hero of Alexandria, about 200 B.C. He describes a reaction steam turbine, a spherical vessel mounted on axes supplied with steam through one of the trunnions from a boiler beneath, the steam, escaping through two nozzles diametrically opposite to each other and tangential to the sphere, causing the sphere to rotate by the reaction or momentum of the issuing steam, and analogous to a Barker's water-wheel. Thus, the first engine deriving its motive power from fuel was a crude form of steam turbine, and though it could have been applied to useful work, and could easily have been made sufficiently economical to replace manual and horse-power in many instances, yet it lay dormant till 1629 A.D., when Bianca

* Delivered Nov. 3, 1899. Abstract.

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suggested the same principle in a different form. Bianca's steam turbine consisted simply of a steam jet fed from a boiler impinging against vanes or paddles attached to the rim of a wheel which was blown round by the momentum of the steam issuing from the jet.

The piston engine is, however, of comparatively modern origin, and dates from about the year 1700 A.D. Engines of this class are so well known that it suffices to say that they have been practically the sole motive power engines from fuel in use from 1700 up to 1845, and have constituted one of the most important factors in the development of modern engineering enterprise.

Air engines were introduced about the year 1845, and although the larger engines of the Stirling type were very economical in fuel, yet, on account of the inherent difficulty of heating large volumes of air within metal chambers or pipes, a difficulty arising from the low conductibility of air, and consequently the overheating and burning of the metal, they have only come into commercial use for very small powers.

During the last 35 years gas engines have been perfected and more recently oil engines; and in point of efficiency both convert a somewhat larger percentage of the heat energy of the fuel into mechanical energy than the best steam engines. All successful oil and gas engines are at present internal combustion engines, the fuel being burnt in a gaseous form inside the working cylinder. Very numerous attempts have, however, been made to construct internal combustion engines to burn solid fuel instead of gas. Some have been so far successful as to work with good economy in fuel, but the bar to their commercial success has been the cutting of the cylinder and valves by fine particles of fuel. This difficulty is not present when the fuel is introduced in the gaseous or liquid form, and hence the success of gas and oil engines, but could this difficulty be overcome the solid fuel would be the cheaper to use.

Internal combustion engines, gas engines, oil engines, cannon, &c., owe their superior economy in fuel to the very high temperature at which the heat is transferred from the fuel to the working substance of the engine, and consequently the great range of temperature in the working substance of the engine. In steam engines the temperature is limited by the practical difficulties of deterioration of metal and material involved in the construction. However, though this is the state of the case at the high end of the temperature range, in the engines we are considering the case is different at the lower end of the temperature range. In all the internal combustion engines mentioned the consumed gases are rejected at a comparatively high temperature, while in the condensing steam engine the heat is rejected to the condenser at a comparatively low temperature. Internal combustion engines may be said to work between limits of temperature high up on the temperature scale and farther removed from the absolute zero, while the steam engine works between temperatures lower down on the temperature scale and nearer the absolute zero. As it is the ratio of the heights of the higher to the lower limits of temperature from the absolute zero of temperature that broadly speaking measures the economy of the engine, it follows that the internal combustion engine has the advantage at the high end, while the steam engine has the advantage at the low end, and as we shall endeavour to show, steam engines of the turbine class have advantages over the piston engines in permitting a larger extension of the temperature range at the low end.

About 15 years ago I was led by circumstances to investigate the subject of improving the steam turbine. In recent times several attempts had been made to apply steam turbine wheels of the Hero and Bianca types to the driving of circular saws and fans. The velocity of rotation with either of these types must necessarily be very high in order to obtain a reasonable efficiency from the steam—a velocity much in excess of that suitable for the direct driving of almost all classes of machinery. Gearing was considered objectionable, and it therefore appeared desirable to adopt some form of turbine in which the steam should be gradually expanded in small steps or drops in pressure, so as to keep the velocity of flow sufficiently low to allow of a comparatively moderate speed of rotation of the turbine engine. The method adopted was to gather a number of turbines of the parallel flow type on to one shaft and contained in one case, the turbines each consisting of a ring of guide and a ring of moving blades, the successive rings of blades or turbines being graduated in size, those nearer the exhaust end being larger than those near the steam inlet, so as to allow a gradual expansion of the steam during its passage through the turbines.

The form of the turbine was that of a rotating drum with outwardly projecting rings of blades which nearly touched the containing cylindrical case, and on the case inwardly projecting rings of guide blades which nearly touched the drum. In the first examples of the engine there were two groups of turbines right and left-handed on each side of the steam inlet, the exhaust taking place at each end of the turbine case so as to completely balance end pressure from the steam. More recently one series of turbines only has been used, those on the other side of the steam inlet being replaced by packing rings or rotating balance pistons which balance the end pressure and divert the whole of the steam through the turbines on the other side. The steam entering the annular space between the shaft and the case, passes firstly through a ring of guide blades attached to the case and is given a rotational direction of flow: it then passes to the succeeding ring of blades attached to the shaft, by which its direction of rotation is reversed, thereby impressing the difference of its rotational momentum in torque to the shaft. The steam then passes to the second ring of guide blades and the process is repeated, and so on, gradually expanding by small increments at each ring of blades: the succeeding rings of blades get longer and wider, and at intervals the diameter of the turbine drums, cylinders, and rings are also increased. In condensing turbine engines of the larger size an expansion ratio in the turbines of 100-fold and upwards is attained before the steam passes to the exhaust pipe and condenser.

The loss of power present in engines of the piston class, due to cylinder condensation arising from the variation of steam pressure in the cylinder, is not present in the steam turbine, as the steam pressure remains constant at each turbine ring and each part of the cylinder and barrel; and the numerous tests of steam consumption that have been made have shown that compound steam turbine engines of moderate sizes when working with a condenser are comparable in steam consumption per effective horse-power with the best compound or triple condensing steam engines of the piston type. They have been constructed in sizes up to about 1,000 H.P. for driving alternators and dynamos, and several sets of about 2,000 H P. are nearing completion. They are in use at the Newcastle, Cambridge, Scarborough, London Metropolitan, and other stations. Recently steam turbines have been successfully applied to driving centrifugal and screw fans and pumps, and as an instance of endurance, one turbo screw fan for induced draught of about 60 H.P. has been at work continuously day and night for the last three years, with the exception of Christmas and midsummer holidays.

There is no remarkable feature to note about centrifugal fans and pumps worked from steam turbines, excepting that in the case of pumps it has been found that with a slight modification of proportions lifts up to 200ft. can be dealt with in a single pump with the same efficiency of pump as in the case of ordinary centrifugal pumps at moderate lifts. But the screw fans and pumps have some features of novelty which it may be interesting to mention. The runner or screw which drives the air or water is similar to a ship's propeller, and is placed in a double truncated conical pipe at the narrowest part between a trumpet-mouthed converging entry and a gently-diverging conical exit. By this means the air or water is gently accelerated up to a suitable velocity at the propeller, and by the diverging cone the velocity is gradually checked, and the energy converted into available pressure to overcome the head against which the fan or pump has to work. Under most conditions the efficiency is found to be almost equal to that of the centrifugal fan with spiral case and superior to the ordinary centrifugal open fans without casing, while the volume of air or water passed is much greater in proportion to the size. These results might naturally be expected, for on consideration it will be seen that the only losses are those due to friction in the conical pipes and the ordinary losses of screw propellers.

In conclusion, it may be remarked that in the history of engineering progress the laws of natural selection generally operate in favour of those methods which are characterised by the greater simplicity and greater efficiency, whether these advantages be great or small.

THE POST OFFICE AND THE NATIONAL TELEPHONE CO.

The following circular letter has been sent to the clerks of all the Vestries and District Boards in the county of London:—

General Post Office, London, October 31, 1899.

SIR: The Postmaster-General, having been informed that the National Telephone Co. is negotiating with the Vestries and District Boards of the county of London with reference to the laying of telephone pipes and wires under the streets of London, thinks it desirable to make, for the information and use of road authorities, a short statement of the law governing the use of streets for such a purpose. The National Telephone Co., save when it is endowed by the Postmaster-General with authority to exercise certain powers of construction conferred by the Telegraph Acts, has no power, either with or without the consent of the road authority, to take up streets. It possesses no statutory powers, and as to the disturbance of a street without such powers, reference may be made to the similar cases of Reg. *v.* the United Kingdom Electric Telegraph Co. (Limited), 2 F. and F. 73; 26 J. P. 324; and Reg. *v.* Train, 31 L. J. M.C. 169.

By the Telegraph Act, 1892, section 5, the Postmaster-General is empowered to authorise any company or person licensed to transmit telegrams, to exercise the powers which are conferred on the Postmaster-General himself by the Telegraph Acts, 1853 and 1878, and by certain provisions of the Telegraph Act, 1892. The exercise of such powers is, however, limited by the following restrictions:—

"(*a.*) A licensee shall not exercise any powers under the said enactments except in an urban sanitary district or such area adjoining an urban sanitary district as is described in the licence;

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"(*b*.) Notwithstanding anything in the Telegraph Act, 1878, a licensee shall not exercise any powers under the said enactments without the consent in London of the County Council, and in any urban sanitary district outside London of the urban sanitary authority, and elsewhere of the County Council, and shall be subject to any terms and conditions which the County Council or urban sanitary authority may attach to any such consent, and shall comply with any regulations of such council or authority from time to time in force in relation to telegraphic lines. (Telegraph Act, 1892, sec. 5 (2))."

By the agreement for the purchase of the company's trunk lines, dated March 25, 1896, the Postmaster-General agreed to give the company from time to time such authority as is contemplated by the enactment just quoted, with reference to any exchange area which the company might specify. This undertaking was qualified by certain provisoes, which it is not necessary to quote. No authority has at present been conferred by the Postmaster-General upon the company to exercise powers of constructing telegraphs in any part of the county of London.

Until the company—

(*a*) is endowed with the authority of the Postmaster-General, and

(*b*) has obtained the consent of the London County Council to the exercise of the powers conferred by the Postmaster-General's authority,

it commits a nuisance, and is liable to legal proceedings, if it disturbs any street in London, even though it should have come to an arrangement with the road authority on the subject.

I am, sir, your obedient servant,
G. H. MURRAY, Secretary.

[Reference is made to this circular in our "Notes" column.]

CORRESPONDENCE.

HIGH-PRESSURE LOW CANDLE POWER LAMPS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Many central station engineers who have had any extended experience of electricity supply at 230 volts or thereabouts will no doubt endorse the view expressed in your last issue in commenting on Prof. Fleming's report to the Town Council of Douglas. I for one quite agree with your views that the 8-c.p. lamp is as good a commercial article, as regards efficiency, life, &c., as a 16 or higher candle-power.

For 12 months I have had in my own house three 6-c.p. lamps in one fitting, which have been burning about 400 hours, and they are in good condition at the present time and have been satisfactory in every way. I have also got one or two 6-c.p. lamps in single fittings, which have been burning a longer number of hours, but not any of these have been renewed. In Bradford we have one large hotel and several small shops using a total of 800 8-c.p. lamps, and we have not had a single complaint since July, 1897, when the higher pressure was adopted throughout the town.

There is no necessity to go into the laboratory side of the question regarding the exact efficiency of low candle-power lamps, but I may say that, owing to our free supply of incandescent lamps for renewals, which amounted to over 9,000 last year, we have been led to look carefully into the respective merits of almost every incandescent lamp which is imported into this country. We have tested about 30 different makes, both for life, uniformity of candle-power, and efficiency, and there can be no question that at the present time the majority of manufacturers make equally as good if not better 200–230 volt lamps for all candle-powers than was the case when 110–115 volts was the standard voltage.—Yours, &c.,

Bradford, Nov. 4. ALFRED H. GIBBINGS.

MAGNETIC DECOHERER.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: On page 521 of the August number of *Science Abstracts** I see that Mr. T. Tommasina has discovered a magnetic coherer, and from the wording of the notice one may well be excused for presuming that gentleman to be the original discoverer. May I therefore ask you to do me the favour to publish the following abstract from a letter written by me in October last year to a well-known electrician, who up to the present has not acknowledged its receipt? Writing on wireless telegraphy, and particularly of a plan for improving the coherer, I said: "Instead of the vibrator I use, above the coherer, a single-coil electro-magnet (see sketch), and with the nickel and silver filings I mix a small proportion of iron filings, and find that the slight movement of these among the nickel, &c., is sufficient to produce the desired effect."—Yours, &c., H. B. GREENWOOD.

Buenos Ayres, Oct. 13.

[* See also *The Electrician* of June 2, 1899, p. 183.—ED. *E.*]

THE HARROGATE ELECTRICITY WORKS ACCOUNTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: With reference to your analysis of the Harrogate electrical works accounts appearing in your issue of October 20th last, you state that the capital outlay amounts to £141 per kilowatt capacity, also that the capacity of the plant is 275 kilowatts. I beg to inform you that the capacity of the plant at the date named—viz., March 25, 1899—was 575 kilowatts, which makes the capital outlay at the rate of £67 per kilowatt, which is less than half as stated by you, and compares very favourably with other visiting resorts, as the following table will show:—

	Capital outlay
Hastings	£137
Eastbourne	133
Bournemouth	165
Southport	115
Cheltenham	140
Blackpool	74
Harrogate	67

With reference to the deficit which, as shown, amounted to £1,523 on December 31, 1897, your table for 1899 sets forth that this sum is increased to £2,251 at the end of March, 1899, but you take no cognisance of the fact that at that date there remained owing to the Corporation, for current supplied during the quarter ending March, 1899, the sum of £1,506. 14s. 10d. Thus at that date the previous year's deficit of £1,523 has been very considerably reduced.

As showing the increase of the amount of business, I may say that the revenue for the quarter ending March 25, 1898, amounted to £998. 17s. 2d., and the revenue ending March, 1899, for the quarter amounted to £1,506. 14s. 10d.

I shall be glad if you will correct these points in your next issue.—Yours, &c., GEO. WILKINSON.

Harrogate, Oct. 31.

[The figure 275 kilowatts was supplied to us by Mr. Wilkinson himself, either when he sent us the accounts to March, 1899, or shortly after. No item for a sum owing to the Corporation, for current supplied during the last quarter, appeared on the copy of accounts sent to us.—ED. *E.*]

LEGAL INTELLIGENCE.

The Electric Construction Co. (Limited) v. The Imperial Tramways Co. (Limited) and the British Thomson-Houston Co. (Limited) (third parties).

This case commenced, before Mr. Justice Cozens-Hardy in the Chancery Division, on Wednesday, and was an action for an injunction to restrain defendants from infringing letters patent No. 9,527, Jan. 10, 1885, granted to Thos. John Handford, of which plaintiffs were the holders. The infringement complained of was the use of electric motors supplied by the defendants on the Middlesbrough, Stockton, and Thornaby Tramways. The British Thomson Houston Co. were added as third parties, but were treated as defendants. The patent sued upon having expired, the plaintiffs asked for damages in lieu of the injunction they claimed in their writ.

The following is the complete specification of the patent (No. 9527/85) alleged to be infringed. As no question of "disconformity" has been raised, it is unnecessary to quote the provisional specification. The patent is communicated from abroad by Frank Julian Sprague, of New York, T. J. Handford being the agent in this country:—

IMPROVEMENTS IN MOTORS FOR ELECTRIC RAILWAYS.

This invention relates to electric motors mounted upon railway cars or carriages for the purpose of propelling the same, and its object is to so arrange and support the motor that the relative positions of its armature and field magnet will not be changed, and the mechanical connections between the armature and the driving axle will not be disturbed by any movement of the car body or carriage body on its springs, while at the same time the driving axle is relieved of dead weight.

In accomplishing these objects, the yoke or back piece of the field magnet of the motor is hung from a cross-piece of the truck of the car or carriage by heavy springs; or from the car body itself in case of a street car or other vehicle having no truck. The driving

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axle of the car or carriage at its middle portion is enclosed in journals situated between collars on the axle, and these journals are held by clamping parts joined together on one side of the axle by a plate to which they are bolted, and on the other side bolted to parts extending from the pole pieces of the magnet. The clamping pieces are of non-magnetic metal. The field magnet is thus sleeved or centred upon the axle. The bearings of the armature shaft are carried directly upon the field magnet pole pieces, being supported by arms attached to the journal boxes and to the said pole pieces.

Upon the inner side of each of the driving wheels is either a toothed wheel or a friction wheel; or these may be secured directly to the driving axle. Upon each end of the armature shaft is a toothed wheel or a friction wheel, and these engage respectively with the toothed or friction surfaces of the driving wheels to propel the car or carriage when the armature revolves.

In order to relieve the driving axle of the dead weight of the motor centred upon it, supporting springs are employed which are connected with the sleeve centreing the motor upon the axle or with the polar extensions of the field magnet, or at any other suitable point. These springs extend to cross bars upon the truck frame, or to the car body if there is no truck. Their tension is adjusted by nuts locked by other nuts. This adjustment may be such as to carry wholly or partly the weight of this end of the motor, or so as to actually exert a pressure upon the lower side of the driving axle. By this arrangement the hammering effect which would result from supporting the motor directly upon the axle is reduced to the minimum.

Means are provided for adjusting the contact of the friction or toothed surfaces. A screw passes through the plate which unites the clamping parts of the journals and sets against another plate situated in contact with the journal boxes in such a manner that when the screw is turned, as the latter plate cannot move, the former plate, the clamping parts and the field magnet and armature are drawn in one direction or the other, and the gears are thus adjusted.

The armature being carried rigidly by the field magnet, these two parts must always maintain precisely the same relative position under every vertical or lateral movement of the wheels or of the car body or carriage body, and as the field magnet which carries the armature is itself centred by the axle of the wheels to which the armature shaft is geared the engaging gears also must always maintain precisely the same relative position except when purposely adjusted as before explained. Other forms of gearing, as belts or friction clutches, may in some cases be employed, as the relative position of axle and armature is always the same.

It is to be understood that with a carriage employing trucks, the carriage body is supported upon the said trucks by springs in the usual manner. And in order that the said invention may be perfectly understood, I shall now proceed more particularly to describe the same, and for that purpose shall refer to the several figures on the accompanying sheet of drawings, the same letters of reference indicating corresponding parts in all the figures.

Fig. 1 of the accompanying drawings represents a plan of an electric railway motor embodying the said invention and employing a toothed gearing between the armature and driving wheels. Fig. 2 is a section of the truck with the electric motor in elevation. Fig. 3 is a view similar to Fig. 1 of a motor employing a friction gearing; and Fig. 4 a view similar to Fig. 2 of this motor.*

Referring first to Figs. 1 and 2 A is the frame of the truck of a railway carriage and B B and B' B' are the wheels of the same. The truck body is supported from the axles C C' through springs in any usual manner. D is the field magnet of an electro-dynamic motor and E the armature thereof. The yoke or back piece *a* of the field magnet is hung from a cross piece F of the truck by heavy springs *b b* or from the car body itself in case of a street car or other vehicle having no truck.

The driving axle C at its middle portion is enclosed in journals *c c* situated between collars *d d* on the axle, and these journals are held by clamping parts *e e* joined together on one side of the axle by a plate *f*, to which they are bolted, and on the other side bolted to extended parts *g g* from the pole pieces *h h* of the field magnet. The clamping pieces *e e* are of non-magnetic metal. The bearings *i i* of the armature shaft are carried directly upon the field magnet pole pieces, being supported by arms *k k* attached to the journal boxes and the said pole pieces.

Upon the inner side of each of the driving wheels is a toothed wheel *l*, which may be made in one piece with the wheel, but is preferably made itself in two parts bolted or otherwise removably attached to the wheel, or whether made in one or two parts, if may be secured directly to the driving axle. Upon each end of the armature shaft is a toothed wheel *m*, and these engage respectively with the toothed surfaces of the driving wheels and thus communicate motion to the said wheels to propel the car or carriage when the armature is revolved.

The armature being carried rigidly by the field magnet, these two parts must always maintain precisely the same relative position under every vertical or lateral movement of the wheels or of the car body or carriage body; and as the field magnet which carries the armature is itself centred by the axle of the wheels to which the armature shaft is geared, the engaging gears also must always maintain precisely the same relative position. At the same time the connection of the entire motor with the

Fig 1

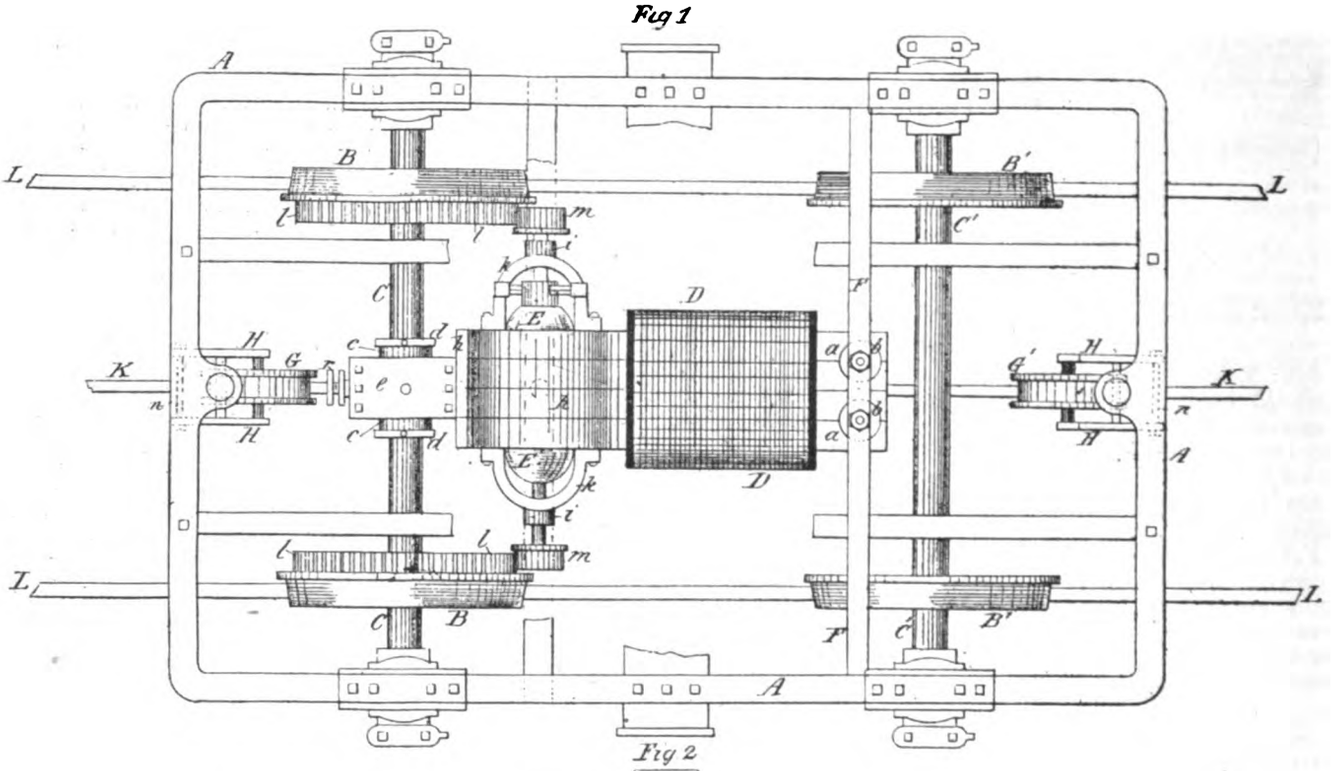
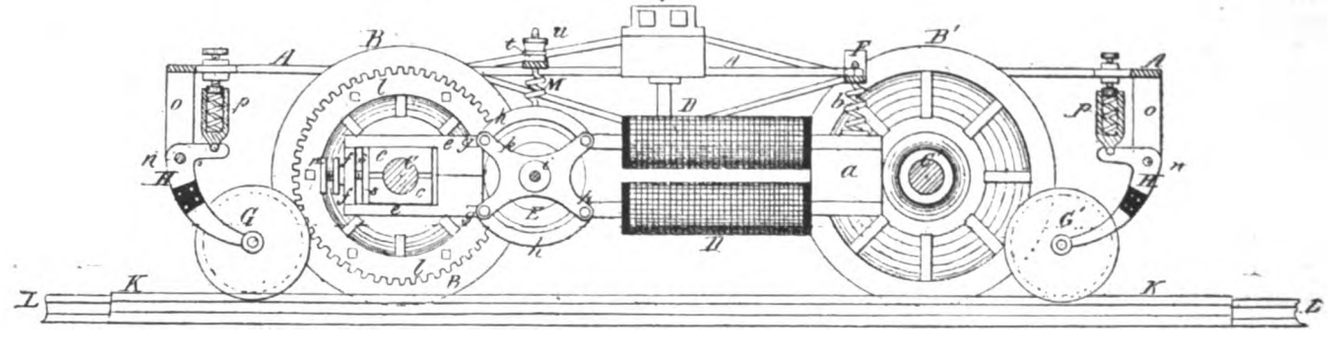


Fig 2



* We have omitted Figs. 3 and 4, as they are similar to Figs. 1 and 2, except in so far as friction gearing replaces toothed gearing.

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truck is through springs, so that its position is not affected by the movements of the truck on its springs.

G and G¹ are contact rollers running on the intermediate rail K. Each contact roller has bearings between the ends of curved arms H H, pivoted at *n* between supports *o* extending down from the car or carriage, and having a spring *p* attached to the other end connecting it with the car body or carriage body whereby the roller is constantly maintained in good contact with the intermediate rail K which forms one side of the supplying circuit. The other side of the circuit is formed by the working rails L L and the ground

In the form shown in Figs. 3 and 4, friction gears are used between the armature and driving wheels instead of toothed wheels as before. I I are friction surfaces attached to the driving wheels or the driving axle, and J J are friction wheels engaging therewith on the armature shaft. Means are provided for adjusting the contact of the friction surfaces. A screw *r* passes through the plate *f*, and sets against a plate *s* situated in contact with the journal-boxes in such a manner that when the screw is turned, as the plate *s* cannot move, the plate *f*, clamping parts *e e* and the field magnet and armature are drawn in one direction or the other and the friction gearing thus adjusted.

A similar device is shown in Figs. 1 and 2 for adjusting the toothed gearing if necessary. It is evident that any other form of gearing may be employed, as belts or friction clutches, since the relative position of the axle and armature shaft never changes except when purposely adjusted.

Means are provided for relieving the driving axle of the car or carriage of the dead weight of the motor, at the same time that the motor is centred upon such axle. In order to accomplish this, supporting springs M are employed which may be connected with the sleeve centring the motor upon the axle or (as shown in the drawings) with the polar extensions of the field magnet of the motor or at any other suitable point. These springs extend to cross bars on the truck frame or to the car body in case no truck is used. Their tension is adjusted by nuts *t* which are locked by other nuts *u*. This adjustment may be such as to carry wholly or partly the weight of this end of the motor, or so as to actually exert a pressure upon the lower side of the driving axle. By this means the hammering effect which would result from supporting the motor directly upon the axle will be reduced to the minimum.

The claims are :—

1. The motor of an electric railway car or carriage having its field magnet centred or sleeved upon a driving axle, its armature supported directly upon the said field magnet, and having a shaft separate from the driving axle and gearing communicating motion from the armature shaft to the driving axle, substantially as hereinbefore described.

2. The motor of an electric railway car or carriage supported partly or wholly by springs from the car body, carriage body or truck, and having its field magnet centred or sleeved upon a driving axle, its armature supported directly upon the said field magnet, and having a shaft separate from the driving axle and gearing communicating motion from the armature shaft to the driving axle, substantially as hereinbefore described.

3. The motor of an electric railway car or carriage centred upon the driving axle at one end and having spring supports at the other end.

Mr. Fletcher Moulton, Q.C., M.P., Mr. Bousfield, Q.C., and Mr. Gray appeared for the plaintiffs ; and Mr. Cripps, Q.C., Mr. Astbury, Q.C., and Mr. A. J. Walter for the defendants and third parties.

Mr. MOULTON said Handford's patent related to dynamos or motors mounted on cars or carriages for the purpose of propelling them. The invention was for a special way of mounting electric motors so as to obviate very great inconvenience which would otherwise be met with in connection with their use. In the pleaded defences to the action there was a denial of infringement and an allegation that plaintiff's patent was invalid.

Mr. ASTBURY said that invalidity of the patent was the substantial defence.

Mr. MOULTON said the objections to plaintiff's patent were, he believed, as wide as usual, but the defendants did not allege disconformity. Defendants further alleged that plaintiff's invention was not new, and that it formed the subject matter of a prior grant, which was in the Patent Office but not published. There had never been a decision on this point, but those who were responsible for the defence said it was a good one. The third paragraph of the defence raised the question in another form, and it said that the man who applied for, but whose patent was not published, was the true inventor. The defendants further said it was not subject matter for letters patent.

His LORDSHIP : Is that under a separate head, or merely formal ?

Mr. ASTBURY : We say there was no subject matter in this invention. It is therefore important.

Mr. MOULTON : The subject of Handford's invention was the mounting of electric motors on electric cars. The electric cars were driven either by a current which came from batteries situated on the car or by currents communicated from fixed conductors to the cars. The current had to pass round the dynamo in the car, and then it was made to revolve at a great number of revolutions per minute, and the power had to be communicated to the wheels, which was the driving power, and the consequence was that it had to be communicated by gearing straps, or something of that kind, so as to drive round the axle of the wheel. A dynamo was always very massive, heavy and bulky, and it had to revolve with great accuracy. In the first place, it was necessary to have the dynamo which acted as a motor so mounted that disturbance did not throw it out of gear. The method of fixing the dynamo to the car invented by Mr. Handford had, counsel believed, been universally adopted in electric traction for getting over the difficulties he had mentioned. Mr. Handford fixed his motor by having it sleeved on the driving shaft and its armature worked in a parallel shaft. If a jolt came to the driving wheel, it did not give a jolt to the whole motor, which relieved itself by a slight rotation. If the motor was balanced on the axle, a blow would be communicated to the whole motor. The rotation of the motor caused by the jolt was partly checked by means of springs which held the motor at one end ; and another function of the springs was to prevent the serious jolt of the car. His learned friends said that was not subject matter for letters patent. The learned counsel then read the complete specification of Handford's patent (which is set out above), and referred to the claims therein made. The learned counsel said that the utility of the invention could not be denied, and he did not think it could be denied that there had been infringement.

Mr. DUGALD CLARK said he had examined and made himself acquainted with the plaintiff's specifications and the alleged anticipations. He had also been shown drawings of the alleged infringements. What the inventor of the patent in question did was to arrange his electric motor so that it should remain in gear with the driving wheel. He also desired to so arrange his motor that it was not exposed to rude shocks. Those objects were accomplished by the inventor. The object sought to be attained in the attachment would not be the same whether the motor was electric or steam. In the steam motor the problem was a very different one, and the connection of the motor to the axle, to be worked successfully, required very different conditions altogether. It was necessary that the driving wheel should remain in gear and the motor should not be exposed to road shocks, and it was necessary in every case to suspend the motor so that it should remain in gear. It was steam power that was dealt with at a very early date, but the first attempts were failures. Roughly speaking, the same objects had to be attained with either steam or electric power, but the great liability was as to shock, and so far as that was concerned most of the locomotives were not free from shock. Undoubtedly an object was to reduce shocks. He (Mr. Clark) did not know that the supporting spring was an essential method of the plaintiff's, but some method of spring was essential. The object of the spring between the field magnet and the body of the car was to suspend the end of the motor in such a way that the truck could move without moving the motor appreciably. He called them springs of suspension. It was a novelty at the time to have a motor centred or sleeved upon the driving axle. He believed it was not novel to have an armature supported on a field magnet. In an electric motor he believed it was novel to have a shaft supported from the driving axle ; he could not call to mind any electric motors that had it. In steam motors there was such a thing. There must always be the gearing communicating motion from the armature to the driving wheel. Except as regards the spring, they had had all the other elements of plaintiff's claim—but not in combination with a motor ; and the relieving of the axle of dead-weight indicated what the inventor was trying to do—that was, the avoiding of shock, which was shown by the springs making the motor one-sided. He had seen an extract from the "Official Gazette of the United States of America Patent Office," dated June 30, 1885, and it showed the plan of what was now being claimed, but he found no description, and without that it would be unintelligible. Knowing it now, he could recognise it, but as the plan stood it would leave the whole thing for invention, because, although shown sleeved at one end of the driving axle and with the other end attached in some way to the frame, there was nothing to show that there was not a rigid frame ; and in that case there was no invention whatever. There was no sign of elastic attachment, which he (witness) took to be the whole essence of the invention : there must be an elastic attachment of some kind equivalent to a spring. With reference to Reckenzaun's electric motor, which he said was not centred on the driving axle, it was bolted to the frame, and the invention which it was the object of the plaintiff to make was not present. There was no centring in the sense of the word as used in plaintiff's specification. Eliminating the spring element, they had in Reckenzaun's a frame which was not sleeved to the axle, but the same as if they had the truck made without springs and the motor fixed to the frame. So far as the field magnet was concerned, it was all one rigid mass. With regard to Finney's electrical invention, the frame of that motor was attached to the driving axle ; it was not sleeved on the axle in the sense in which the word sleeved was used : there must be some elasticity of movement, otherwise there was no sense in the word, and therefore in the plaintiff's case it must imply springs or spring connection. In Adams's invention the action was altogether different ; and it showed he had no idea of avoiding shock, the armature being in the very position where it would receive the worst usage. Adams missed the object of plaintiff's invention by his concentric and equal arrangement. The same spring attachment was found as in plaintiff's, but there was nothing in that, because it must be attached in a certain way to do certain things. One of the objects—he would not say the main object—of plaintiff's invention was to attach the field magnet in such a way that it would always occupy the same relative position to the wheels and armature, and not be disturbed by the spring connection between the body of the car and the wheel, and to do that in such a way as to avoid shock. Adams's invention had actually been used in the United States, but it was not successful in avoiding shock. It was quite obvious it would not do so. Having referred to the Jenson (Edison) invention, Hermann's, Benn's, Pyott's, Garland's, Longstaff and Pullen's, and Cryder's, witness said in the case of Hermann's steam road waggon the motor for the driving power was sleeved or centred on the driving axle along with the boiler and all the other parts, and the arrangement was such that working on a rough road all the teeth of the gear wheels would be broken off. He quite admitted that the theory in this case was the same as plaintiff's, but it was applied in an utterly impossible way. The specifications to which his attention had just been called came the nearest to plaintiff's so far as the other elements of the invention outside the spring connection was concerned. In that of Longstaff and Pullen all the weight was concentrated over the driving wheel, and although there was a spring at one end, it would not produce the effect produced by plaintiff's spring, for the same reason as Adams's arrangement did not. In his opinion the plaintiff's invention was a practical one for getting over defects in mounting electric motors. The problem of getting over these practical defects was not the same as in electric motors. A steam motor was one in which the parts all remained in the same position relatively to one another. In electric motors there was rotation round the axis.

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Mr. MOULTON: Does it follow that a successful method of supporting steam motors would be a successful one for supporting electric motors?—No.

You have had several specifications referring to steam motors put to you. Have these all been failures?—Yes, to the best of my knowledge.

They do not show the systems which have been adopted for suspending steam motors?—Not one of them.

To the best of your belief, did any one of these specifications become common knowledge or come into common use?—No; not one.

Are they quite different from the plaintiff's specification?—Yes.

Mr. JAS. SWINBURNE said he had studied carefully the plaintiff's specification. In his opinion it clearly described the invention which the previous witness had referred to in his evidence. The invention was a useful one. He had given a considerable amount of attention to electricity and electric motors. In his opinion the plaintiff's invention proved of exceptional utility in connection with electric traction. It was enormously used. The problem solved by Handford was so arranging a motor that it got a minimum of shock and a minimum of communicated motion, and that was most desirable for the motors in use in the year 1885. The invention of Handford consisted of a combination, and although sleeving a body on an axle was known and springs were also known at the date of the patent, the combination was new. There was nothing in the drawings which had been put in to teach him the plaintiff's invention. He did not think that the public could have learned the plaintiff's invention from those drawings. In Reckenzaun the motor was not in any sense sleeved on the driving axle. In Finney the motor was rigidly fixed to the frame. There did not appear to be any springs in the whole affair. It could not be said that that was the plaintiff's method of suspension at all. In Adams the motor was put right on the top of the axle, on the centre of the axle, so that all the shocks were communicated to every part of the motor. The springs there used were not in any sense the springs used by Handford. Springs would be practically essential for electric motors on tramcars. The spring which was the essence of plaintiff's specification was not indicated by Reckenzaun.

Lord KELVIN was then examined by Mr. Bousfield. You have, I think, given a good many years of your life to electrical problems of one sort or another? Let me ask you, first of all: Suppose in 1885, the date of this specification, you had your mind directed to the question of how best to attach a motor to a thing like a tramcar with a body connected by springs to the wheels; was there anything in common knowledge at that time, with reference to steam engines and other kinds of motors, which would have helped you to a solution of the difficulties of that problem?—No.

Then, taking these specifications—which I do not think it is suggested were part of common knowledge—taking the specifications with reference to these devices relating to steam engines, do you think it would have helped you to a solution of this problem as to how to attach an electric motor most advantageously to a thing like a tramcar, with a body supported by springs on wheels?—No; I do not think so.

Can you point out, Lord Kelvin, any difference between Finney's method and a method such as I have described?—In Finney's method there are no springs.

Can you see any one of these specifications which is like the plaintiff's?—No.

Cross-examined by Mr. Cripps: I understand the point of difference you refer to is that you do not find the springs in these other cases which have been put to you?—That is one essential difference.

And you look on the spring as an essential feature of the plaintiff's invention?—Yes; without springs it would be the play of Hamlet with the part of Hamlet left out.

Mr. JOHN ALEX. H. BLACKBURN, manager of the plaintiff company, said he had had a very large experience in the working of electric motor traction, and for the last four or five years had been more or less engaged in investigating as to the different types of motors which have been in use from time to time.

The witness was not further examined.

Mr. BOUSFIELD then addressed his lordship. He said he thought the problem before this inventor was a fairly clear one: he came in at a time when it was thought that electricity could be usefully applied to tramcars, and the problem was how to avoid shock. Plaintiff's method had been the only successful one, and it had been universally adopted.

Mr. CRIPPS opened the case for the defence. His first point was that the matter was one of fine construction and nothing else, and the question was whether in claim 1 the inventor had not disclaimed—to use a common expression—the spring element in the invention. He argued on the evidence so far before the court that the spring element was an essential element of plaintiff's invention, because in the body of the patent one saw constant reference to the word spring; but when they came to the end there were found three claims all based on the spring element, and in claim 1 not so; yet the court was asked to read the spring element into claim 1, from which he (counsel) contended it was specifically eliminated. Mr. Cripps, apart from the question of construction, contended that the four elements, other than the spring element, which plaintiffs claimed, had been anticipated in specifications to which the attention of the court had been called; and he further argued that in certain of these specifications there was the equivalent of plaintiff's spring attachment.

Mr. JOHN IMRAY, C.E., said he had considered the plaintiff's specification, and also the various specifications which had been referred to by way of anticipation. With regard to plaintiff's specification, in other forms of gearing, such as bolts or friction clutches, there would be no necessity at all for springs. The mechanical object of springs was to take off shocks, and that was a matter well known in mechanics long before the date of plaintiff's invention.

What were the understood means of avoiding shock?—Usually buffers, strong things which would take off the blow. Springs were perfectly well known for that purpose. In his opinion there was no difference, except in detail, between the way in which Reckenzaun supported his motor and that of the plaintiff: taking away the right-hand spring and leaving the left-hand spring, the two methods were precisely the same. With the exception of the spring attachment, he found all the elements of plaintiff's invention present in Finney's specification and performing the same functions.

If anybody were told to make a motor as shown in the United States Official Gazette, and supply the commonest form of part to avoid vibration, what would he do?—He would put springs to where the motor is attached to the truck. It was a usual thing at that date to put springs to support the carriage.

Supposing the field-magnet is hung from the car body itself, instead of being hung to the cross-piece, what would be the effect of the springs of the car body upon the magnet, having regard to the fact that it was sleeved at the other end?—If you put the car body on springs, there would be no need for springs to hang the car motor. Comparing Hermant's with claim 3 of plaintiff's specification, witness considered the former was designed to solve the same problem as plaintiff's. The one essential of the plaintiff's, where he had tooth-gearing, was that the two shafts (the armature shaft and the main driving shaft) must always be kept a constant grading distance; and that was provided for in Hermant's.

Cross-examined by Mr. FLETCHER MOULTON: He certainly did suggest that Reckenzaun's was a case of sleeving, if you took out the springs.

Mr. FLETCHER MOULTON: I was speaking of it with springs, and I put it to you that no mechanician would ever describe that as sleeved.—He might not say "sleeved"; he might say centred.

His LORDSHIP: Centred or sleeved, do they mean the same thing?—It depends entirely on how the portions come into play.

Mr. MOULTON: Sleeving is a mode of centring?—Yes.

The effect in producing swivelling is the same?—Yes.

In further cross-examination, witness said there were no springs shown at all. As regards Sprague's (U.S.A. Official Gazette), supposing there was a rigid attachment to the car body by two links instead of springs at the other end, and the car body rocked, there would be a twisting action; and if there were two springs the movement of the car—supposing they had springs for the other end and the car body was on springs—the movement of the car body rocking would compel the motor to go askew. Pyott had no springs on his front or hind axle, but he put springs on his centre axle. Supposing you had a steam motor with the gearing apparatus, you must get the driving and driven wheels constant, just the same as in an electric motor.

Mr. W. WORBY BEAUMONT, M.Inst.C.E., said he had considered the problems in this case. With regard to the drawing in the U.S.A. Official Gazette, he agreed with Mr. Imray as to the indications of springs. He agreed that any engineer accustomed to that class of work would at once assume that there was something there of the nature of a buffer—something of the sort indicated in Adams's specification and in the plan of Cryder. He agreed generally with the evidence of Mr. Imray as to the various other specifications.

Mr. FLETCHER MOULTON: You have told his lordship that Reckenzaun's is the same as the plaintiff's invention. Do you withdraw it?—No. I do not know whether you were speaking of Reckenzaun with or without springs.—I was speaking of it without springs.

The witness, in re-examination by Mr. Cripps, said that he found in Reckenzaun all the four elements, plus the spring element, in the plaintiff's claim.

Mr. ASTBURY then addressed his lordship on the evidence which had been given, and submitted that plaintiff's specification had been anticipated "heaps of times."

Mr. MOULTON, in reply, said he did not think that the construction of the plaintiff's claims would be difficult if his lordship would bear in mind one principle which had been laid down again and again in the judgments of the different courts—namely, that in interpreting the specification the claims were not to be interpreted as if they stood alone; but both for and against the patentee his lordship was bound to take into consideration the whole text of the specification in construing the claim.

His LORDSHIP: I must construe the whole document, no doubt.

Mr. MOULTON then referred in detail to plaintiff's specification, and said he paraphrased the claim in the following way: Handford said he hung the off-end of his motor by springs from the truck, and he centred the other end on the driving axle. He then had springs connected with the truck which would take off as much weight as the inventor chose by means of his adjustment. In the plaintiff's invention there were three elements. One end of the motor was suspended on springs, the other end being centred and the weight taken off by supporting springs. The inventor seemed to have attached some importance to his description of his special way of supporting the armature, but he (counsel) did not care about that, as he did not think it was material now. With regard to the alleged anticipation, he submitted that he had called evidence of the very greatest value as to the position of this invention. He proved that there was no common knowledge at the time which would lead people to do what the plaintiff's invention did, and that no less than five attempts had been made to mount an electric motor prior to plaintiff's, but they all could be distinguished from that invention. His lordship had to consider the special requisites of the electric motor as contrasted with the steam motor, and that would not allow any specification for a steam motor to be an anticipation of plaintiff's patent. Beyond that there was direct and uncontradicted evidence to show that nothing in those anticipations with regard to steam had become part of the knowledge of engineers. He submitted that the plaintiffs had proved the validity of the patent.

Mr. Justice COZENS-HARDY said he would take time to consider his judgment.

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British Insulated Wire Co. (Limited) v. Dublin United Tramway Co. (Limited) and National Conduit and Cable Co. of New York.

In the Vice-Chancellor's Division at Dublin, on Wednesday, the Vice-Chancellor heard an action for damages brought by the British Insulated Wire Co. against the Dublin United Tramways Co. (Limited) and the National Conduit and Cable Co. of New York. The Solicitor-General for Ireland, Q.C., M.P., Mr. C. L. Matheson, Q.C., Mr. Blood, Q.C., and Mr. Gerald Fitzgibbon appeared for the plaintiffs; and Mr. Stephen Ronan, Q.C., Mr. J. Gordon, Q.C., and Mr. F. Murphy represented the defendants. The action was one for damages for infringement of a patent, and his lordship was asked to make an order for an inquiry as to damages.

The SOLICITOR-GENERAL said the writ was issued on September 10, and originally claimed an injunction as to two patents, No. 11,894 (1884) and No. 13,340 (1886). The latter patent had now dropped out of the case, and the court was only concerned with patent No. 11,894 (1884). An injunction in this case would involve the taking up of all cables in the Dublin tramway system, but as the plaintiffs' claim would be met by damages, they only asked for an inquiry as to damages. The patent was for an improvement in the insulation of electric conductors or cables. It consisted in applying to the conductor some non-conducting material, which is placed around it and which insulates the cable.

Mr. RONAN, Q.C.: We admit the cable laid down is in substance made according to the principle of plaintiffs' cable. The Solicitor-General might have told your lordship that the patent expired on September 2nd last, before the writ was issued.

The SOLICITOR-GENERAL: The infringement is admitted by affidavits, and it is quite obvious that there must be an inquiry as to damages.

Mr. RONAN: There is some infringement unquestionably.

The SOLICITOR-GENERAL said the invention consisted in the discovery that Manilla paper—a pure vegetable paper—formed the best insulator.

Mr. RONAN, Q.C., said the patent was only a 14-year one, and they admitted using the invention.

Mr. MATHESON, Q.C., said plaintiffs had put in a tender for £30,092, and the Tramway Co. had given the contract to the New York company, so that a big amount was involved, and there should be an account.

The SOLICITOR-GENERAL said the British Insulated Wire Co. received a letter on October 18, 1897, from the Tramway Co., asking them to tender for the electric mains and cables for their tramway system, the tenders to be lodged before Nov. 1. The date of sending in tenders was subsequently postponed to Nov. 15, and on the 13th plaintiffs sent in a tender; and the measure of damages would be the profit plaintiffs would have made in the contract, because they were the only people in the United Kingdom empowered legally to sell that cable.

Mr. RONAN: The only damage that can be recovered in respect of the patent is for user, but they cannot recover for any act done outside the jurisdiction. For instance, people might make it in America. The point is, What acts have been done within the jurisdiction? I may repeat that the patent expired on September 2, and we should have been at perfect liberty to send our goods into Ireland and the Tramway Co. to take them on September 3; and the mistake we made is that we sent them a few weeks before, and for that mistake we must pay.

The SOLICITOR-GENERAL said the amount of the plaintiffs' tender was £30,092. 12s. 10d., and afterwards they got information that cables were being delivered in Dublin which were an infringement of their patent; and they sent a representative in August, 1898, to Dublin, and he saw the cables in the streets and being delivered from America. He took samples, which showed that the cables were identical with the plaintiffs' patent. The expiring years and months of a patent were most valuable, and had the plaintiffs got the contract a large profit would have been made. The statement of claim was delivered on September 9, limited to the patent of 1884. The American company occupied a similar position in America to the British Insulated Wire Co. here, and the Tramway Co. preferred to get their goods from the American company. Down to the 2nd September the plaintiffs were sole proprietors of the patent, and they gave no licence to anyone in the United Kingdom to sell their cable. It was clear that this was a deliberate action on the part of the defendants.

Mr. E. TRACEY, secretary to the plaintiff company, said his company, who carried on business at Prescott, Lancs., were manufacturers of cable for all electrical purposes. They were owners of patent No. 11,894/94. In October, 1897, they were invited to tender for a contract for pipes and cables for the Dublin tramways, and did so tender. The contract price was £30,092. The contract was not given to his company, and they got no reply from the company with regard to it. In October, 1898, they sent a representative over to see what cables the Tramway Co. were laying down in Dublin.

Mr. BLOOD: Have your company, whilst they have owned this patent, ever issued a licence to anybody to use it?—No.

Did they ever—even in one single instance—issue a licence to anybody to use it?—No.

And you were the only manufacturers of this cable according to the patent, and the sole vendors?—Yes.

Mr. GORDON: Was the cable that you tendered for covered with jute outside the lead?—No.

Now look at your tender—was not the cable outside the lead covered with jute?

The VICE-CHANCELLOR: The tender speaks for itself.

Mr. GORDON: We would have refused it on that ground. I regard this point, however, as merely one of detail in so far as the estimation of damages is concerned. It might be found that the material made by this company was not the same as we expected, and that there were two or three things in it that the Dublin company would not have accepted at all.

The VICE-CHANCELLOR: Was not what you subsequently bought from the American company essentially the same thing as the British company had?

Mr. GORDON: Yes.

The VICE-CHANCELLOR: Of course, the essence of the patent is the insulation.

Mr. BLOOD (to witness): What amount of profit would your company have made on this contract if they had got it?—The profits would have amounted to £2,735.

Mr. GORDON: But is not that on the cable alone, without considering the cost of labour or of putting down the cable?

The VICE-CHANCELLOR: What you had to do was to deliver the cable here in Dublin, I suppose?—Yes.

Mr. BLOOD: There was a separate contract for labour.

Mr. GORDON: Had that anything to do with putting down the cables?—Yes. We had to lay down the cables and join them up.

The VICE-CHANCELLOR: How is that?—It is the habit of most tramway companies to lay their own cables. In this tender of £30,000 there is a sum for joining up, and that is part and parcel of the same contract.

Mr. GORDON: Suppose you had simply been selling the cable material to be delivered at the North Wall, without joining up or anything else, what would have been your profit?—I cannot answer that without going fully into figures and consulting books that are not here in court.

Mr. GORDON: The £30,000 obviously includes everything—the laying down of the cables and the joining up, as well as the supply of the material. Tell me, Mr. Tracey: Are you able to distinguish what portion of the £30,000 would go to buy the cable, and what portion would defray the cost of laying it down and joining it?—No; I am not prepared to say that.

Mr. BLOOD: Were you allowing for every requirement of the Tramway Co., in accordance with their specification, when you mentioned the sum as a profit?—Yes.

That figure represents the amount of profit your company would have made on the individual contract?—Yes.

Mr. GEORGE H. NESBITT, chief engineer to the British Insulated Wire Co., stated that the tender given by his company followed the specification of the Dublin United Tramways Co. In his opinion the price asked would have given a profit of £2,735. The estimate asked was for cable laid and jointed in Dublin.

Mr. BERTRAM GUISEPPI, electrical engineer, employed by the plaintiff company, said he came to Dublin in August last. He saw cables being laid down at Westland-row Station and other places. He produced a specimen of the article which was being laid then, and a quantity of which he saw at the quay in course of consignment to defendants. He also produced a piece of his own company's cable.

Mr. BLOOD: Are they identical?—Yes.

They both contain your patented process of paper insulation?—They do.

Mr. ERNEST R. ROYSTON, patent agent and engineer, said he was acquainted with plaintiffs' patent No. 11,849, of September 2, 1884. He was also acquainted with the American patent.

The SOLICITOR-GENERAL: Have you compared them, and are they identical?—Yes; they are the same patent.

Mr. RONAN, for defendants, said the present action was brought by writ of summons. The claim was for an injunction to restrain defendants from infringing the patents of the plaintiffs, and it mentioned two patents—one of 1884, which was the only one his lordship had heard of, and another of 1886. The patent of 1884 expired eight days before the commencement of the action; therefore the action, so far as it claimed an injunction to restrain the infringement of the patent of 1884, was nonsense, because you could not get an injunction to restrain the infringement of an expired patent. That was elementary law. A long series of affidavits had been put in by defendants. They had given reasons why they had not infringed the patent of 1886, and as a result the statement of claim in the action with regard to the 1886 patent was dropped altogether. Lord Herschell's opinion was that to infringe a patent you must "use, exercise, or vend an article patented in this country." It had no doubt been made out that the Dublin defendants did use some of it prior to September 2, 1897, the date of the expiry of the 1884 patent. The patent provided for sale, not purchase. The New York company sold to the Dublin company. The contract was an American contract to be completed in America. It could not therefore be shown that an article patented here had been vended here. The only element, then, that arose was that of use, and he submitted that the Tramway Co. could only be held responsible, going on the basis of profits, for the amount of cable that it used prior to September 2, when the patent expired.

Mr. GORDON said some few thousand yards of cable—an infinitesimal portion of the contract—had been delivered before September 2, and for that only could the defendants be held responsible.

Mr. BLOOD, replying, said defendants went outside the United Kingdom in order to obtain, by piracy, what they could not legally obtain in the United Kingdom except from the plaintiff company.

The VICE-CHANCELLOR said it was admitted that the Tramway Co. were not justified in having used the quantity of cable imported into this country during the time that the patent was in force. The case should go into chambers, and he would direct that in measuring the loss sustained by the plaintiffs the actual quantity of cable delivered prior to September 2 should alone be considered.

Repair of Roadways by Tramway Companies.

At the Dublin Southern Police Court, on Friday, the Dublin United Tramways Co. were summoned by the Corporation for having neglected, on a certain date in August, to keep the tram rails and the paving between the rails at various places on their tramway system in good condition or

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repair, as provided by the statute, which alleged neglect was a source of danger to the ordinary traffic, and rendered the defendant company liable to a fine of £5 per day so long as the said neglect continued. Various sections of the tramways were specified, and it was alleged that these were not sanded and kept in good order to the satisfaction of the Corporation. The part of the roads the company was asked to sand was the spaces between the rails and 18in. beyond the ouside rails.

Mr. O'SHAUGHNESSY, who appeared for the Corporation, said that the complaint was that the company, while enjoying solely a right of passage over the streets, with obligations imposed upon them, had actually taken possession of the streets, and had rendered them dangerous for the use of the citizens. Under their Act of 1897 the tramway company were obliged to keep, at their own expense, the tram lines in good condition, so as not to be a danger or annoyance to the ordinary traffic. That Act did not transfer to the company any right of property in the streets. Under the old horse system of haulage the company, for its own accommodation, was accustomed to put sand upon the pavements between the rails, but since the introduction of electric traction they had neglected absolutely to sand the streets (except where the old horse system prevailed), notwithstanding requests from the Corporation. The result of the lines not being sanded was that the sets became slippy, h rses were constantly falling, and many people were injured.

After hearing some evidence the case was adjourned until Saturday when further evidence was given and the case again adjourned.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *October 20, 1899.*

Automobile Club of America.—On Monday of this week the Automobile Club of America was organised in this city by various gentlemen who are owners of private automobiles. There is a list of over 100 applications for membership. The objects of the club are the formation of a social organisation composed in whole or in part of persons owning self-propelled pleasure vehicles for personal or private use; to afford a means of recording the experiences of members and others using motor vehicles or automobiles; to promote original investigation in the development of motor carriages; to co-operate in securing rational legislation and the formation of proper rules and regulations governing the use of automobiles in city and country, and to protect the interests of owners and users of automobiles against unjust and unreasonable legislation; the encouragement and development in this country of the automobile, and to promote and encourage the construction and maintenance of good roads. There are four classes of membership—namely, honorary, life, active, and associate. The honorary membership, which is limited to twenty-five, includes, *ex officio*, the President of the United States, the Governor of the State of New York, the Mayor of the City of New York, and the director of the United States Road Inquiry. The secretary announced that recognition of the club had been received from the French and the English organisations, and reciprocal relations established.

Storage Battery Plant at Buffalo.—The Buffalo General Electric Co., Buffalo, N.Y., has recently installed in its Wilkeson-street station a new storage battery plant for regulation and reserve. Niagara current is stored in the batteries during the light load, and in case of accident they may be utilised to furnish current for the continuous-current dynamos used in charging, driving them as motors, thus furnishing power for operating the direct-connected alternating current motor as a generator and temporarily furnishing current for the alternating-current lighting system. The storage batteries are connected on the three-wire system, and consist of 75 cells of Chloride accumulators on each side. Nineteen cells on each side are used for regulating, and the switching devices are operated by small motors. The batteries are of 3,000 ampere-hours capacity, and consist of 52 plates 16in. wide by 36in. high. Two boosters are used in connection with the plant, each having a capacity of 200 kilowatts at 375 revolutions per minute. These machines operate with a current from 1,050 to 1,540 amperes at a potential of 130 to 190 volts. The plant equipment has been much increased lately, and there are now a total of 26 arc machines of the Brush type, each having a capacity of 125 lights and operating at a pressure of 6,250 volts and a current of 9·6 amperes. These machines are connected in pairs, each pair being driven by a 150-kw. motor. These motors operate at 352 volts and 25 cycles, and have a speed of 500 revolutions a minute. Two large alternators are used for supplying the alternating incandescent lighting circuits of the city, and are driven by large three-phase motors of 565 H.P. each. The motors are direct-connected, and receive the alternating current at 352 volts and 25 cycles at the switchboard. The alternators have a different frequency from the current received by the motors, as the lighting system of the city is equipped with transformers of 60 periods. Two large rotatory converters supply continuous current of 500 volts for the power circuits of the city. They receive the current at 352 volts and 25 cycles.

Compensated Revolving Field Generators.—In a Paper read by Mr. H.G.Reist before the annual meeting of the Ohio Electric Light Association, in Cleveland, on October 10 and 11, the principle now employed by the General Electric Company for compounding alternators was described. In previous types of alternators automatic adjustment was not made for all variations or degrees of inductive as well as of non-inductive load. In this system the exciter is on the same shaft with the alternator revolving field, and had the same number of poles, so that the two operate in synchronous relation. In addition to the exciter commutator and the pair of collector rings which deliver current to the field of the alternator, the shaft carries three collector rings, which are connected to taps in the exciter winding in the same manner as collector rings are connected to the winding of rotatory converters. The current passes to the collector rings from one or several series transformers inserted in the main alternator circuit, which circuit, passing through the exciter armature, reacts magnetically upon the exciter field, in proportion to the strength and to the phase relation of the main alternating current. Consequently the magnetic field, and hence the voltage of the exciter, is due to the combined effect of the exciter shunt field and the magnetic effect of the alternating current, and therefore the exciter voltage rises not only as the non-inductive load increases, but also with additions of inductive load. The connections between the armatures of the two machines are such that the polarities induced in the exciter armature are somewhat ahead of the exciter-field magnetism, but yet assist the field magnets. The result is that with increasing main current, the current passing through the exciter armature strengthens the exciter fields and thereby the fields of the generator. If the current lags, as under an inductive load, the magnetisation produced by the alternating current in the armature comes more nearly in phase with the exciter magnetism, thus strengthening the field more with a given line current.

Opening the Soulanges Canal.—The Soulanges Canal, one of Canada's finest artificial channels, was officially opened by the Dominion Government a few days ago. The canal has been under construction for seven years, and cost $5,250,000. Five miles from the upper end of the canal a power-house is situated on the south bank. The building, which cost $20,000 is built of brick. Hydraulic power is used for generating electricity. A working head of 20ft. can be obtained from the canal; 500 E.H.P. may be developed in two units of 250 H.P. each. The power is used for the general lighting of the canal and operating the lock gate machinery, sluice valves, and road bridges. There are seven of the latter, which swing on a pivot set in the side of the canal instead of mid-stream as customary. Along the north bank of the waterway long-burning arc lamps of 2,000 c.p. are placed at intervals of 480ft. The electric line poles are 30ft. high, hexagonal in form, and are made from the red cedar of British Columbia. The water-wheels were supplied by the Stilwell-Bierce and Smith-Vaile Co., of Dayton, Ohio. The electric plant and power-house was built by the Canadian General Electric Co., of Toronto, Ont.

October 27, 1899.

Convention of Street Railway Men.—The annual meeting of the American Street Railway Association was held in Chicago October 10th, 11th and 12th, and was well attended. The Papers read at the meeting were, perhaps, below the standard, yet they were not without interest. In his address, President Sergeant drew a comparison between the electric railway

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situation at the present time and when the Convention last met in Chicago, 1883. At that time there were 153 miles of single track in the city—and at the present time the mileage of surface street railways is about 736—of interurban street railways about 261, and of elevated railways about 100 miles, making an increase since the former meeting of 944 miles of track. He referred to the present tendency toward consolidation of small competing roads into a large homogeneous system. This, he said, was the result of the introduction of electric motive power which involves such changes of administration, system, and service that the advantage of combination with rivals became more and more manifest. Mr. Charles T. Yerkes read a Paper on "Investments in Street Railway—How They Can be Made Secure and Remunerative." A most important matter in regard to the security of street railway securities is the length of charter under which they are operating. The charters should be equal to those of steam roads, and, in fact, they should be longer. The cost of a steam railway to-day is not nearly equal to the cost per mile of a street railway, even counting all the appurtenances that go with each. An electric railway plant costs almost ten times as much as a horse car plant, and therefore, if it is right to give the latter a charter for 20 years, the electric railway should receive a charter for 200 years, and city ordinances to correspond. He thought that the Legislature should treat the street railway fairly, and that the street railway companies should treat the municipality and State in the same spirit. He advocated the appointment of a commission in each State by the Governor, whose duties should be to see that the laws concerning street railways are carried out, and that the companies have the protection to which they are entitled by law. In the discussion, Mr. H. H. Vreeland, president of the Metropolitan Street Railway Co. of New York city, stated that he considered the labour question to be the life of the street railway. The transportation questions, except as represented by labour, are insignificant as compared with the great problem of handling labour. A Paper was read by Mr. Ira A. McCormack on "Train Service and its Practical Application." In the discussion of this Paper Mr. Vreeland of the Metropolitan Street Railway Co., of New York, gave some interesting figures regarding the traffic on his company's lines. He said that last year his company moved 265,000,000 cash passengers and 90,000,000 transfer passengers, or a total movement equalling the whole of that of steam railroads of the United States. The system is handled with reference to time tables, and the preparation of these requires the services of an expert employed for that purpose. Other Papers read were the following:—"The Construction and Maintenance of Street Railway Track," by Mr. Edward Butts; and "The Care of Car Equipment," by Mr. J. H. Vander Veer.

Germicide Attachment for Telephones.—Not very long ago the public press called attention to the possibility of communication of contagious diseases by the use of telephones. It was pointed out that the interior recesses of the instruments offered lodgment for disease germs, and these instruments became agents for the spread of infectious diseases. The matter was taken up by health boards in the various cities, and in many cases the actual presence of disease germs was discovered. As this case presented a need for an invention, inventors have not been slow to give the matter the attention that its importance demands. Last week two patents were issued for antiseptic and germicide attachments for telephones. One of the attachments consists of a removable cover for the telephone mouthpiece having applied to its inner side a receptacle for a germicide. When the telephone is not in use this receptacle is removed from the opening of the mouthpiece, being replaced after a telephonic conversation. The other invention consists in the use of a lining for a telephone mouthpiece, consisting of a detachable cup formed of an antiseptic gauze known to the trade as "bichromid" gauze. It is claimed that this antiseptic gauze cup prevents the retention of any living germs, such germs being destroyed by the antiseptic contained in the gauze.

CONSTRUCTION OF STREET RAILWAY TRACKS.*

BY EDWARD BUTTS.

The rails should be not less than 6in. in depth, with a width of base equal to the exposed upper surface. Where streets are paved with asphalte and a stone toothing course placed adjacent to the rails, the rails must be at least 9in. in depth, in order that the base may be securely imbedded in the concrete below. Rails should be centre-bearing and rolled in 60ft. lengths, and handled so that they will be perfectly straight when placed in their final location. Tie-rods 1in. in diameter should be placed 6ft. centre to centre along the line, supplied with hexagon nuts which, when in place, shall clamp the rails securely on both sides. The tie-rod threads should extend far enough from the rod ends to allow the rod to be put in place without bending same. The top of the tie-rod should be placed at the centre, between the top and bottom of rails, to accommodate better the paving, especially if brick or stone is adopted. The construction for rail foundations consists of digging a trench 20in. wide on top and 16in. wide on bottom by enough depth to get 6in. below the rails when same are to established grade. In this trench, at 10ft. intervals, are placed wooden blocks $8 \times 10 \times 16$in., and the rails are spiked securely to these blocks, which serve to hold the rails while the same are being laid and tamped to surface, the joints being held in position by temporary splices.

After nicely gauging, aligning, and surfacing the track, the trenches are filled with concrete, bedding the base of the rails up to the bottom of the proposed paving. This concrete, which is placed in the trenches around the rails, is composed of crushed stone, measuring not more than ½in. in greatest dimension, mixed with Portland and domestic cement and sand.

The quantities of the above are mixed two parts sands, one-half part Portland cement, one-half part domestic cement, and five parts crushed rock, all by measure. Great care should be taken to get the mortar flushed close against the rails and to bring same full up under the rail trams. The concrete in the trenches should be allowed about six days to set; however, this depends upon the condition of the atmosphere, as it sets much more rapidly in warm than in cold or chilly weather. The concrete for paving foundation may be composed of one part domestic cement, two parts sand, and four parts broken stone by measure, the broken stone to be not larger than 2½in. in the greatest dimension. All concrete should be thoroughly tamped until the mortar flushes to surface.

After the concrete has set cast-weld joints should be formed at all joints, including the special work which may be needed. The cast-weld joint on 80lb. rails should weigh 150lb., and on 100lb. rails 200lb. additional metal: the additional metal should be composed of two-thirds pig-iron and one-third common scrap iron. The metal should be heated to a bright yellow temperature, and each joint formed with one pouring. The depressing clamps should remain in place for at least one hour after the pouring, and the surface of the rails finally dressed smooth, so that the transition of the car will be the same as if on a continuous rail. In preparing the joint, better results as to smoothness are obtained by inserting a thin shim between the rails than by placing the rails too close to admit the shim. These cast-welded joints should be so formed as to admit the wearing surface of the pavement with the least amount of interference practicable.

As a general proposition, the wearing surface of the paving should be composed of the same material as the balance of the street, otherwise there will be an undue amount of vehicle travel on the street railway tracks, and consequently more frequent accidents will occur, as well as a more limited durability of the wearing surface. For instance, if the street is paved with asphalte and the track with brick or stone, heavy loads on slight grades will be driven on the stone or brick, for the reason that the latter material furnishes a better footing and keeps the grease well in play in the wheel boxes. On the contrary, if the street railway tracks are paved with asphalte and the street roadway with brick or stone, the drivers of light vehicles, &c., will immediately seek to occupy the street railway tracks.

At all times attention should be paid to drainage, and at street crossings, where the established grade is level, the surface of the tracks on one side should be elevated several inches to prevent the retention of water pools. At all changes of grade the rails should be bent to form vertical curves and no joints allowed in these curves, as it is almost impracticable to form a uniform curve unless shop work is resorted to. There is no economy in trying to construct a railway too hastily, as in so doing inferior work is generally done, and a future expense is the result.

The special work, turnouts, crossings, and cross-overs, should be of cast-steel construction except steam railway crossings, which are best of regular built-up work located on the foundation. The tongues of turnout switches should be placed on the high or super-elevated rail of the curves, otherwise the guard rail of the mate should extend the full length of the casting on which the tongue is located. All curves of a radius under 300ft should be provided with guard rails, and curves of less than 50ft. radius should be double guarded.

* Abstract of a Paper read before the Chicago meeting of the American Street Railway Association.

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DUBLIN ELECTRIC TRAMWAY ACCIDENTS.

Yesterday was issued Mr. A. P. Trotter's report upon the Dublin tramways accidents on June 20, July 30 and 31, and Aug. 6 last. The report is dated Oct. 2, and deals first with the evidence taken at the inquiry opened in Dublin on Sept. 28. This evidence was fully reported in our issue of Oct. 6. Upon the evidence Mr. Trotter concludes his report with the following :

CONCLUSION.

The four accidents which form the subject of this inquiry were due to the rising of the trolley head above its ordinary position. In two cases (July 30 and 31) the trolley head wrecked the overhead wires ; in one case (June 20) the overhead wires were so strong that the cast-iron standard on which the trolley pole is hinged was broken, and in the last (Aug. 6) the trolley head, intentionally made detachable, came off. In the first and the last of these accidents one person was injured by the fall of parts of the trolley ; in the accident of July 30 six passengers complained of injuries from electric shocks, and in the remaining accident no one was injured.

Breaking of Trolley Standard.

It appears that accidents similar to that of June 20 happened somewhat frequently on the old southern tramway system. Those standards were merely fastened to the roof by coach-screws. That construction was undoubtedly defective, but it has been abandoned and does not affect the present case. The detachable trolley head appears to be well suited to prevent the recurrence of such an accident.

Wires Wrecked by Trolley.

The expression "trolley" is rather indefinite, and includes the pole or arm, the trolley head at the end of this pole, and the wheel which forms part of this head. Trolleys leave or "jump" the trolley wire from many different causes. These causes may be minimised, but can hardly be removed altogether. It is important, therefore, to prevent such an occurrence from doing injury. So well known is this kind of accident, that it is put forward by some tramway engineers as a reason for not using guard wires, but this objection may be at once removed by preventing the trolley head rising more than a short distance above the trolley wire.

The Use of a Stop on the Trolley Pole.

The height of the trolley wire above the rails necessarily varies a little, and the maximum height must be considered, with allowance for "pitching" or oscillation of the car. A limit should then be fixed—in some cases this is 6in., and in one town it is said to be 3in. The limit, in the case of centre-running trolleys, as in the ordinary American style, can be easily arranged by putting a spring hook on the end of the trolley rope and a ring on the car, doing away with the yard or two of slack, which the conductors at present tie up anyhow.

Having regard to the extraordinary accident of July 30, when the trolley rope was mistaken for a bell rope, this ring might be fixed on the edge of the canopy over the end platform. In the case of the "Dickinson" or swivel trolley heads, the slack on the trolley rope cannot be used to fix this limit, and an adjustable screw stop may be placed, and is now commonly placed, on the lower end of the trolley pole, as in the "Dawson" pattern.

Where the "Dickinson" system is used to a limited extent, the trolley wire being nowhere more than 5ft. or perhaps 6ft. from a perpendicular to the centre of the track, the trolley rope may be employed in the ordinary way, but it would be better to secure it to the foot of the trolley pole by a hook and ring. Where the swivel system is employed to a greater extent, with an 8ft. or 10ft. reach, trolley ropes are likely to cause accidents, and must he secured carefully, or dispensed with altogether, a bamboo with a hook being used instead.

I do not consider that the Tramway Co. was to blame in the first instance for the accident of July 30. In the wide experience of Mr. Parshall no similar accident had been heard of. The trolley is generally pressed upwards by powerful springs with a pressure of about 25lb., and in this case, the line being low on account of the bridge, the force applied to the supposed bell-pull must have been between 30lb. and 40lb.

It is much better to use arm construction than span wires where the line is brought down low to go under a bridge, because, if the trolley leaves the wire when the wire is low, the blows on the span wires would be much more severe. In such a place guard wires, if any, should be kept at the usual height, to clear the trolley head. This change has been made at Amiens-street.

An Improved Trolley Head.

The difficulty of preventing trolleys from leaving the wire, and the accidents due to this cause, have received attention from tramway engineers, but without much success. Horizontal sliding collectors are used on some tramways instead of trolleys, but that system appears to be more suited for continuous suburban lines than for intricate thoroughfares as those in Dublin.

One of the principal objects of the "Dickinson" trolley system is to enable short bracket arms to be used instead of span wires, and to dispense almost entirely with "pull-off" wires ; but, owing to peculiar local conditions, the Tramway Co. have been compelled to use both span wires and swivel trolley heads. The pattern of head used until lately, while not more likely to leave the wire than the centre-running trolley, was more likely to catch and to tear down the overhead wires. Mr. Towle has endeavoured to produce a trolley head which, while containing some features calculated to prevent "jumping," aims chiefly at avoiding the damage which the older pattern did to the overhead wires.* The novel form and the detachability promise to be valuable improvements.

* For an illustrated description of this trolley head see *The Electrician*, for Sept. 8, 1899, p. 695.—[ED. *E.*]

Brackets v. *Span Wires.*

The centre-pole arrangement with brackets on each side for carrying the trolley wire, exceedingly adapted for tramways in wide streets, is used to a limited extent in Dublin ; but it is said to be unsuitable on account of the unsystematic driving of cars, wagons, &c. Some of the brackets used in Dublin are of great length—several exceed 20ft. Improvements in the swivel trolley head, or greater confidence in its use, should enable much shorter brackets to be employed. It appears that the choice of the bracket or of the span-wire system rests more with the Corporation than with the discretion of the tramway engineers.

Electric Shocks on Tramways.

Without wishing to make light of the effect of electric shocks of 500 volts, or to underrate the importance of securing the confidence as well as the safety of the public, it should be observed that the electrical pressure of 500 volts has been deliberately chosen because the results of shocks due to light or brief contact with a charged wire are not serious. The employés on tramway works often receive them, generally through carelessness.

The injury produced by such a shock may generally be estimated by the resulting burns ; shocks due to higher pressures are accompanied by injuries to the nervous system. A passenger on an electric tramway should not be in more danger of receiving an electric shock than a passenger on a railway is in danger of being scalded.

RECOMMENDATIONS.

Guard Wires.

Guard wires are at present a necessary evil. They should be so well connected to earth, by connecting the poles to the rails, that any serious rush of electric current will melt fuses in the feeder boxes. If the traffic on any section is so irregular as to be likely to cause a heavy demand for current, the length of that section should be reduced so that the maximum working current can be carried by a fuse of practical dimensions and one which will melt in case of a "short circuit." An automatic circuit opener is always placed on each feeder circuit, at the main switchboard at the works. These frequently open when a temporary demand for current largely exceeds the normal current. The switchboard attendant cautiously closes the circuit opener, which sometimes opens again. It would be well if matters could be so arranged that, in the event of a "dead short-circuit," after two or three attempts to close the circuit opener, the attendant should be able to "blow" a section fuse in a feeder box by holding up the circuit opener. In the very rare event of a short circuit on a feeder, the circuit opener on the generator would open. The tramway engineers should be allowed free discretion by the Dublin Corporation as to the best mode of "feeding" the half-mile or quarter-mile sections of the trolley wire, and the placing of the switches.

I am not prepared to recommend the general use of wooden strips instead of guard wires. I consider that the adoption of the system of guard wires carried on the telegraph or telephone poles, in common use on the Continent, is very desirable. This has been tried at Blackburn.

I attach more importance to the substitution of this system of guard wires for the present one, than to any other improvement in electric tramways for the safety of the public ; but this is a matter which must be arranged between the tramway engineers and the telegraph and telephone authorities, the Board of Trade having no powers in the matter.

The Prevention of these Accidents.

The use of brackets instead of span wires would prevent such accidents as those of June 20 and July 30.

The use of a stop to prevent the trolley head, after leaving the wire from touching the guard wires, or the abolition of guard wires of this kind will prevent such an accident as that of July 31.

The new form of trolley head will prevent such accidents as those of June 20 and August 6.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers, or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London :—

NOW READY.

"The Electrician" Electrical Trades' Directory and Handbook for 1899.—The *Second Edition* of the "Big Blue Book" for 1899 is now ready. The volume contains the large Sheet Tables of Electricity Supply Stations and Electric Railways and Tramways. The price of the Directory and Handbook is now reduced to 6s, post free 6s. 9d. ; abroad, post free, 7s. 6d. (United States 8s. 6d.).

"ELECTRIC MOTIVE POWER," by Albion T. Snell, contains the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. Price 10s. 6d., post free ; abroad, 11s.

"ELECTRICAL TESTING FOR TELEGRAPH ENGINEERS."—By J. Elton Young, M.I.E.E. The scope of the book aims at furnishing a fuller treatment of the subject, from the standpoint of the Telegraph Engineer, than it has hitherto received, whilst it endeavours to facilitate a thorough comprehension of the theory of testing as applied to electrical lines in general. Demy 8vo, fully illustrated. 10s. 6d., post free ; abroad 11s.

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TENDERS INVITED.

The *Newcastle-upon-Tyne* Electric Tramways committee invite tenders for two 1,000-H.P. generators. Further particulars are given in an advertisement, and specifications, &c., may be obtained from the consulting engineer (Mr. Charles Hopkinson), 29, Princess-street, Manchester, or 26, Victoria-street, London, S.W. Tenders (addressed to the committee) must be left at the office of the town clerk (Mr. Hill Motum), Town Hall, Newcastle-upon-Tyne, not later than noon of Nov. 30.

The *Leeds* Corporation invite tenders for wiring and fitting the Union-street Baths for the electric light. Specifications may be seen and tenders obtained at the city engineer's office, Municipal Buildings, Leeds. Tenders must be delivered at the town clerk's office by noon of Nov. 13. See advertisement.

The *Poplar* (London) District Board of Works invite tenders for laying mains upon the solid system for the distribution of continuous current upon the three-wire system. Further particulars are given in an advertisement elsewhere, and specifications, &c., may be obtained from the electrical engineer to the Board (Mr. Alfred Blackman), Electricity Works, Glaucus-street, Bromley-by-Bow, E., after the 6th inst. Tenders must be sent to the clerk (Mr. Leonard Potts) by 10 a.m. of Thursday, Nov. 16.

The *Accrington* Corporation invite tenders for electric cables, wires, street boxes, and connections. Further particulars can be obtained of the town clerk (Mr. A. H. Aitken), or at the offices of the consulting engineer (Mr. J. N. Shoolbred). 22, Victoria-street, London, S.W., and tenders must be sent in to Mr. Aitken by the 18th inst. An advertisement gives additional information.

The *Pontefract* Guardians invite tenders for the electric lighting of their workhouse infirmary buildings and premises. An advertisement contains further particulars, and specifications, &c., can be obtained from the consulting engineer (Mr. G. R. Peers), 95, Deansgate, Manchester. Tenders must be sent to the clerk (Mr. W. A. Glover), Poor Law Offices, Pontefract, by 10 a.m. of 24th inst.

The *Salford* Electric Light committee require tenders for the electrical bonding of tramway rails. Specification, &c., may be obtained from the borough electrical engineer (Mr. Charles L. Turner), Walness-road, Broughton, and tenders (addressed to the chairman of committee) must be delivered to Mr. L. C. Evans, Town Hall, Salford, not later than 9 a.m. on Thursday, 16th inst. See advertisement.

The *Bury St. Edmunds* Town Council invite tenders for wiring and fixing electric light fittings in certain public buildings. An advertisement contains further particulars, and specifications, &c., can be obtained at the offices of the borough surveyor (Mr. J. Campbell Smith), Town Hall, Bury St. Edmunds, where tenders must be delivered on or before 22nd inst.

The *Wimbledon* District Council require tenders for the supply and erection of two 350-kilowatt steam alternators. Specifications, &c., can be obtained from the consulting engineers (Messrs. Preece and Cardew), 13, Queen Anne's-gate, Westminster, S.W. Tenders, addressed to the clerk to the Council (Mr. W. Whitfield), must be delivered at the Council Offices, Broadway, Wimbledon, not later than 10 a.m. on 22nd inst. An advertisement contains further particulars.

The *Battersea* (London) Vestry require tenders for the supply of arc lamps and arc lamp-posts. An advertisement contains further particulars, and specifications, &c., can be obtained on application to the vestry clerk (Mr. W. Marcus Wilkins), municipal buildings, Lavender-hill, London, S.W. Specifications and drawings are also to be seen at, but not obtained from, the consulting engineer (Prof. A. B. W. Kennedy), 17, Victoria-street, Westminster, London, S.W., and tenders must be delivered at the vestry clerk's office by noon of Monday, Dec. 4.

The directors of the *North Eastern Railway* invite tenders for telegraph stores for the six months ending June 30, 1900. Some particulars are set out in an advertisement, and forms of tender may be obtained on application to Mr. Graves, Telegraph Department, York. Tenders must be sent in to the secretary (Mr. C. N. Wilkinson) not later than noon on Monday, 20th inst.

The *Londonderry* Corporation invite tenders for the supply of carbons for the year ending Dec. 31, 1900. All particulars may be obtained on application to the resident electrical engineer (Mr. R. V. Macrory), and tenders must be lodged with the town clerk (Sir R. Newman Chambers), Guildhall, Londonderry, not later than 30th inst. See advertisement.

The Council of the county borough of *West Ham*, London, E., invite tenders for (*a*) three 84-kilowatt steam dynamos, boosters, switchboard, steam exhaust and feed-water pipes; (*b*) accumulators; (*c*) water-cooling and condensing plant; (*d*) motors; (*e*) telephones. Plans of the station, specification, &c., can be obtained at the borough electrical engineer's office, Abbey Mills, West Ham, and tenders must be sent in to Mr. Fred. E. Hilleary, town clerk, Town Hall, West Ham, E., not later than 4 p.m. of Thursday, Nov. 30. An advertisement elsewhere sets out some conditions of contract, &c.

The *Hoylake and West Kirby* District Council invite tenders for the supply, delivery, and erection of—(1) Lancashire boilers, superheaters and Green economiser; (2) quick-revolution steam engines, alternators, motor alternator, feed pumps, piping, tanks, crane, wiring electricity supply works, &c.; (3) high and low-tension switchboards and connections; (4) secondary batteries and accessories; (5) transformers and accessories; and (6) high and low-tension mains, &c. Tenders to Mr. Roderick Williams, Town Hall, Hoylake, by noon of Nov. 15.

The *Hammersmith* (London) Vestry invite tenders for wiring their stables depôt. Specifications from Mr. H. Mair, M.Inst.C.E., Town Hall, Hammersmith, W. Tenders must be in by the 22nd inst. See advertisement.

The *Islington* (London) Vestry invite tenders for condensing plant. Specifications, &c., may be obtained at the offices of the electricity department, 50, Eden-grove, Holloway, N., and tenders must be addressed to the electrical engineer (Mr. Albert Gay). An advertisement gives further particulars.

The Vestry of *St. Mary, Newington* (London), invite tenders for the supply and erection of a 400-kw. steam dynamo and continuous-current transformer for their electricity supply works. Tenders to the clerk (Mr. L. J. Dunham) before noon of 13th inst.

The *Portsmouth* Corporation invite tenders for the supply and delivery of 40, 60, or 80 electric tramcars. Tenders to the town clerk (Mr. Alexander Hellard), Town Hall, Portsmouth, not later than 10 a.m. 17th inst.

The *Swansea* Corporation invite tenders for the supply and erection of five Lancashire boilers, with jet condensing plant, feed pumps, economiser, piping, &c. Tenders to the town clerk (Mr. Jno. Thomas), Guildhall, Swansea, before noon of 20th inst.

The Lighting committee of the *Wolverhampton* Corporation invite tenders for the supply and erection of two 500-kw. direct-coupled generating sets. Tenders to the borough electrical engineer (Mr. C. E. C. Shawfield), electricity works, Commercial-road, Wolverhampton, by noon of Nov. 13.

The *Greenock* Police Board invite tenders for leasing the lines of tramways within the burgh and converting for electric traction on the overhead trolley system. Copies of conditions, &c., can be obtained from the town clerk (Mr. C. MacCulloch), with whom tenders must be lodged before 23rd inst.

The *Blackpool* Tramways committee invite tenders for the construction of the permanent way of a double line of tramway from Springfield-road to the Gynn. Tenders to borough engineer by 20th inst.

The *Chorley* Joint Hospital Board require tenders for telephone installation, wiring, and electric light fittings, &c., at the Infectious Diseases Hospital, Heath-Charnock. Tenders to clerk by 18th inst.

The *Aarhus* (Denmark) Electricity committee require tenders for water-tube boilers, steam dynamos, switchboard, &c., and accumulators. Tenders to the committee, gas works, Aarhus, by Dec. 28.

The *Manchester* Corporation require tenders for eight electroliers for the city police courts. Particulars from Mr. Rison, Town Hall, Manchester.

The Urban District Council of *Bray* (Ireland) require tenders for a jet condensing plant. Tenders before the Council meeting on 20th inst.

The Electricity department of the *Glasgow* Corporation invite offers for ten miles of 2in. cast-iron pipes. Tenders to Sir J. D. Marwick, City-chambers, Glasgow, on or before Nov. 20.

The *Glasgow* Corporation require tenders for 4,000 tons steel straight track rails, 400 tons steel curve rails, and 200 tons steel fish-plates. Specification from the general manager, and tenders by 25th inst.

The *Middlesbrough* Electric Lighting committee invite tenders for condensing plant and pipework. Tenders to Mr. George Bainbridge, Municipal Buildings, Middlesbrough, not later than 4 p.m., Nov. 22.

The *Chelsea* (London) Vestry require tenders for three motor vans. Particulars from the surveyor, and tenders to the vestry clerk, Town Hall, Chelsea, by 21st inst.

The Governors of *Felsted* School, Essex, invite tenders for the supply and erection of electric lighting plant. Tenders by Nov. 27.

The *Midland Railway Co.* invite tenders for stores, including telegraph instruments, stay rods, poles, &c., telegraph and signal wire, &c. Tenders to Derby by 14th inst.

The *Cheshire* Lines Committee require tenders for telegraph materials, instruments, wire, &c. Tenders to the secretary by noon of Friday, Dec. 1.

The *Hackney* (London) Vestry require tenders for refuse destructors. Tenders to vestry clerk by 4 p.m. of Tuesday, Dec. 12.

The *Halifax* Tramways committee require a lathe and upright radial drill. Tenders by 14th inst.

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Tenders for the hire of plant, &c., required for the electric lighting of the State apartments, *Dublin Castle*, during the next session, will be received until 20th inst. by the secretary of the Board of Public Works (Mr. H. Williams), Dublin.

The *Mistretta* (Sicily) Municipal Council require tenders for electric lighting by Dec. 31.

The Royal Co. of *Portuguese* Railways, Santa Apolonia, Lisbon, invite tenders, until the 22nd inst., for the supply of 8 tons of galvanised iron telegraph wire.

TENDERS RECEIVED AND ACCEPTED.

The Birkenhead Corporation have accepted the following tenders:—Bolckow, Vaughan and Co. (steel rails), Ibbertson Bros. (bolts, nuts, &c.), Phœnix Bolt and Nut Co. (wrought iron and tie bars), Holme and Green (erection of tramway power station), at £4,813.

The tender of Messrs. Kendall and Maine has been accepted by the Peterborough Corporation, for the erection of electricity supply station buildings at £2,334. 8s. 4d.

The Bermondsey (London) Vestry have accepted the tender of the National Electric Wiring Co. for wiring the Town Hall, at £408. 14s.

The Southampton Corporation have accepted the tender of the Westinghouse Electric Co. for eight additional motor equipments at £2,030.

APPOINTMENTS VACANT AND FILLED.

The Huddersfield Electricity committee invite applications for the position of electrician-in-charge. Further particulars are given in an advertisement, and applications must be sent to the borough electrical engineer (Mr. A. B. Mountain), St. Andrew's-road, Huddersfield, not later than 26th inst.

The Devonport and District Tramways Co. require a clerk of works to superintend the construction of permanent way for electric traction. Applications to the engineers to the company, 20, Victoria-street, Westminster, S.W. See advertisement.

The Burnley Electricity committee require an assistant electrical engineer. Some particulars are set out in an advertisement, and applications must be sent to Mr. W. T. Fullalove, town clerk, Town Hall, Burnley, by Nov. 15.

A mains engineer is required for the electricity department of the Aberdeen Corporation. Applications to the borough electrical engineer (Mr. J. Alex. Bell), Cotton-street, Aberdeen, by 20th inst. See advertisement.

The Wimbledon District Council require an assistant engineer. Applications to the resident electrical engineer (Mr. F. Barnes Spencer) by 20th inst. See advertisement.

A capable draughtsman is required at the Bristol electricity works. Particulars to Mr. H. Faraday Proctor, city electrical engineer, Templeback, Bristol. See advertisement.

The electricity department of the Bristol Corporation has vacancies for improvers who have had a thoroughly scientific education and practical experience in engineering workshops. Particulars to Mr. H. Faraday Proctor, city electrical engineer, Templeback, Bristol. See advertisement.

The National Electric Supply Co., Preston, require an assistant engineer for mains. See advertisement.

A railway signal and electrical engineer is required by the New Zealand Government. Salary £400. Further particulars from the Agent-General, 13, Victoria-st., London, S.W.

A physical science master is required for the City of London School. Salary £300, increasing to £450 per annum. Applications to the secretary, Victoria Embankment, E.C., by Nov. 31.

Mr. A. Nichols Moore, of the City of Hull Corporation tramways, has been appointed engineer-in-charge on the staff of the Blackpool and Fleetwood Tramroad Co.

Mr. C. S. Pasley, formerly assistant with the Westminster Electric Supply Corporation, has been appointed assistant engineer at the Hastings Corporation electricity works. There were 67 applicants for the position.

Mr. H. F. Fredericks, at present one of Prof. Kennedy's assistants, has been appointed borough electrical engineer at West Hartlepool, at a salary of £300 per annum.

BUSINESS NOTICES.

The Edison and Swan Co. have concluded an arrangement with the Hart Accumulator Co. whereby they are granted the sole agency for the Hart Co.'s accumulators and manufactures in Glasgow and Dublin. Any inquiries for Hart cells from these centres should be sent to the Edison and Swan Co.'s Glasgow (153, West George-street) and Dublin (12, Dawson-street) branches.

The temporary central office of the Liverpool Corporation tramways department, after 16th inst., will be 6, St. Thomas-street, Liverpool.

Messrs. J. Pearson, G. Normanton, N. Brooke, J. Morton, W. H. Foster, J. R. Atkinson, W. Emmott, and F. Whiteley (trading as the Electrical Development and Light Regulating Syndicate) have dissolved partnership. W. Emmott and F. Whiteley continue under the old style.

Messrs. Niblett and Sutherland have taken Mr. E. Marcuson into partnership, and the future style of the firm will be Niblett, Sutherland and Marcuson.

BANKRUPTCIES, LIQUIDATIONS, &c.

At the public examination of A. E. McKechnie the filed accounts showed liabilities £908, assets 6s. Prior to July, 1896, debtor was engaged in promoting electrical companies and in developing electrical patents, out of which he said he made £10,000. He lost £7,000 in a railway investment. Examination concluded.

The public examination of Claude Vautin, electro-metallurgist, 66, Old Broad-street, London, E.C., was to have taken place at the London Bankruptcy Court on Tuesday. Accounts had been filed showing total liabilities £90,910, assets valued to yield a surplus of £29,517. The debtor pleaded illness as a bar to his attendance, and the examination was adjourned.

Sydney Ferris Walker, electrical engineer, 195, Severn-road, Cardiff, was again examined at Cardiff. Mr. Belcher, for the trustee, complained that debtor had not complied with the order of the court to supply particulars showing how he made up the details in his deficiency account. Mr. Gilling, for debtor, said the bankrupt had misunderstood the order. Debtor denied that he had a valuable scientific library. The books consisted mainly of records of societies to which he belonged. The examination was adjourned, debtor to supply the required accounts by Dec. 1.

A first dividend in the bankruptcy of Wilks, Sloan and Co., electrical and consulting engineers, 112, Bath-street, Glasgow, is payable on Dec. 18, at 196, St. Vincent-street, Glasgow.

A meeting of the Shropshire Electric Light and Power Co. (Limited) will be held, on Dec. 4, at 9, The Square, Shrewsbury, to receive an account of the winding-up. Mr. W. N. Naunton is liquidator.

A meeting of the London and Lancashire Electric and General Engineering Co. (Limited) will be held at Broad-street-avenue, London, E.C., on Dec. 4, to receive an account of the winding-up. Mr. F. A. Franklyn is liquidator.

In the failure of James S. Elwards, electrical engineer, Moorgate-court, London, E.C., a list of creditors is issued containing 40 names. The "Institute of Electrical Engineers" (*l*) is down as a preferential creditor for £77. The liabilities are £14,309, assets £1,420.

An adjourned petition, presented by Mr. G. Trenan, 7, New-court, Lincoln's Inn, London, W.C., for the winding up of the Milver Portable Electric Battery Syndicate (Limited), will be heard on 15th inst.

Under the deed of assignment for the benefit of the creditors of John A. Edmondson, Globe Electrical Works, Kirkstall-road, Leeds, Mr. Myles Lee (Lee and Whitfield), 17, East Parade, Leeds, trustee, has declared a dividend of 20s. in the £.

Sales by Auction.—Mr. Herbert Humphries, of Brierley Hill, will sell by auction, at the Grand Hotel, Birmingham, on Thursday, Nov. 16, at five o'clock prompt, the important and extensive freehold property known as the Acetylene Works, Corngreaves, Cradley Heath, together with the goodwill and the costly electrical plant used in the manufacture of carbide of calcium. The Corngreaves works have a railway connection with the Great Western Railway, and the buildings are modern and substantial. The premises have been occupied by the Midland Acetylene (Parent) Syndicate (Limited). The electrical plant and other particulars are set out in an advertisement on another page, and it will be seen that this plant was manufactured by leading firms, and is in a condition equal to new. The works comprise an area of 5,011 square yards. Mr. Humphries' offices are at Brierley Hill and Stourbridge, from which particulars, &c., can be obtained; or from Messrs. Burt and Hairland, solicitors, Bournemouth; Messrs. Homfray, Holberton and Mellor, solicitors, Brierley Hill and Cradley Heath; or of Mr. E. Mason, chartered accountant, St. Paul's Chambers, Dudley and Cradley Heath.

Messrs. Wheatley Kirk, Price and Co. will sell by auction, on Tuesday, Nov. 21, at 10 a.m. for 10.30 prompt, the entire contents of the Globe Works, Kirkstall-road, Leeds, comprising motive power and gearing, fixed and loose engineering plant, tools, stock and stores, steam engines, electrical installation, six open type motors, lathes, planing machines, &c.; also a large quantity of new stock and stores, and the entire collection of modern patterns and drawings, including standard designs of dynamos and motors. Admission will be by catalogue, which can be obtained of the auctioneers, 49, Queen Victoria-street, London, E.C., and Albert-square, Manchester, or from the trustee, Mr. Myles Lee, 17, East Parade, Leeds. Some further particulars are given in an advertisement.

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As announced in an advertisement elsewhere Mr. W. F. Laing will sell without reserve, on Thursday next, the 16th inst., at 28A, Commercial-road, Aldgate, London, E., at 11.30 precisely, the extensive stock of a lamp importer and manufacturer, including a quantity of electric lamps, globes and shades, lamp glasses, art brass and iron brackets, incandescent fancy globes, floor lamps, &c.

Factory Premises for Sale.—In an advertisement it is announced that a leasehold factory, suitable for electric or light engineering works, motor-car factory, &c., is for sale. The plant comprises automatic and plain lathes, milling, drilling and profiling machines, a Dowson gas plant, three gas engines, &c., and is in first-class order.

Telegraph Stores Sale.—As announced in an advertisement elsewhere, the Postmaster-General invites tenders for the purchase of about 35 tons of old copper wire, plates, &c., and a quantity of other metals, indiarubber-covered wire, glow lamp tops, secondary batteries, &c. The forms of tender can be obtained on application to the controller of stores (Mr. Charles E. Stuart), General Post Office, London, E.C., and tenders will be received until 10 a m. on Wednesday, 15th inst.

Ediswan "Comet" Revolving Shade Lamp.—A lamp and shade fitting just introduced by the Edison and Swan Co. should meet a large demand. It is made in various designs for many different purposes. It can be arranged for desks and reading tables, for jewellers and engravers, as an orchestra light, as a piano light (and there is a distinct demand for this particular type), there is a design suited for use in the bedroom, and also one for use in trades where an adjustable lamp with revolving shade is essential. Perhaps this lamp and shade will be nowhere more welcome than in the surgery, and we therefore illustrate, in the figures accompanying this notice, two examples of a standard used in surgical work. The arm (as shown in Fig 1) is controlled by a balance in the tube, and the adjustability of this shade is claimed to be perfect. In Fig. 2 a bracket, acting on the same principle as in Fig. 1, is shown, which is, however, more serviceable in rooms and places where space is limited. In connection with these surgery fittings a wall bracket is also made which can be adjusted to any desired position, the ball and socket arrangement giving the bracket a free movement in any direction. For dentists' use and for the operating table these fittings will be indispensable. These latest novelties of the Edison-Swan Co. are of real practical value.

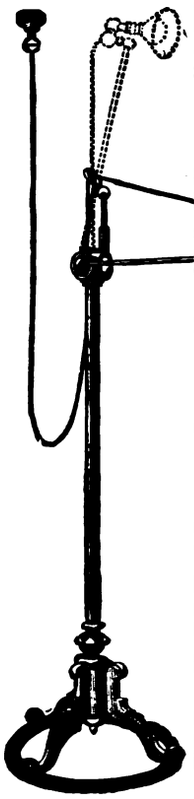

Fig. 1.

Fig. 2.

B.T.H Plant.—A pamphlet just issued by the British Thomson-Houston Co. gives illustrations of a new continuous-current stationary motor (type C.E.), which is built in any form, partially or totally enclosed, for slow speeds in sizes ranging from 2 H.P. to 10 H P., and for moderate speeds from 3 H.P. to 15 H.P. This type of motor is designed to stand hard usage, and in its totally enclosed form is claimed to meet the most stringent requirements. In the circular these motors are shown attached to printing, type-composing, planing and sewing machines, chaff cutters, &c.

High Voltage Lamps.—An excellent sheet of illustrations, of the newest types of high voltage lamps manufactured by Messrs. E. Goossens, Pope and Co., is just issued. Special attention has been given to the demand for novelties in this class of lamp, and the illustrations shown in the circular, which are all full size, show that the obscuring of all lamps in the sheet is effected by sand blast, which does away with the discolouration so prevalent where lamps have been frosted by chemical means. A large stock of the lamps is held in London at the Company's branch at 5, Guildhall-chambers, Basinghall-street, E.C., from which address copies of the list can be obtained. In these lamps it may be remembered no plaster is used in the caps.

Personal.—We learn that Mr. W. I. M. Menzies, who has for 15 years past been in the service of the Consolidated Telephone Construction and Maintenance Co. (for nine years as general manager), has just concluded his engagement with the company. Mr. Menzies has had a large and varied experience in the management of large undertakings, and his association with railway companies and Government officials in all parts of the country should be of great value to him in any future position he may occupy. Those who have held business relations with Mr. Menzies during the past decade will recognise that his tact, courtesy, and ability fit him for any position of trust and responsibility.

Mr. Alfred H. Gibbings, the city electrical engineer to the Bradford Corporation, writes informing us that he has now commenced a consulting practice.

Water Tube Boilers.—Messrs. B. R. Rowland and Co. (Limited), of 12, Exchange-street, Manchester, inform us that the United States Commissioners of the Paris Exposition, 1900, have selected the Morrin patent "Climax" water tube boiler for supplying steam to the whole of the United States section, and a United States cruiser has been placed at the disposal of the American manufacturers of this boiler for transhipping from Brooklyn to Havre. The large boilers installed at Paris will be under the superintendence of Messrs. B. R. Rowland and Co., who have the sole rights of manufacture outside the United States.

Pearson Fire Alarm System —There has been a great deal of the "puff preliminary" in connection with the doings of the Pearson Fire Alarm System (Limited), and from a circular just issued to the shareholders, "in response to inquiries," it looks as if an extension of the company's system is to be carried out. It is stated that the Corporation of London have granted the company permission to lay wires under certain streets, and that in the Cripplegate district (between Aldersgate and Moorgate) a large number of automatic alarms have been fixed. The cause for the singularly regular attention which this company has received from the financial press is given in the announcement that subsidiary companies are to be formed in each leading provincial town, commencing with Northampton and Manchester. So far there appears to have been more cry than wool in connection with this company's practical operations as distinguished from its "finance."

Cooling Tower and Condensing Plant.—Mr. C. H. Wheeler, president of the Wheeler Condenser and Engineering Co., of New York and London, has arrived in London. The firm informs us that they have a large number of contracts in hand covering their cooling tower and condensing plant.

"Engineering Magazine."—The contents of the November issue include articles on—"Electric Power Distribution and the Small Consumer," "Electricity for the Auxiliary Machinery on Warships," "Proposed Pacific Cable Routes," "Standardising in Engineering Construction," "Revolution in Machine shop Practice," "Works Management for the Maximum of Production," "Development of German Shipbuilding," and "Evolution of Mining and Ore Treatment in Colorado."

Tools and Machinery Catalogue.—A formidable catalogue, bulking 312 quarto pages, crowded with illustrations and particulars of a great variety of all descriptions of tools and machinery has been issued by Messrs. Charles Nurse and Co., of 182-184, Walworth-road, London, S.E.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Nov. 1 to Nov. 7, with the ports of destination :—

Africa—Alexandria, £475 (including £89 telegraph wire); Cape Town, £713; Durban, £2,483 (including £2,342 telegraph material); East London, £257; Port Elizabeth, £319. *Argentina*—Buenos Ayres, £892 (including £791 telegraph material). *Australasia*—Adelaide, £100; Christchurch, £17; Hobart, £19 (telegraph wire); Launceston, £113; Lyttelton, £24; Melbourne, £32; Sydney, £771 (including £76 telegraph material); Wellington, £972. *Belgium*—Antwerp, £90; Ostend, £100. *Ceylon*—Colombo, £10 (telegraph material). *China*—Shanghai, £394. *Denmark*—Copenhagen, £23 (telegraph wire). *France*—Marseilles, £69. *Germany*—Hamburg, £345 (including £235 telegraph material). *Gibraltar*—£20. *Greece*—Piræus, £15. *Holland*—Amsterdam, £94; Rotterdam, £127. *Hong Kong*—£64 (including £24 telegraph material). *India*—Bombay, £36. *Japan*—Tokyo, £1,278; Yokohama, £1,408. *Madeira*—£13. *Mauritius*—£35 (telegraph stores). *North Atlantic*—£5,200 (telegraph cable). *Spain*—Santander, £108. *Uruguay*—Monte Video, £100. *West Indies*—Jamaica, £14 (telegraph material). Total, £16,730, against £8,786 in the corresponding week last year (Nov. 2 to 8).

MUNICIPAL, FOREIGN, AND GENERAL NOTES.

Aberdeen.—At a special meeting of the Corporation on Thursday last it was decided to promote a Bill for the extension and improvement of the tramways, and for the electrical equipment of same, at an estimated cost of £123,902.

Adelaide (S. Australia).—The undertaking of the Adelaide Suburban Tramway Co. has been definitely acquired by the Westinghouse Electric Co., who propose to substitute electric for horse traction as soon as the necessary Parliamentary powers are obtained.

Amazon Valley.—In the vast region of the Brazils watered by the Amazon the openings for new industries and for the obtaining of State Government concessions are considered promising. The English have hitherto controlled a large share of the industries of the district, but Belgian capitalists are now providing capital for the buying up of property at Pará, where the electric lighting plant has passed into their hands. The municipality of Pará in July last awarded concessions for an electric railway, waterworks, and other important enterprises. Concessions will shortly be given out for an electric railway at Iquitos, a city 3,000 miles up the Amazon, at the foot of the Andes, in Peru. An electric railway has been established at Manaos 15 miles in length, and is now in full operation.

Arnberg (Germany).—Electricity works are being erected in this town, and the water-power of the river Ruhr will be utilised in the generation of current. A tunnel 975 metres long has been bored through the Lusenberg hill behind the town, through which the water will be led to the turbines, which are to be placed underground in order to obviate freezing. The cost of constructing the station building, tunnel, &c., apart from the generating plant, will be 170,000 marks. About 2,000 H.P. will be available.

Ashton-under-Lyne.—Damaging reports having been circulated concerning the dynamos which have been put down at the electricity works, the following letter from the consulting engineers (Messrs. Lacey, Clirehugh and Sillar) appears in the *Ashton-under-Lyne Reporter* of the 4th inst.:—

We understand that an impression exists that the dynamos which have been installed by the Ashton Corporation for generating electricity for supplying light and power both to the town and to the Oldham, Ashton, and Hyde Electric Tramways are not satisfactory. In justice to the manufacturers, Messrs. P. R. Jackson and Co., we think it only fair, as consulting engineers to the Corporation, to make the actual facts public. Three dynamos are at work, each of which should be capable of giving 500 E.H.P., and it is a condition in the specification that each machine, before being finally accepted, should be tested at full load for six hours, and at the end of that period no accessible part of the dynamo should have a temperature higher than 70°F. above that of the surrounding atmosphere. The first dynamo tested complied with the specification in every way, but the armatures of the remaining two heated above the specified limit. Messrs. Jackson, on being notified of this, at once admitted the error and offered to rectify it, and this is at present being done. The fault has in no way militated against their use, as they have been in daily service on the tramways and lighting ever since.

There are several features in the dynamos which are quite new, and have enabled results to be obtained which, as far as we are aware, have never been approached before. When it is remembered that the Ashton Corporation are the first who ever supplied power for tramway and lighting purposes simultaneously from the same machine, and that there has never been any intermission in supply since the opening of the works, we think you will understand how unfair it is to attach blame to the manufacturers, whom we consider worthy of a considerable amount of credit. We would also point out that the total capital expenditure on the works is the lowest per horse-power in tailed that has ever been known in this country, and in addition, the whole of the material employed is of the highest quality; also that the Ashton Corporation are the first municipality to undertake the supply of power to a tramway company, from which source a large revenue is already coming in.

From the above, you will see that there are so many novel features in the works that it could hardly be expected that everything would immediately work perfectly, but there is no doubt that if properly managed the works will be a source of very great profit to the town.

Aston.—A resolution in favour of the purchase of the local tramways and for the construction of additional lines has been unanimously passed by the Council.

Asylum Lighting.—The Northumberland County Council are considering the question of lighting their asylum electrically.

Bala (North Wales).—At a recent meeting of ratepayers a resolution was passed calling upon the Council to engage a consulting engineer to report on the advisability of obtaining electric lighting powers.

Barmouth.—Mr. F. J. Warden-Stevens has been engaged, at a fee of 25 guineas, to prepare a report as to the Council obtaining electric lighting powers.

Barnard Castle.—The Northern Counties Electricity Supply Co. will apply for a provisional order for this district, and the application will be supported by the Council.

Barnsley.—An inquiry was held here on Wednesday into the application of the Council to borrow £3,661 for the electric lighting of the Harvey Institute, the Corn Exchange, the Market Weighhouse, and other public buildings. Evidence in support of the application was given by the town clerk (Mr. H. Horsfield), the consulting electrical engineer (Mr. T. L. Miller), and the resident electrical engineer (Mr. S. E. Bastow). There was no opposition.

Barrow-in-Furness.—Owing to the progress of the electricity department and the increasing demand for electric current, the consulting engineers (Messrs. Kincaid, Waller and Manville) have been instructed to report upon the advisability of providing additional plant.

Battersea (London).—The vestry have resolved to extend the electric light mains and to erect additional arc lamps at an increased expenditure of £5,381. Tenders are invited on another page for the supply of arc lamps and columns.

Belfast.—After a debate, extending over two days, on the vexed question of electric traction, the Corporation on Wednesday appointed a committee to confer with the Belfast Street Tramway Co. as to the terms upon which they would be prepared to sell their undertaking.

Berwick.—After considering the report of their consulting engineer (Mr. A. A. Campbell Swinton), the Council have decided to support the application of Edmundson's Electricity Corporation for a provisional order

Blackpool.—Application is to be made to the Local Government Board for sanction to borrow £42,515 for extensions of the electricity supply undertaking. The extension scheme has been prepared by the borough electrical engineer (Mr. Robert C. Quin), and the loan will be expended as follows:—New buildings and chimney, £6,500; four boilers, £4,500; steam dynamo, £10,000; steam, exhaust, and water pipes, coal conveyor, &c., £2,000; condensers, traction sets, battery, and switchboard, £8,400; high-tension feeder mains and three new transformer chambers, £7,500; and, with 10 per cent. for contingencies, the total is brought up to £42,515. This expenditure will bring the electricity works capital expenditure to an amount largely in excess of the gas works account.

Bolton.—An inquiry was held here on Tuesday into the application of the Corporation to borrow £100,000 for electric lighting purposes. The borough electrical engineer (Mr. Arthur Ellis) explained that the loan would be employed as follows:—£11,911 for buildings, £47,524 for machinery, £4 072 for accumulators, £23,535 for mains, £7,323 for transformers, and £5,634 for meters. Since the commencement of supply in October, 1894, the extensions had been almost continuous, on account of the great demand for current for lighting purposes. In 1898-9 the number of consumers was 559, the equivalent number of 8-c.p. lamps 43,740, the number of units sold 416,635, the length of mains laid 50,870 yards. There was a profit of £1,205. 14s. 6d., out of which £1,000 went in reduction of rates. Since March 10,193 lamps had been connected, bringing the total to 53,933, and 56 consumers were now awaiting connection. There was no street lighting by electricity, but the chairman of the Electricity committee (Dr. Panton) said that they were making strenuous efforts to get an arc lighting scheme for the town adopted. The application was unopposed.

Brecon.—Mr. Bertram Thomas has been instructed by Col. John Morgan, D.L., to prepare an electric lighting scheme for Brecon, and a provisional order is to be applied for. The estimated cost of the project, which Col. Morgan has generously undertaken to defray, is put at £6,000.

Ceylon.—The introduction of the "25-cent" telegram has led to a phenomenal increase in telegraph receipts. This telegram rate is probably the cheapest in the world, and its introduction has caused a considerable extension of telegraph business throughout the island. 54 miles of lines were added during 1898.

Chertsey.—The Woking Electric Supply Co. will apply for a provisional order for Chertsey.

Cleckheaton.—At a meeting of the Council on Tuesday it was decided to apply for electric lighting powers. The Council's consulting engineer is Mr. A. H. Gibbings, of Bradford.

Conference of Railway Managers.—Mr. George H. Turner, general manager of the Midland Railway, has been unanimously elected chairman of the Conference of General Managers of the Railway Companies of Great Britain for 1900.

Cork.—The amended scheme for electric lighting submitted on Aug. 22 has been adopted by the Council.

Croydon.—The Corporation have definitely decided to equip their tramways on the overhead system, and to lease the lines to the British Electric Traction Co.

Dawlish.—On the recommendation of their consulting engineers (Messrs. Taylor and Field), the Council propose to apply for a provisional order.

Dolgelly.—Before embarking upon electricity supply, the Council have decided to make a canvass of the ratepayers, in order to ascertain the probable support which would be accorded to a scheme estimated by the Electric Lighting committee to cost about £4,500.

Dundee.—The first annual supper of the staff of the Dundee electricity station was held last week under the presidency of

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ex-Provost Brownlee, who gave a short history of electric supply in Dundee and enumerated the many difficulties which had to be contended with prior to its establishment. Mr. W. H. Tittensor, the city electrical engineer, proposed the toast of his assistant engineers and referred to the competency of the staff under his control.

Edinburgh.—At the Lord Provost's committee, on Friday, the expediency of making an arrangement with the National Telephone Co. in connection with the telephone service within the city was considered. The committee came to the conclusion that it would be advisable in the public interest to enter into a provisional agreement with the company on terms which would safeguard the rights of the Corporation in their streets, give a more efficient telephone service, and an alteration in rates which would benefit subscribers and lead to an extension of the service. There would also be a substantial rent paid to the Corporation by the company. The proposed agreement would expire in 1911.

Electric Traction in Lanarkshire.—Owing to the rejection by the Light Railway Commissioners of the scheme for the construction of a light (electric) railway between Hamilton, Motherwell and Wishaw, efforts are being made to induce the local authorities to themselves join in promoting a bill for the construction of the line.

Electric Tramways in South Lancashire.—The South Lancashire Tramways Co. intend to promote a Bill next session to acquire powers for the construction of a network of electric tramways in South Lancashire. The scheme affects 18 local authorities. One main line will run from St. Helens through Newton and Leigh to Bolton; another through Tyldesley to Swinton, where a connection will be made with the Manchester tramways; and a third through Atherton and Hindley to Wigan.

Erdington.—The Council will apply for a provisional order.

Fatality.—Mr. Frederick Lyall, electrical engineer, in the service of the Caledonian Cycle and Motor Car Co, during a ride from Fetteresso to Aberdeen on a motor car, met with an accident which proved fatal. The machine got out of control.

Friends in Need.—The members of the Sick Benefit Society of Messrs. Crompton and Co.'s Arc Works, Chelmsford, have decided to subscribe a penny per week during such time as may be necessary towards a fund for the wives and children of soldiers taking part in the Transvaal war. The firm have been asked to deduct the amount from the wages of those employees who give their consent to the scheme—an arrangement worthy of general adoption.

Messrs. Robey and Co., of Lincoln, have contributed 50 guineas to the Transvaal Refugee Fund.

Glasgow.—Col. Sir F. Marindin and Mr. A. P. Trotter officially inspected the Glasgow Cross-Govanhill electric tramway route on Wednesday. This line was opened for traffic yesterday.

Gloucester.—A report by the resident electrical engineer (Mr. W. J. Bache), on the proposal to light the Guildhall and other public buildings electrically, has been referred to the consulting engineer Mr. R. Hammond).

Grays (Essex).—An inquiry was held here last week into the Council's application to borrow £13,000 for establishing electricity supply. There was no opposition. The consulting engineer (Mr. A. H. Preece) submitted plans and specification and technical details. The Council have received numerous applications for current, and it is estimated that the undertaking will be a financial success after the first year.

Great Yarmouth.—On Friday an inquiry was held into the application of the Corporation to borrow £27,000 for electric lighting purposes. The present loan is required for extensions to Gorleston and for electric tramway plant. The total capital expended was £38,615, and the Council had received sanction for borrowing £40,000. There was no opposition.

Hanley.—An inquiry was held on Tuesday into the unopposed application of the Town Council to borrow, amongst other sums, £4,000 for the extension of electric lighting mains and for providing additional transformers, and also £1,000 for providing electric motors and fittings. The former loan to be for a period of 25 years and the latter 10 years. Ald. Hammersley said that the revenue of the electricity department last year was £7,670, and the undertaking was very successful.

Hartlepool.—The Corporation recently received a proposal from the Hartlepool Electric Tramway Co. for the acquisition of their provisional order. Though the Council are indisposed to transfer the order, the matter has been referred to committee.

Heckmondwike.—An inquiry has been held into the Council's application to borrow, amongst other sums, £14,000 for establishing electricity supply. The clerk (Mr. Anlay Macaulay), who gave particulars of the application, said the Council obtained a provisional order in 1891, but owing to a report from their consulting engineer (Mr. W. C. C. Hawtayne) they recently decided to establish electricity works. This proposal had had the sanction of the ratepayers. Mr. Hawtayne submitted plans and specifications and gave details of the proposed scheme. There was no opposition.

Houghton-le-Spring.—The Council have sanctioned a proposal to construct electric tramways.

Interruptions.—On Monday evening a temporary failure of the electric light occurred at *Birmingham*, resulting in the supply being partially cut off for about 1½ hours. This is the first serious interruption of supply that has occurred in Birmingham.

At *Halifax* there was an hour's interruption of supply on Monday in the evening. From seven to eight o'clock the electric cars near King's Cross and High Wells sections were at a standstill, and the street arcs were out.

At *Dublin*, on Friday last, one of the overhead trolley wires of the electric trams was found broken in Parkgate-street, the damage being caused, it is supposed, by a fire escape on its way to a conflagration.

Japan.—A recent report from the U.S. consul-general at Yokohama refers to the progress of the electrical industry in Japan. The art of electro-plating has developed considerably at Tokyo, where a large workshop was established as far back as 1887. After passing through many vicissitudes, this industry has firmly established itself in Tokyo. The manufacture of telephone apparatus has so far advanced in Japan (with the exception of springs) that the bulk of the telephone apparatus used in the country is home-made. The manufacture is carried on both at Government and private works. In Tokyo a number of these private factories have been established, mostly in a small way. In the town of Osaka there are also several telephone instrument manufacturing firms. The electric motors required for the Kawasaka electric tramways were manufactured at the Shibaura Engineering Works, and are the first electric motors manufactured in Japan. It is stated that the machines are working well, and that the same manufacturers are supplying plant and apparatus for the Hoshu electric tramways. The whole of the plant for these latter lines, with the exception of wheels and springs, is being manufactured in Japan. An electric tramway is in operation also in Kyoto.

Kettering.—The refuse destructor scheme has been postponed pending the presentation of Prof. Kennedy's report on electric lighting.

Leek.—Messrs. Burstall and Monkhouse have been appointed consulting engineers, at a fee of 30 guineas, to prepare a preliminary report as to the establishing of electricity works.

Light Railways.—The Middlesex County Council notify that they propose to apply for powers to construct five lines of light (electric) railways in their district. Power to employ electric or other mechanical power is being sought, and the lines will be constructed to the standard gauge. The first line will be constructed between Willesden and Wembley, the second between Wembley and Harrow-on-the-Hill, the third between Harrow-on-the-Hill, Wembley, and Wealdstone, the fourth between Harrow Weald and Great Stanmore, and the fifth between Friern Barnet, Finchley and Southgate.

The Garstang Council propose to make application for power to construct a light (electric) railway, and are in negotiation with the Blackpool and Garstang Light Electric Railway Co.

The Light Railway Commissioners have sanctioned the construction of a light railway between Faversham and Maidstone. The line will be 12 miles long, and is estimated to cost about £87,000.

The Wandsworth District Board of Works have decided to oppose the application of the London County Council to the Light Railway Commissioners for powers to construct a system of light (electric) railways, as the board think that the procedure should be under the Tramways Act.

English Industrials (Limited) have prepared and submitted to the interested local authorities particulars of their project for the construction of a light (electric) railway between Beeford and Hornsea.

A scheme has been brought forward for the construction of a light railway from Witney to Burford, which the Gloucester and Oxfordshire County Councils are likely to support.

The Light Railway Commissioners have submitted the Cheltenham-Cleeve-hill light (electric) railway order to the Board of Trade, and objections must be lodged with the Board before 29th inst. The promoter (Mr. Thomas Nevins) is applying for an order for extensions.

The Board of Trade have confirmed the light railway order authorising the construction of a light (electric) railway from Stourbridge to Kinver by the British Electric Traction Co. The gauge of the line will be 3ft. 6in. A period of three years is allowed for its construction, and passengers, minerals, animals, &c., may be conveyed.

The Wellingborough Council have decided to support the application of the British Electric Traction Co. to construct a light (electric) railway from Wellingborough through Finedon to Kettering.

Limerick.—The Corporation have definitely committed themselves to an electric lighting scheme estimated to cost about £18,000. The Limerick provisional order was obtained in 1892, and a report was obtained from Prof. Kennedy, who, however, is not able to continue

as consulting engineer, owing to pressure of work in connection with the London County Council electric tramway scheme.

Lincoln.—At the Council meeting on Tuesday it was decided to apply for powers to construct and work electric tramways.

Littlehampton.—A special meeting of the Council is to be held in order to consider an application for sanction to a proposed application for a provisional order.

Llanelly.—An agreement has been entered into with the British Insulated Wire Co. for the erection of electricity supply works for lighting and traction purposes in this district. The company undertakes to supply current for private lighting at 6d., for public lighting at 4½d., and for heating and power at 2d. per unit. The council retain the right of purchase at 14, 21, or 28 years.

London County Council.—At Tuesday's meeting the recommendation of the Highways committee with regard to the use of electricity by the London United Tramways (set out in *The Electrician* for November 3rd) was again adjourned, pending a report from the Hammersmith Vestry. The Highways committee presented a report on the subject of electric tramways in Westminster. The Council has already decided to apply to Parliament for powers to embank the Thames from Victoria Tower Gardens to Lambeth Bridge, and to widen Millbank-street to 70ft. The committee consider it desirable that the Council should also obtain powers for the construction of a double line of tramway, to be worked on the underground system of electric traction, along Millbank-street after the widening has been carried out. It was estimated the tramway would cost about £6,000. The consideration of the matter was deferred.

Lytham.—A report from the Council's consulting engineer (Mr. F. H. Medhurst) on the proposal to establish electricity supply was recently submitted. The estimated cost is put at £24,000. Consideration of the matter has been deferred.

Malton (Yorks.).—The Council have sanctioned the application of the Northern Counties Electricity Supply Co. for a provisional order.

Manchester.—Plans are being prepared for the construction of an underground electric railway in Manchester, which will connect all the city railway stations. The scheme has not yet been brought officially before the Corporation, but several members have informally expressed approval, and parliamentary powers are to be applied for next session.

Manchester-Liverpool Electric Railway Scheme.—A syndicate has been formed, with a capital of £40,000 in £100 shares, and will apply for parliamentary powers for the construction of a high-speed electric railway between Manchester and Liverpool on the Behr mono-rail system. The Exploration Co. of London hold the right of option of acquiring Mr. Behr's patents, but have concurred with Mr. Behr in entering into an agreement with the syndicate under which, in the event of their obtaining parliamentary powers and the requisite capital being subscribed, Mr. Behr and the Exploration Co. bind themselves, at the request of the syndicate, to grant a licence for the use of the invention on certain terms, as follow :—(1) Payment in cash of £60,000 when railway is opened throughout ; (2) twelve yearly payments of £6,000 in cash ; (3) a yearly royalty of 25 per cent. of the net profits in perpetuity, after payment of 5 per cent. on the paid-up share capital. Under the agreement the Exploration Co. is entitled to one-third of all net profits of the syndicate after the holders of the original share capital of £40,000 shall have received, either by dividend or otherwise, an amount equal to the amount paid up in cash on the £40,000 of share capital. The Exploration Co. have requested Messrs. Mather and Platt (Limited) to carry out at their works such tests of electrical plant as may be found necessary, and in perfecting details of same ; and, in consideration, the Exploration Co. have entered into the preliminary contract with Messrs. Mather and Platt for the construction of the electric power plant. The directors of the syndicate are : Messrs. J. S. Bergheim, London ; Mr. E. Tootal Broadhurst, Manchester ; Mr. D. Cunningham, Liverpool ; Mr. J. H. Macmillan, Manchester ; Mr. Wm. Mather, Manchester ; Mr. William Oulton, Liverpool ; and the Hon. R. J. Strutt, Witham, Essex.

Milan.—The transit service in this Italian city is wholly electrical, 42 miles of track being owned by the municipality. One line entirely encircles the city, and is divided into five sections. The Società Generale Edison has an agreement with the municipality for the management of the tramways, which expires in 1920. The track was constructed by the municipality, who transferred it to the Società Generale Edison on payment of £175 per kilometre of single track. The arrangement between the municipality and the society provides for the deduction from the total annual receipts of all sums paid by the society to the municipality and by the municipality to the society, the remainder being divided in the proportion of 40 per cent. to the society and 60 per cent. to the municipality. In 1898 nearly 45,000,000 passengers were carried by the city tramways.

Mile End (London).—A special meeting of the Vestry has been summoned for the 27th inst. to consider the advisability of applying for a provisional order. The County of London Co. already possess electric lighting powers for the district.

Nantwich.—The Council have under consideration two schemes for the electric lighting of the district, one involving an expenditure of £11,000, and another £7,000. A provisional order is to be applied for.

Newport (Mon.).—In a report presented by the Council's tramway expert (Mr. Horace F. Parshall) it is stated that the site of the present electric lighting station cannot be utilised for a tramway power station without impairing its efficiency. Mr. Parshall is of opinion that the best site available is immediately below the athletic grounds ; that the overhead system should be carried out on the span-wire system throughout with a centre running trolley ; and that the use of top seats be adopted. His estimate of the total cost, exclusive of land, with all provision for future developments, is £91,480, but if armoured cables are laid direct in the earth, £85,030. Parliamentary powers are to be obtained.

Northallerton.—The Electric Light and Gas companies have both been invited to tender for the lighting of the streets.

Oldbury.—The Gas committee has been instructed to deal with the application of the Midland Electric Corporation for Power Distribution with regard to the supply of electric current for public and private lighting in the district.

Provisional Order Notice.—The Brierley Hill Council give formal notice of intention to apply for a provisional electric lighting order.

Provisional Order Transfer.—The Heaton Norris District Council give notice of intention to transfer their provisional order to the Manchester Corporation. The Council reserve the right to repurchase at 21 years, or at any subsequent period of five years. The charge for electric current in the Heaton Norris district is to be the same as in Manchester.

Radcliffe.—Powers are to be obtained for the construction and working of electric tramways.

Redruth.—The application of Edmundson's Electricity Supply Corporation for a provisional order will be supported by the Council.

Romford.—A formal resolution in favour of applying for a provisional order was passed by the Council last week.

Runcorn.—The Highways and Buildings committee have been empowered to engage an electrical engineer to report upon the question of establishing electricity supply in the district.

St. Helens.—Pending the settlement of the controversy between the Corporation and the London and North Western Railway, as to who is responsible for restoring the Peasley Cross Bridge to its proper height, the tramway manager (Mr. Cuttler) has had the standard on which the trolley is carried reduced in height so that the large bogey car used for the directors' inspection on Wednesday passed safely under the bridge.

Sale (Cheshire).—The Board of Trade have postponed the question of the revocation of the provisional order until Jan. 30 next. Current is already being supplied by the Altrincham Electric Supply (Limited) to a few houses in the district, with the consent of the Council.

Shoreditch (London).—The Vestry have adjourned the debate on the report of the Electric Lighting committee respecting the allocation of the available surplus of the electricity department, amounting, it is said, to £6,463. The committee consider that all money received as contributions from the rates since the inception of the electricity undertaking (being chiefly repayment of debt and interest before the works were commenced) should be repaid to the rates. This item, which is £1,255. 8s. 2d., represents deficiencies in years ended March 25, 1895-6-7. On this repayment being made no monies from the rates will be involved in the undertaking either on maintenance or capital account, as all capital has been provided for out of borrowed money. The committee also propose to recompense the dust destructor undertaking for steam supplied, from the waste heat obtained from the parish refuse, by arranging for the electricity undertaking to pay a sum equal to the cost which they would have incurred had the electricity been generated from coal, and from the average of 17 metropolitan stations the chief engineer states that the cost of coal is about 1d. per unit on the total units sold, the other costs of handling the fuel, &c., being already fairly apportioned to the electricity department. On this basis the cost to the electric lighting undertaking would amount to £4,297. 5s. 8d., and, after deducting from that sum the amount already spent for coal, viz., £1,375. 13s. 6d., there appears a balance of £2,921. 12s. 2d. to be credited to the dust destructor accounts as representing the full value of the steam supplied to the electricity undertaking. This payment would still leave a deficit in the dust destructor accounts of £694. 10s. 4d., against which the value of the steam supplied to the baths and washhouses should be set, as from the estimate of Mr. Manville it would have cost the baths more than this sum for all charges in connection with the heating of the baths and washhouses

by separate boilers. In view also of the saving to the rates during the past year of over 1s. per ton, or £1,186. 8s. 11d., on the parish refuse burnt, from the previous cost of barging, the committee think that the electricity undertaking should not be further saddled with the cost in past years of a distinct branch of the municipal service, such as dust disposal, which is payable out of the general rate and not legally chargeable to the lighting rate. The above proposals will dispose of the deficit on the dust destructor account. The committee have unanimously agreed to allocate £250 out of the surplus of the electricity undertaking to the Library committee's account. This will leave an available surplus of £2,036. 10s. 4d., out of which the committee propose to apply £1,000 to reserve, and the balance of £1,036. 10s. 4d. is carried forward. The committee's recommendations will be considered at the next meeting.

Shrewsbury.—The general market is now lighted electrically.

Stafford.—The market buildings are to be lighted electrically at an estimated cost of £230.

Telephone Municipalisation.—At a meeting of the Glasgow Corporation, last week, the Telephone committee reported that they had received a communication from the Postmaster-General asking that, in order to enable him to complete the licence to the Corporation for the erection of a telephone exchange, he should be furnished with new resolutions of the various local authorities similar to those formerly passed. The burghs included in the area have been asked to comply with this request.

The General Purposes committee of the Burslem Council have reported that, at the recent joint conference of local authorities at Longton on the question of providing a cheaper telephone service, the principle of competition was agreed to be desirable, and it was recommended that a committee be formed (one representative from each district) to obtain information as to the practicability of establishing a cheap telephone service, either by combination of local authorities or by a company.

Torquay.—The demand for electric current continues to increase, and at present the equivalent of about 10,000 8-c.p. lamps is connected to the mains, and extensions will shortly have to be considered.

Tunstall.—Electric lighting powers are to be applied for by the Council.

Underground Telephone Facilities.—The Battersea and Hammersmith vestries have decided to participate in the conference of London local authorities to consider the applications of the Postmaster-General for consents to the laying of underground telephone cables.

U. S. Patent Regulations.—The United States Department of War has just announced an arrangement for protecting United States patents and trade marks in Cuba, Porto Rica and the Philippines upon compliance with certain conditions. The cost is but small, and the concession may well prove of interest to those doing business in these countries.

Wallasey.—The Council have received sanction to the borrowing of £10,000 for electric lighting extensions.

Warrington.—An inquiry was held here on Wednesday into the application of the Corporation to borrow £44,966 for electric lighting purposes. The town clerk (Mr. J. Lyon Whittle) supported the application. A canvass of ratepayers had been made, and already applications for an equivalent of over 12,000 8-c.p. lamps were to hand. Plans and specifications were submitted by the consulting engineer (Mr. A. H. Preece), who stated that provisional contracts had been entered into for the supply of plant, and the Corporation would be in a position to supply electric current by July next. Answering a question, Mr. Preece said he thought electricity would successfully compete with gas. He was not aware that at Liverpool the street electric arcs were being superseded by incandescent gas lights. The inspector said he had not come across any place where the electric light had brought any burden on the ratepayers. Neither had he heard that gas had suffered in consequence of electric light. There was so much gas now being used for cooking purposes that it was making up for any loss which might be sustained as an illuminant in competition with electric light. As to the refuse destructor works, the steam raised would be utilised by the electricity department. There was no opposition.

Wimbledon.—An inquiry will shortly be held into the council's application to borrow £22,000 for extensions of the electric lighting undertaking. The electricity department can now give a continual supply of current during the 24 hours.

Wolverhampton.—In the annual report of the Lighting committee recently presented to the Council it is stated that the demand for electric current continues to increase, and that the equivalent number of 8-c.p. lamps connected in September was 21,542, against 16,853 in October last year. There was an increase of nearly 45 per cent. in the units sold to private consumers. Various extensions of the distributing mains had been made in a number of streets; the three-wire system of distribution had been adopted.

COMPANIES' MEETINGS AND REPORTS.

Eastern Extension, Australasia, and China Telegraph Company (Limited).

The fifty-second half-yearly general meeting of this Company was held on Wednesday, at Winchester House, Old Broad-street, under the presidency of the Most Hon. the Marquis of TWEEDDALE, K.T.

The MANAGER and SECRETARY (Mr. F. E. Hesse) read the notice calling the meeting, and subsequently the minutes of the last ordinary general meeting, which were approved by the present meeting and signed by the Chairman as correct.

The CHAIRMAN then said: Gentlemen, I have now to invite your approval of the report and accounts, which I presume you will take as read. The report of the proceedings of the last half-year I think will be deemed highly satisfactory. The gross revenue for the six months under review—to June 30th last—has amounted to £324,361, showing an increase of £47,079 as compared with that of the corresponding period of 1898. This satisfactory result is due to increased traffic all over the Company's system, but more particularly with Manila and China. The working and other expenses have amounted to £107,266, showing an increase of £4,393. This is accounted for partly by the opening of the new stations at Iloilo and Cebu in the Philippine Islands, and partly by the greater number of staff necessary to deal with the increased volume of traffic. The usual interim dividends at the rate of 5 per cent. per annum have been paid for the past half-year, amounting to £62,500; and after transferring £5,000 to a special reserve fund in connection with the proposed removal of the head offices, and £100,000 to the general reserve fund, the sum of £13,299 is carried forward to the next account (cheers). During the half-year under review the general reserve fund has been debited with £68,931 in connection with renewal work to the Saigon-Hong Kong cable and extensions to Iloilo and Cebu. Unfortunately, the political situation in the Philippines shows little or no improvement, and it would seem that further heavy fighting must ensue before American rule is firmly established there. All I can hope is that before I next have the pleasure of meeting you six months hence a more satisfactory state of things will have been brought about (hear, hear). You will have learned from the newspapers that shortly after I last addressed you Her Majesty's Government announced that they had decided to co-operate with certain of the Governments of Australasia and Canada in the laying of a State-owned-and-worked cable across the Pacific Ocean. Your Directors, in concert with the Eastern Telegraph Co., considered it right, in the interests of the proprietors, to protest against the British Government entering into active competition with private enterprise and pledging the public credit of the country for such a purpose, more particularly as the companies had previously offered to provide an alternative "all-British" cable to Australia by an admittedly better strategic and commercial route via the Cape, and on terms more advantageous to the Governments interested. Accordingly, a deputation from the two companies waited upon the Chancellor of the Exchequer and Secretary of State for the Colonies, in order to express the companies' grave objections to so serious an attack upon private interests, and correspondence was subsequently exchanged between the Colonial Office and the companies on the subject. The remarks that fell from the Chancellor of the Exchequer and the Colonial Minister at the deputation made it clear that the Government was not disposed to withdraw from their promise to assist the Colonies in the manner indicated. At the same time they expressed the opinion that the loss of traffic would not be so serious as the Company appeared to anticipate; and, further, that there was no intention of competing on any other than fair and equitable terms. After careful consideration of the situation so created, your Directors came to the conclusion that the interests of the Company would best be served by at once offering to meet the oft-expressed wishes of the Australasian Colonies for an alternative cable route and a reduced tariff. They accordingly submitted a proposal for extending the new Cape cable to Australia, without requiring any subsidy or guarantee from the Australasian Governments, and for at once reducing the tariff between Great Britain and Australia to 4s. per word, to be followed by further reductions, on a sliding scale, down to 2s. 6d. per word as the traffic responded to the reductions. The only condition attached to the proposal was that the Company should be accorded the same freedom of dealing directly with the public in Australia as prevails in this country and elsewhere. Without such freedom the Company would be entirely dependent upon the Governments for the collection, transmission, and delivery in Australia of the traffic, making it impossible for them to carry on their business on equal terms with their competitors. The proposal has been very favourably received by the Press, Chambers of Commerce, and mercantile communities generally in Australia, and we have reason to believe that it will eventually be accepted. The moment we receive satisfactory assurances on this point, the laying of the cable from the Cape to Australia will be proceeded with. With regard to the Pacific project, you will remember that the Imperial Government at first decided to limit their assistance to a subsidy payment not exceeding £20,000 per annum; but as this decision caused great disappointment in Canada and Australasia, the Government were induced to reconsider their offer, and we understand that they are now prepared to take part in the ownership, working and management of the cable. The details, however, have yet to be settled, but it has been announced that an advisory board representing the British Government, the Australasian Colonies, and Canada has been or will be immediately appointed for this purpose. That the Pacific cable when laid—say, in two or three years—will divert some of our traffic is, of course, self-evident. Still, I think we may, with our two independent cable routes and access to our own offices in the principal towns of Australia, look forward to the

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coming competition without serious apprehension (hear, hear). You will observe from the seventh paragraph of the report that it is proposed to alter the trust deeds of the staff pension and superannuation funds, so as to admit of the retiring age being reduced from 60 to 55. This change is very desirable, inasmuch as we find the existing limit age too high, and tending rather to the retention of employés who are no longer able to give efficient service. To effect this salutary alteration in the trust deeds the contributions of the staff and of the Company to the pension fund will have to be increased from 2½ per cent. to 4 per cent. The staff, I believe, will gladly agree to this proposal; and I am confident that the proprietors, who have always shown a hearty wish to improve in every way the position of the staff generally, will without the slightest doubt give their support to this proposal (hear, hear). A formal resolution will be submitted to the meeting, after the adoption of the report, authorising the Directors to increase the Company's contribution from January 1st next to 4 per cent., together with a sum sufficient to enable the trustees to pay the pensions which have already been purchased and may be purchased prior to December 31, 1899, at the age of 55 instead of 60 years. The sum required from this Company to make up the back payments is roundly about £11,000, and if this amount be spread over 20 years, as proposed by the actuary, it will only represent a few hundred pounds per annum in addition to the increased contributions. Authority will also be taken to make an alteration in the superannuation trust deed, by which the age limit will be reduced to 55 years, the Company guaranteeing to make up the loss (if any) that there might be in the fund on account of such reduction. I may say that the actuary informs us that there is little or no probability of any loss arising under this head. With these observations, I will invite your approval of the following resolution:—

"*That the report and accounts of the Directors now submitted be received and adopted.*"

Mr. FRANCIS A. BEVAN seconded the motion.

The CHAIRMAN put the resolution to the meeting, and, having declared it carried unanimously, said: Then, gentlemen, I have to propose the next resolution, which is rather a long one, although it is purely formal, namely:—

"*That the Directors be authorised to increase from January 1, 1900, the Company's contribution to the staff pension fund under the indenture of June 30, 1893, to 4 per cent., and from time to time to contribute a sum or sums which, in the aggregate, will be sufficient to enable the pensions which have already been purchased and those which may be purchased prior to and including December 31, 1899, to be paid to the persons who otherwise would have been entitled thereto under the said indenture at the age of 60 years to such persons at the age of 55 years; and that the Directors be authorised to guarantee or make good the deficiency (if any) there may be in the staff superannuation funds under the indenture of June 30, 1893, and which may arise by reason of the funds being paid to the persons who otherwise would have been entitled thereto under the said indenture at the age of 60 years to such persons at the age of 55 years That the Directors be empowered to make or concur in the making of such alterations in the said indentures as they may deem expedient for the purpose of carrying out and giving effect to the before-mentioned resolution.*"

Mr. JOHN DENISON-PENDER seconded the motion.

A SHAREHOLDER inquired whether the resolution was intended to apply to the staff abroad.

The CHAIRMAN: Yes; we could hardly distinguish between the different members of the staff. Besides, the proportion of home staff is very small compared with the foreign.

Mr. JOHN NEWTON said that he was glad to see that the Directors looked after the staff well, as they did after the shareholders. He trusted, however, that the pension fund would not be used for the benefit of the individual so much as for the benefit of the Company—he meant in this way: The Government said to every man in their employ that he must retire at the age of 65, but they made special exceptions by which a man might go on until he was 70, especially if his services were too valuable to be surrendered. In the case of the Company, too, it might be far better for them to pay the full salary to a member of the staff who had reached the age limit rather than that he should retire at 55 (hear, hear). He hoped that in connection with the Company's fund, if a man of 55 was of sufficient vigour not to necessitate his retirement, he would not fall on the pension fund, but would remain on the salary fund of the Company. He wished to draw attention to a remarkable lecture which was delivered on the previous day by a gentleman who was not exactly a friend of the two companies, and who described them as having got into "the quagmire of a monopoly." Probably the chairman had had his attention drawn to the lecture, in which reference was made to the fact of how much the Colonies and England were knitted together at the present time. The lecturer, however, did not admit that it was by means of the cable companies, more largely than by any other influence, that the Colonies were now so closely knitted to this country that they could help the latter in any difficulty that might arise, as had been the case recently at the Cape. Reference was also made by the lecturer to a remark that their cables always broke when a full service was required of them. Although that was a meeting of the Eastern Extension Co., they were so nearly allied to the Eastern Co. that he thought the Chairman might have given the shareholders a little information as to the position of the cable which was so prominently referred to by Sir Edward Sassoon. It seemed to him, notwithstanding the break of cables, that we were daily provided with a great deal of information from the Cape. Whether it was correct or not they did not know, but it must come over their cables. He thought that a statement about any of their cables being broken should not be allowed to go forth without the matter being put straight. The cables had rendered immense services to the country in knitting the Empire together. They were told by their friend that he would not cease to attack this "quagmire of a monopoly." He (Mr. Newton) thought it was scarcely fair to those who had put their money into cables communicating between this country and all parts of the world that they should be described as a sort of vampire feeding upon the country. He did not think that such attacks would be made on the brewing interests of the country, although they were also in "the quagmire of a monopoly." He did not think that the property ought to be attacked, as telegraph property was so constantly and persistently attacked, because of the rates they charged for communicating information from England to abroad and from abroad to this country. Not a word, however, was ever said by the companies' critics as to the immense development of coding, which reduced the 4s. a word, or whatever the charge might be, to a very trifling figure indeed. It was now proposed that they should be attacked by every Chamber of Commerce in the country, but he trusted that the immense number of shareholders in telegraph property would put their feet down and stop such attacks on what he maintained had been the most beneficent monopoly ever known in the world, and which had rendered more service to civilisation than even steam or any other great invention. Their enterprise was not a monopoly at all, and it ought not to be so considered.

The CHAIRMAN: Ladies and gentlemen, with respect to the alteration of the pension and superannuation funds, there is no intention of compulsorily retiring any of our staff at the age of 55. What is proposed only enables us to do this in cases where the inefficiency of any member of the staff is due to age or any other cause. There is no object whatever in retiring a good man at the age of 55 if he has plenty of work in him. I read Sir Edward Sassoon's remarks this morning. The lecture is evidently a *rechauffé* of what he said when he went before the Chancellor of the Exchequer and the Colonial Minister. He makes one reference to a remark which I made on the subject of the interruption of cables during the time of war. I said, as a matter of fact, that the interruption of communication between Cuba and the United States was never effected, although one would have supposed that the United States, having complete power of the sea, and having some object in interrupting the communication, would have taken effectual steps to do so. As a matter of fact, however, they did not. With respect to the question of monopoly, this is an old charge against the companies. I had to meet it when I saw the Chancellor of the Exchequer and the Colonial Minister, and I then pointed out that we had no monopoly at all between this country and Australia, or between this country and India. To India there are various routes, and so there are to China; and the word "monopoly" does not apply to us in any way whatever. The best evidence of that is that the Government are going to lay a cable, which they could not do if we had a monopoly. Then, with respect to the breakdown, reading that paper I judged that the lecturer meant to leave the impression that we are cut off from the Transvaal and Natal because the cables are interrupted. That is the only interpretation that can be put upon it. He quoted what Mr. Chamberlain once said—that when we are in trouble in Africa the cables generally give out, and he then pointed out that this is illustrated on this particular occasion. However, only one cable is interrupted—the east coast cable. The west coast cable is working as well as it could possibly work. With respect to the east coast cable, too, I may say that everything has been done that could be done to ensure its speedy repair. We have no fewer than three repairing ships on the coast ready to repair any fault, and I confess that we are not a little disappointed that this particular fault in the Mozambique cable has not been repaired before this. There is, however, no interruption between this and the Cape so far as telegraphic communication is concerned. It is impossible, as you will easily understand, to command the cables or to prevent interruptions from taking place. They arise from various causes, natural and artificial, sometimes proceeding from ships' anchors and sometimes being caused by mischievous persons. I am, however, happy to say that during this war an interruption has not once occurred in the communication. Moreover, if the Government had only listened to us a year or so ago, we should have had a third cable to the Cape before this. We are laying a third cable now, having comparatively recently obtained permission to land at the Cape. Had that permission been given to us a year or a year and a half ago, that cable would have been laid before now, and neither Sir Edward Sassoon nor anyone else would have been able to reproach us.

Mr. NEWTON inquired whether the new cable would be on the east or the west coast.

The CHAIRMAN: The west coast.

A SHAREHOLDER asked the approximate cost of extending the cable from the Cape to Australia, and also whether the funds necessary would be provided from the reserve or by new capital.

The CHAIRMAN: The cost of that cable will be debited partly to the Eastern and partly to the Eastern Extension Co., and the share of the Eastern Extension Co. will be something like £1,000,000. He then put the resolution, and having declared it carried unanimously, said: That constitutes the business of this meeting. I think you will agree with me that the Company is in a very prosperous condition, and that our future is by no means one that we need be anxious about.

Mr. GIBB then proposed a hearty vote of thanks to the Chairman, Directors, and staff for the efficient manner in which the affairs of the Company had been conducted.

Mr. NEWTON seconded the motion, which was carried unanimously.

The CHAIRMAN: Gentlemen, I beg to thank you, on the part of my colleagues and myself, for the cordial way in which this vote has been proposed and received by you. We appreciate your good wishes and opinions, I can assure you, most heartily. I believe that we shall be able to give you a very good report at the end of this half-year (applause).

The proceedings then terminated.

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West India and Panama Telegraph Co. (Limited).

The report of the directors of this company for the half-year ended June 30 states that the amount to credit of revenue is £30,929. 10s. 8d., against £39,612. 14s. 2d. for the corresponding half-year of 1898. The expenses have been £21,492. 4s. 8d., against £21,704. 17s. 5d., leaving £9,437. 6s., which, with £4,920. 0s. 8d. brought from last account, makes £14,357. 6s. 8d., with which it is proposed to deal as follows :—

First Preference dividend (six months), 6s. per share, £10,368. 18s.; second Preference dividend (six months), 6s. per share, £1,400. 14s.; Ordinary shares, 6d. per share (free of tax), £2,208. 0s. 6d.; balance forward, £379. 14s. 2d. The total receipts show a decrease of £8,683. 3s. 6d. compared with the corresponding period of 1898, when they were abnormally large consequent on the Spanish-American war.

The expenses of repairing cables during the half-year amounted to £8,334. 8s. 3d., being £572. 15s. 1d. less than those for the corresponding period. The St. Lucia-St. Vincent cable, which was interrupted by the hurricane of September last year, has been finally restored. The cost of renewing the original part of this section, amounting to £2,616. 8s. 4d., has been charged to reserve. The Jamaica-San Juan (Porto Rico) cable was interrupted by the hurricane which occurred in August last year, which also damaged some of the company's land lines, all of which have since been repaired.

A contract has been entered into for the manufacture and delivery to the West Indies of 310 knots of cable for stock.

The Danish colonies of St. Thomas and St. Croix have renewed their subsidies for a further term of five years.

IMPROVED ELECTRIC GLOW LAMP CO. (LTD.).—A private meeting of this company was held yesterday (Thursday) morning.

CITY NOTES.

MEMORANDA.—Bank rate 5 per cent. (since Oct. 5, 1899). Price of silver 27⅛d. per oz. (Nov. 9). Consols (2¾ per cent.) 103¾—104⅛ for money, 104⅛—104⅜ for account; 2½ per cent. 101–101¼ (Nov. 9). Stock Exchange Settling Days: Consols, Dec. 1; Stocks and Shares Continuation Days, Nov. 13 and 28; Ticket Days, Nov. 14 and 29; Pay Days, Nov. 15 and 30; Mining Share Carry-over Days, Nov. 11 and 27.

BRUSH ELECTRICAL ENGINEERING CO. (LIMITED).—Subscriptions have been invited this week to an issue of £75,000 Four and a-Half per Cent. Perpetual Second Debenture stock at a premium of £5, a balance of £50,000 of this stock being reserved for holders of the existing £50,000 Four and a-Half per Cent. Redeemable Second Debenture stock (for exchange). The proceeds of the present issue are required to discharge loans from bankers, and to provide funds for further extensions of the Company's Loughborough works. The debentures are fully secured, and have doubtless been fully subscribed. The present price of the Redeemable Second Debenture stock is practically that of the new issue (104½-105), the yield being about 4¼ per cent. With sound investments of this character available it is not surprising that investors in electrical securities have shown a reluctance to subscribe to recent issues of a highly speculative nature.

STOCK EXCHANGE NOTICES.—Application has been made to the Stock Exchange Committee to allow the further issue of 565 £10 fully-paid shares (Nos. 205,994 to 206,558) of the *Brazilian Submarine Telegraph Co. (Limited)* to be quoted in the official list. Application has also been made to the committee to appoint a special settling day in and to grant a quotation to £150,000 Five per Cent. (1891) Preference stock, £200,000 Five per Cent. (1896) Preference stock, and a further issue of £225,000 Consolidated Ordinary stock of the *City and South London Railway Co.* in lieu of Preference and Ordinary shares now quoted.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	1899	£	£		£	£
*Birmingham Tramways.	Nov. 4	4,339	+ 471	18	75,040	+ 8,046
Blackpool Corporation...	„ 2	172	+ 6	31	19,569	+ 4,305
Blackpool and Fleetwood	„ 6	189	– 3	18	19,061	+ 5,926
Bradford Corporation ...	„ 5	348	+ 79	64	21,263	...
Brisbane Trams	Sept. 20	1,527	+ 618	51	66,456	+ 19,668
*Bristol Trams & Carriage	Nov. 3	3,140	+ 573	18	56,206	+ 5,433
*Buenos Ayres & Belgrano	Oct. 8	2,365	+ 963	40	85,914	+ 39,864
City & South London Ry.	Nov. 5	1,045	+ 18	19	18,323	+ 21
Dover Corporation	„ 4	175	+ 10	31	6,973	...
Dublin United	„ 3	2,670	+ 2,335	...	...	...
Dublin Southern Dist....	„ 3	692	– 41	...	...	...
*Glasgow Corporation ...	„ 4	8,740	+ 658	...	...	...
*Liverpool Corporation...	Oct. 28	7,027	+ 1,045	43	295,746	+ 34,020
Liverpool Overhead Rly.	Nov. 5	1,873	+ 422	19	31,139	+ 895
*Sheffield Tramways	„ 5	1,875	+ 789	44	62,138	+ 17,713
*South Staffs. Trams... .	„ 3	697	+ 33	44	29,355	+ 1,469

* Partly electrical.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Oct. 31.		Price Wednesday, Nov. 8.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Nov. 8. Highest	Lowest
			TELEGRAPHS.					£ s. d.			
£110,900	100	4%	*African Direct Telegraph 4% Mort. Deb. (red.)	100	104	100	104	3 16 11	January and July	...	...
25,000	10	...	Amazon Telegraph	3	4	3	4	...	June and December	...	...
£125,000	100	5%	Do. 5 per Cent. Debentures	85	90	85	90	5 11 1		...	...
£875,520	Stock	15/0	Anglo-American	65	68	65	68	4 8 3	Feb., May, Aug., Nov.	66½	66
£3,062,240	Stock	30/0	Do. Preferred	116½	117½	116½	117½	5 2 2	„ „	116¾	116½
£3,062,240	Stock	18/0	Do. Deferred	16½	17	17	17½	5 2 10	...	17⅛	16¾
205,993	10	5/0	Brazilian Submarine xd and bonus	15	15½	15	15½	4 10 4	Mar., June, Oct., Dec.	15⅝	15⅜
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1900)	107	111	107	111	4 11 6	June and December	...	...
10,000,000	$100	$1½	Commercial Cable Capital Stock	180	190	180	190	4 4 3	Jan., Apr., July, Oct.	...	...
£1,365,141	Stock	4%	* Do. 4 per Cent. Debenture Stock	103	105	103	105	3 16 6	„ „	104	103½
16,000	10	8/0	Cuba Submarine Ordinary xd and bonus	9	10	9	10	8 0 0	February and August	...	...
6,000	10	10/0	Do. Preference 10 per Cent. xd	19	20	19	20	5 0 0	„ „	...	...
12,931	5	2/0	Direct Spanish Ordinary	4	5	4	5	4 0 0	April and October	...	...
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference	9	10	9	10	5 0 0	„ „	...	...
£30,000	50	4½%	Do. 4½ per Cent. Debentures	103⅞	107⅞	103⅞	107⅞	4 4 1	January and July	...	...
60,710	20	3/0	Direct United States Cable	11⅞	12¼	12	12⅜	5 12 0	Jan., Apr., July, Oct.	12	...
£120,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red.)	101	104	101	104	4 7 10	June and December	...	...
£4,000,000	Stock	5%	Eastern Ordinary	156	161	157	162	4 6 8	Jan., Apr., July, Oct.	161	158
£1,795,000	Stock	3½%	Do. 3½ per Cent. Preference Stock	99	102	99	102	3 8 8	„ „	100½	99
£1,432,288	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.) xd	117	122	117	122	3 5 7	May and November	120½	118
250,000	10	2/6	Eastern Extension	15	15½	15½	16	4 7 6	Jan., Apr, July, Oct	16	15⅝
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	118	123	118	123	3 5 7	February and August	120	...
£16,200	100	5%	* Do. 5% (Austln. Gov. Sub.) Deb., 1900 (reg.)	99	103	99	103	4 17 4	January and July	...	...
£64,400	100	5%	Do. (Bearer)	100	103	100	103	4 17 1	„ „	...	...
£17,400	100	5%	*Eastern and S. African 5% Mort. Deb., 1900 (reg.)	99	103	99	103	4 17 1	„ „	...	...
£21,500	100	5%	Do. (Bearer)	100	103	100	103	4 17 1	„ „	...	...
£300,000	100	4%	* Do. 4 per Cent. Mortgage Debentures, 1909	101	104	101	104	3 16 11	February and August	...	...
£200,000	25	4%	Do. 4 per Cent. Mauritius Sub. Debs. (red.) xd	102%	105%	101%	104%	3 16 10	May and November	...	...
180,227	10	1/9	Globe Telegraph and Trust xd	11	11¼	11¼	11⅜	4 9 4	Jan., Apr., July, Oct.	11⅜	11⅛
180,042	10	3/0	Do. 6 per Cent. Preference xd	15½	16	15½	16	3 15 0	„ „	15⅞	15⅝
150,000	10	5/0	Great Northern of Copenhagen	30	32	30	31	4 0 8	January and July	30½	...
£89,500	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb. (red.)	100	103	100	103	4 7 5	...	...	...
17,000	25	12/6	Indo-European xd	48	52	48	52	4 16 2	May and November	48½	...
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904	106	109	106	109	5 10 1	March and September	103½	...
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.)	103	106	103	106	3 15 6	June and December	...	...
11,839	8	4/0	Reuter's	7	8	7	8	5 0 0	April and October	...	...
3,331	£100 Cert.	6%	Submarine Cables Trust	123	133	129	134	4 9 11	„ „	132	...
15,609	10	...	West African Telegraph	2½	3½	2½	3½	4 9 3	December and July	...	...
£200,000	100	5%	* Do. 5 per Cent. Debentures (red.)	99	102	99	102	4 18 0	March and September	100	...
30,008	2½	...	West Coast of America	½	1	½	1	...	...	...	...
£150,000	100	4%	* Do. 4 per Cent. Debentures	102	105	102	105	3 16 8	January and July	...	...
88,321	10	2/6	West India and Panama	1½	1½	1⅝	1⅝	...	May and November	1⅝	...
34,563	10	6/0	Do. 6 per Cent. 1st Preference	10½	10¾	10½	10¾	5 11 6	„ „	10¾	...
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	8½	9½	9	10	6 0 0	„ „	...	...
£80,000	100	5%	* Do. 5 per Cent. Debentures	104	107	103	108	4 13 11	January and July	106	...
£382,731	Stock	4%	Western & Brazilian 4 per Cent. Debenture Stock	104	107	104	107	3 15 0	June and December	104½	...
£158,100	100	6%	*Western Union 6 per Cent. Sterling Bonds (red.)	98	103	98	103	5 16 6	March and September	...	...

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Oct. 31.		Price Wednesday, Nov. 8.		Rate per Cent. Yield'd.	Dividend Due.	Business Done During Week Ending Nov. 8.	
								£ s. d.		Highest	Lowest
			TELEPHONES.								
44,000	£5	3/0	Chili Telephone (fully paid)	2	3	2	3	6 13 4	August	...	...
224,850	10s.	0/1½	Consolidated Telephone Const. & Manufacturing	¼	½	¼	½	4 15 3	July	...	...
71,000	1	0/6	Monte Video Telephone Ordinary ..xd	½	½	½	½	5 0 0	October	...	...
84,000	1	1 0	Do. 5 per Cent. Preference ..xd	½	1	½	1	5 0 0		...	...
490,000	5	3/0	National	5⅛	5⅜	5	5⅛	5 14 3	February and August	5 3/16	5
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Preference	13½	14½	14	15	4 0 0	" "	14½	...
15,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference	13½	14½	14	15	4 0 0	" "	14½	...
250,000	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref.	5⅛	5⅜	5⅛	5⅜	4 10 11	" "	5⅛	7/8
1,329,471	Stock	3½%	* Do. Debenture Stock 3½ per Cent. (red.)	100	102	100	102	3 8 8	June and December	101	100⅝
171,504	1	0/5	Oriental ..xd	½	1	½	1	5 0 0	April and October	...	...
58,000	5	6/0	United River Plate	4½	5⅛	4½	5⅛	5 14 3	July	...	...
£179,947	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	105	108	105	108	4 13 9	June and December	...	...
			ELECTRICITY SUPPLY COMPANIES.								
100,000	1	...	Bl'ckb'n & Gr'nw'ch D'st'ct Elec. Lt. Ord. (15s. pd.)	¾	1	¾	1	...		...	...
6,000	10	7/9½	Bournemouth and Poole Electricity Supply Ord.	13	13½	13	13½	2 18 5		...	...
6,000	10	4/6	Do. 4½ per Cent. Cumulative Preference	10	11	10	11	4 1 10		...	...
19,661	5	2/6	Brompton & Kensington Electricity Supply Ord.	7½	8	7½	8⅛	3 10 7		...	...
12,000	5	3/6	Do. 7 per Cent. Preference	9	10	9	10	3 10 0	March and September	...	...
20,000	5	...	Calcutta Elec. Supply Ordinary (£4 paid)	5⅛	6⅛	5⅛	6	...		5¾	...
30,000	5	4/0	Charing Cross & Strand Electricity Supply Corp.	9⅛	10⅛	9⅛	10⅛	4 5 9	February & August	10⅛	...
20,001	5	...	Do. (Nos. 3,001 to 50,000)	9⅛	10⅛	9⅛	10⅛	...		...	...
20,000	5	2/3	Do. 4½ per Cent. Preference	6	6⅛	6	6⅛	3 9 3	" "	6⅛	...
34,000	5	2/6	Chelsea Electricity Supply Ordinary	8	9	8	9	3 6 8	March	...	...
£100,000	Stock	4½%	* Do. 4½ per Cent. Debenture Stock (red.)	110	112	111	113	4 0 9	June and December	111½	...
$1,200,000	$1,000	5%	Chicago Edison 1st Mort. 5% 30 year Gold Bonds (red.)	100	110	100	110	4 10 11	April and October	...	...
60,000	10	7/0	City of London Electric Lighting Ordinary	11	12	11½	12½	5 0 0	February and August	11 15/16	11
40,000	10	6%	Do. 6 per Cent. Cumulative Preference	12½	13½	13	14	4 5 9	January and July	13⅛	1 ⅛
£400,000	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	125	130	125	130	3 17 5	June and December	...	...
40,000	10	...	County of London and Brush Prov. Ordinary	10	11	10	11	...		...	...
20,000	10	6/0	Do. 6 per Cent. Cumulative Preference	13	14	13	14	4 5 9	March and September	...	...
£200,000	Stock	7/8	Do. 4½% Deb. Stock Certs. (all pd.) (red.)	111	114	111	114	...		113½	111
15,000	5	10¼	Kensington and Knightsbridge Ordinary	12½	13½	12½	13½	4 1 5		...	...
10,000	5	6¼	Do. 6 per Cent. 1st Preference	7½	7⅞	7½	7⅞	3 17 5	January and July	...	...
110,000	3	...	London Electric Supply Ordinary	3⅞	4	3⅞	4	...		...	...
48,050	5	3/0	Do. 6 per Cent. Preference	6½	6⅞	6½	6⅞	4 8 11		6½	...
£100,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures	104	106	104	106	3 16 4	Mar., June, Sept., Dec.	...	...
62,500	10	5/0	Metropolitan Elec. Supply Ord. (Nos. 1 to 62,500)	15	16	15	16	3 2 6	April and October	15⅜	15½
22,500	10	3/7½	Do. (Nos. 62,501 to 85,000)	14	15	14	15	3 5 10		...	...
£220,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage	117	119	117	119	3 15 7	June and December	...	...
6,452	10	6/0	Notting Hill Electric Ordinary	15½	16½	15½	16½	3 15 0	March	...	...
10,000	5	5/0	Oxford Electric Ordinary	6⅞	7⅛	6⅞	7⅛	3 9 0	"	...	...
300,000	1	8/	Rand Electric	⅞	1	⅞	1	9 1 10		...	...
£130,070	Stock	5%	River Plate El. Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb.	85	90	80	90	5 11 1		...	...
150,000	$100	$2	Royal Electric Company of Montreal Shares	160	180	160	180	4 8 11		...	...
£123,200	100	4½%	* Do. 4½ per Cent. 1st Mortgage Debentures	103	105	103	105	4 5 9	April and October	...	...
31,980	5	5/0	St. James's and Pall Mall Electric Ordinary	15	16	15½	16½	4 7 11	February and August	16	...
20,000	5	3/6	Do. 7 per Cent. Preference	9	9½	9	9½	3 13 8	" "	...	...
65,000	5	...	South London Electric Supply Ordinary (£4 paid)	3¾	4	3⅞	4	...		...	...
79,900	5	5/0	Westminster Electric Supply Ordinary	14½	15½	14½	15½	3 17 5	March and September	14 1/16	...
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
125,000	1	...	Aron Electricity Meter 6 per Cent. Cum. Pref.	13/16	15/16	15/16	15/16	...		...	...
40,000	5	5/0	British Insulated Wire Ordinary	11	12	11	12	4 3 4		12	...
27,500	5	3/0	Do. Preference	6½	6⅞	6½	6⅞	4 8 11		...	...
90,000	2	2/0	Brush Electrical Engineering	1⅞	2⅛	1⅞	2⅛	4 14 1	September	...	...
90,000	2	1/2½	Do. 6 per Cent. Pref. Non-Cumulative	2⅛	2⅜	2⅛	2⅜	4 16 0	"	...	...
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Deb. Stock	109	113	110	115	3 18 5	February and August	...	...
£50,000	Stock	4½%	* Do. 2nd Debenture Stock (red.)	104	107	104	107	4 4 11	June and December	...	...
20,000	5	5/0	Callender's Cable Construction Ordinary ..xd	13	14	13	14	5 7 2	" "	...	...
20,000	5	...	Do. 5 per Cent. Cumulative Preference	5½	6	5½	6	...		...	...
£90,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb. (red.)	113	116	113	116	3 18 7	November and May	...	...
300,000	1	0/9½	Castner-Kellner Alkali Co. (fully paid) ..xd	1⅛	1⅜	1⅛	1⅜	5 16 5		1 3/16	...
60,000	1	0/7½	Chadburn's Ship Telegraph Ordinary	1	1½	1	1½	...		...	...
60,000	1	0/7½	Do. 6 per Cent. Cumulative Preference	1	1½	1	1½	4 16 0		...	...
32,098	3	2/1½	Crompton and Co. (Nos. 1 to 32,098)	3½	4	3½	4	4 10 9	January and July	3 1/16	3⅛
£100,000	100	5%	* Do. 5 per Cent. First Mortgage Deb. (red.)	100	103	100	103	4 17 10	" "	...	...
60,000	1	0/3	Davis and Timmins 6 per Cent. Cum. Pref.	½	1	¾	1	...		...	...
99,261	5	1/9½	Edison and Swan United ("A" Shares) (£3 paid)	2	2½	2	2½	7 4 0	February and August	2 1/16	...
17,139	5	2/9½	Do. (£5 paid)	4	5	4	5	6 0 0	" "	...	...
£350,000	Stock	4%	Do. 4 per Cent. Mortgage Deb. Stock (red.)	95	97	95	97	4 2 6	June and December	95	...
26,100	5	5/11¼	Edmundson's Electric Corporation Ord. (fully pd.)	5	5½	5	5½	5 9 1	Half-yearly	...	...
112,100	2	1/2½	Electric Construction Co. (Limited)	2	2½	2	2½	5 2 3	January and July	...	...
25,000	2	2/9½	Do. 7 per Cent. Cumulative Preference	3	3½	3	3½	4 0 0	July	...	...
182,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	103	106	104	107	3 15 8	January and July	105½	...
91,195	1	...	Elmore's Patent Copper Depositing	½	⅝	½	⅝	...		...	...
15,000	10	8/0	Henley's Telegraph Works Ordinary	...	...	...	...	...	February and August	...	...
3,000	10	9/4	Do. 7 per Cent. Preference	...	...	...	...	...		...	...
£50,000	Stock	4½%	Do. 4½ per Cent. Mortgage Deb. Stock (red.)	111	114	111	114	3 19 6	" "	...	...
50,000	10	5/0	India Rubber, Gutta Percha, &c., Works	21	22	21	22	4 8 11	" "	21⅛	21⅛
£300,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	100	104	100	104	3 16 11	March and September	102	...
37,350	12	12/0	Telegraph Construction and Maintenance	37	41	37	41	4 8 3	March and July	39½	38
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909	103	106	103	106	3 15 6		...	...
20,000	5	4/5⅜	Do. Manufacturing Ordinary	9½	9⅝	9½	9⅝	4 2 1		...	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5½	6	5½	6	4 3 4		...	...
30,000	5	5/0	Willans and Robinson Ordinary	10½	11	10½	11	4 1 10	April and October	10 13/16	10⅞
30,000	5	3/0	Do. 6 per Cent. Cumulative Preference	7	7½	7	7½	4 0 0	" "	7 7/16	7⅜
£100,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Debentures	106	108	106	108	3 18 8	May and November	16	...
			ELECTRIC RAILWAYS, TRAMWAYS, &c.								
12,000	10	6/0	Blackpool and Fleetwood Tramways	19	21	19	21	3 16 2		...	...
£167,900	100	5%	Brisbane Tramway 5 per Cent. Debentures	104	106	104	106	4 14 4		...	...
50,000	10	7%	Bristol Tramways and Carriage Ordinary	23	24	23	24	2 17 2	February and August	...	...
25,000	10	...	Do. Cumulative Preference (£4 paid)	4⅜	4⅝	4⅜	4⅝	...		...	...
£100,000	Stock	4%	Do. 4 per Cent. Debentures	118	119	118	119	3 7 3		...	...
30,000	10	9/0	British Electric Traction Ordinary	16½	17½	16½	17½	6 0 0		16⅞	...
30,000	10	6/0	Do. 6% Cum. Pref. (Nos. 30,001 to 60,000)	13½	14	13½	14	4 5 9		14	13 3/16
£200,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures	126	129	126	129	3 17 10		128½	126⅞
40,000	5	1/9	Buenos Ayres & Belgrano 6% "A" Cum. Pref.	5½	5⅝	5½	5⅝	5 9 1		...	...
27,500	5	...	Do. "B"	5⅛	5⅜	5⅛	5⅜	...		5⅜	5⅛
265,585	Stock	5%	Do. 5 per Cent. Debentures	108	111	108	111	4 10 1		10 7/8	...
35,250	10	3/0	Central London Ordinary	10½	10⅝	10½	10⅝	2 15 10	June and December	10⅝	10⅛
178,303	10	2/4 1/6	Do.	...	...	...	...	...	" "	...	...
£630,000	Stock	2½%	City and South London Railway Con. Ordinary	63	66	63	66	3 4 6	January and July	64½	63½
22,500	10	...	Do. Ordinary (Nos. 1 to 22,500) (fully paid)	6½	6⅝	6½	6⅝	...		...	...
37,000	10	...	Do. (Nos. 22,501 to 60,000) (£4. 10s. paid)	3⅝	4⅛	3⅝	4⅛	...		...	...
15,000	10	5%	Do. 5 per Cent. Perpetual Preference (1891)	14	15	14	15	3 6 8	January and July	...	...
20,000	10	5%	Do. (1896)	13½	14½	13½	14½	...		...	...
£187,701	Stock	4%	Do. 4 per Cent. Perpetual Debenture ..xd	132	134	132	134	2 19 9	May and November	...	...
20,000	10	7½%	Imperial Tramways Ordinary	23	24	23	24	...	March and September	...	...
10,000	10	6%	† Do. 6 per Cent. Preference	15½	15⅝	15½	15⅝	3 13 10	" "	...	...
£200,000	Stock	4½%	† Do. 4½ per Cent. Debenture	114	115	114	115	3 18 6	January and July	...	...
37,500	10	2½%	Liverpool Overhead Railway Ordinary	9½	9⅝	9½	9⅝	3 8 5	February and August	...	...
10,000	10	5%	Do. 5 per Cent. Preference	13½	13⅝	13½	13⅝	3 12 9	" "	...	...
125,000	Stock	4%	Do. 4 per Cent. Debenture	104	106	104	105	3 16 5	January and July	...	...
24,000	5	...	New General Traction Ordinary	3¾	4⅛	3¾	4⅛	...		...	...
30,000	5	6/0	Do. 6 per Cent. Cumulative Preference	5	5⅛	5	5⅛	5 9 1	May	...	...
13,334	10	...	Potteries Electric Traction Ordinary	13	14	13	14	...		...	...
20,000	10	5/10	Do. 5 per Cent. Cumulative Preference	10½	11	10½	11	4 10 11		...	...
£540,000	Stock	3%	Waterloo and City Ordinary	101	104	101	104	2 18 0	June and December	102	...

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.
† The London Stock Exchange Committee refuses to quote these.

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THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,122. [No. 4. Vol. XLIV.] FRIDAY, NOVEMBER 17, 1899. PRICE SIXPENCE (by post, 6½d.). Abroad, 8d., or 16 cents. or 80fr., or 70nf.

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NOTES.

AT a meeting of the Leeds City Council, on Thursday last week, it was announced that £6,500 worth of rubber cable would have to be taken out in various parts of the town, there having been no less than thirty breakdowns on the electric lighting network during the month of September. This large sum, which has, of course, to be provided for out of revenue, would probably have been still greater were it not deemed advisable at the same time to make provision for increased demand and lay larger cable, and in some cases additional circuits, at the same time, so that the cost of relaying is, to a large extent at all events, paid for out of capital.

IT is to be regretted that more particulars are not forthcoming in such cases as to the quality of the rubber originally employed, the average time it has lasted, the probable cause of its deterioration, and similar matters. Even though there may be no further use for rubber-covered cable for street mains, it has undeniable advantages for service wires, leads to street lamps, and similar purposes, if by some modification in the manufacture and composition of the "compound rubber," or in the process of vulcanisation, its durability could be increased. Perhaps, if reliable statistics were obtained, it might be found that such deterioration was confined to certain classes of rubber cable only, or, on the other hand, that a certain class had proved vastly superior to others.

WE must also remember that, although not subjected to such trying conditions as street cables, probably 95 per cent. of the electric light wire buried under the plaster in houses in this country is india-rubber covered, and the practice of employing such wire for the purpose is still being encouraged not only by the fire offices but also by the supply engineers. Is this wire rotting in a similar way to these street cables, if at a slower rate? The subject of the deterioration of india-rubber needs prolonged, careful, and scientific investigation, and it is a research for chemists rather than for electricians. Once the precise nature of the action is discovered, it should be possible, by intensifying this action, to devise a test which should give an indication of the probable durability of the material under ordinary working conditions.

THE treatment of what are generally termed "complex sulphide ores"—that is, ores consisting substantially of a mixture of lead sulphide and zinc sulphide, and carrying silver—has long been a favourite problem on which inventors have exercised their ingenuity, with small result up to the present. Mechanical concentration has but trifling effect, direct smelting seems impracticable, wet extraction processes are beset with difficulties. Much was expected of the Ashcroft electrolytic process, and little came of it save useful technical information coupled with heavy monetary loss. But an electrolytic process, from the nature of things, seems especially well adapted to lead finally to some practicable and remunerative method of working this difficult material. We welcome an attempt by Mr. COWPER-COLES to bring together an account of processes which have been proposed from time to time, and we congratulate him on adding to this account a description of his own experiences. An abstract of his Paper, read on November 6th before the Society of Engineers, was commenced in our last issue and is continued in another column.

THE COWPER-COLES process consists in roasting the ore sweet, screening, leaching with a solution of zinc sulphate containing free sulphuric acid, purifying the strong zinc sulphate thus obtained by scrap zinc to deposit copper, and electrolysing the enriched and purified solution between lead anodes and iron or aluminium cathodes. The author's experience in the electro-deposition of zinc enabled him to obtain fairly good deposits, but sometimes the troubles only too familiar to those who have dealt with the electrolysis of zinc solutions

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made themselves apparent. It is now fairly well admitted that the deposition of spongy zinc is due to the electrolyte becoming basic, and that the best chance of obtaining and maintaining a good deposit is to keep the solution slightly acid. Thus far the zinc part of Mr. COWPER-COLES's process. As concerns the lead, it is leached out with caustic soda, and either electrolysed to recover lead as metal or precipitated with carbonic acid to give white lead. Silver remains in the residual ore, and is leached out with cyanide and recovered by electrolysis. MR. COWPER-COLES speaks freely and candidly of the difficulties which he has encountered, and indeed it does not appear that all these have been overcome. In our opinion, in the present state of experimental knowledge of the treatment of these ores, some simpler if less complete process is to be preferred. Once remove and recover the zinc even at a very modest profit, and the lead (with the silver), freed from the incubus which hinders its smelting, will pay well for treatment by ordinary methods.

MR. F. S. SPIERS' experiments, described before the Physical Society last Friday, may be said to mark a stage in the history of the subject of contact electricity, a satisfactory solution of its problems having baffled so many experimenters since VOLTA'S original discovery. By the exercise of very considerable ingenuity Mr. SPIERS has succeeded in overcoming the nearly insuperable difficulties of measuring the contact difference of potential in high vacua of air and hydrogen, and of removing effectively the adhesive film of condensed oxygen which exists on the surfaces of all metals. It is probable that Mr. SPIERS' apparatus, or some modifications of it, will be found extremely useful in all future experiments on contact differences of potential; and if he has brought us a step nearer to a crucial experiment, deciding between the "chemical" and "contact" theories, he deserves the best thanks of all physicists.

Two articles in the *Statist* of last Saturday may be profitably read by those connected with the administration of electricity supply companies. The first is devoted to an examination of the depreciation and reserve funds set aside by companies owning some of the largest electricity supply undertakings in this country. Nine purveyors of electrical energy in London are mentioned, and 12 in the provinces. Eight of these have put by reserve and depreciation funds during 1898 amounting to less than 1 per cent. of the capital expended (the record being the figure 0·27 per cent. after the cost of repairs, maintenance, and renewals during the year has been deducted), and in only five cases does the amount set aside exceed 2 per cent., and twice only is it more than $2\frac{3}{4}$ per cent. On a basis of 25 years as the average life of the plant and apparatus employed at the works, and assuming that the depreciation fund be invested at 3 per cent., the rate for erecting a depreciation fund works out at $3\frac{3}{4}$ per cent. This period of 25 years taken by our contemporary cannot be considered exceedingly short, for it is safe to prophesy that the majority of the constituent parts of any supply concern newly built to-day will be "scrapped" as obsolete by the year 1925.

THE second article refers to the latest development in the affairs of the County of London and Brush Provincial Co., and its allied companies. The Bournemouth and Poole Electricity Supply Co. (in which the Brush Provincial Co. is largely interested) proposes to buy the undertaking of the Richmond (Surrey) Electric Light and Power Co. (another company in which the Brush Provincial is largely interested) for some £80,000. The present capital expenditure of the Richmond Co. up to date is well under £60,000, the plant capacity is now about 540 kilowatts, and the depreciation fund amounts to but £900. The company commenced operations in 1893: its first dividend was in 1896, and amounted to 8 per cent., the dividend last year being 4 per cent. It will be seen in another column of this issue that the Corporation of Richmond has authorised a sub-committee to enter into negotiation with the Richmond Co., with a view to the acquisition of its undertaking. A review by our well-informed contemporary of the whole history of the County of London and Brush Provincial Company and the financial status of its allied companies would afford interesting reading.

Erratum.—By a printer's error, the word "telephone" was omitted before the word "lines" in the seventh line of the last editorial note on p. 68 of our last issue.

Personal.—Mr. A. J. Lawson has resigned his position as engineer and manager of the County of London and Brush Provincial Electric Lighting Co., the Richmond (Surrey) Electric Light and Power Co., and of the Scottish House-to-House Co. (Coatbridge).

Telegram Censorship.—The Postmaster-General of Cape Colony has announced that no official cablegrams, whether in plain language or in code, will be transmitted *viâ* the Cape, except messages between the Government of Portugal and the Governor of Portuguese East Africa.

Royal Society.—Among the Papers down for reading yesterday were the following:—"Note on the E.M.F. of the Organ Shock, and on the Electrical Resistance of the Organ in *Malapterurus Electricus*," by Prof. F. Gotch, F.R.S., and Mr. G. J. Burch; "On the Least Potential Difference required to produce Discharge through various Gases," by the Hon. R. J. Strutt; and "An Experimental Research on some Standards of Light," by Mr. J. E. Petavel.

Cable Interruptions and Repairs:—

	Date of Interruption.	Date of Repair.
Latakia—Cyprus	June 21, 1899 ...	—
Cayenne—Pinhieros	Oct. 11, 1899 ...	—
Zanzibar—Mombassa	Oct. 27, 1899 ...	—
Lorenço Marques—Mozambique	Oct. 31, 1899 ...	Nov. 15, 1899

As will be seen, the Mozambique-Delagoa Bay cable has been repaired, and communication with South Africa by the east coast route is restored. Three days after the break to this cable, the repairing ship was over the spot where the cable was interrupted, but was prevented from taking up the faulty cable owing to very severe weather.

Gibraltar.—In his annual report Sir R. Biddulph, Governor of Gibraltar, under date September 16, states that the surplus revenue of the Rock for the past five years has amounted to £21,210, and this surplus has enabled the authorities to devote £11,186 out of revenue towards the establishment of electric light works. The capital cost of these works up to December 31st last amounted to £26,186, and £15,000 has been borrowed to make up the balance required in excess of the contribution from revenue. The military buildings which were formerly lighted by gas are now exclusively illuminated by the electric light, as are all the buildings of the Civil Government of Gibraltar. The lighting of the public streets by electricity is about half finished, and many of the private residences are taking current. A complete illustrated description of the Gibraltar station appeared in *The Electrician*, Vol. XLII., p. 430.

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The Metropolitan Electric Supply Co.—The first of the three 1,500-kilowatt Westinghouse sets at the new station of the Metropolitan Electric Supply Co. has been running on load since last Friday. At first some difficulties in connection with the governor were experienced, and the pressure varied unduly in consequence; but on Tuesday night the engineers reported that these had been overcome, and that everything had been running most satisfactorily. No hitch in the electrical part of the plant has occurred during the week. Since Friday the practice of switching off private circuits at the hours of maximum demand has been discontinued, except that on Monday it was necessary to switch one circuit off for half a-minute. So soon as the Willesden station has advanced nearer to absolute completion we hope to publish a complete description of it.

Electric Traction and Magnetic Observatories.—A conference took place at the Board of Trade, on Wednesday, between the representatives of electric railway and tramway concerns and those interested in the protection of the magnetic observatories at Kew and Greenwich. Sir Courtenay Boyle presided. Prof. Rücker and the Astronomer Royal defended the interests of the observatories, and among those who refused to admit that any interference had yet been proved was Major Cardew. In the end a committee was appointed—consisting of Profs. Rücker, Ayrton, and Perry, representing the laboratories; Prof. Kennedy, Mr. H. F. Parshall, Major Cardew, and Mr. Brousson, for the electric traction companies; and Mr. A. P. Trotter for the Board of Trade—"to investigate the amount of magnetic disturbance produced in the neighbourhood of electric tramways and railways constructed and worked under the Board of Trade regulations, and to report as early as possible."

The Electric Lighting of Marylebone.—The Marylebone Vestry has, as is well known, for some time past been desirous of acquiring as much of the Metropolitan Electric Supply Co.'s undertaking as is existing in Marylebone. Several reports have been presented, and last week it was once again recommended that the negotiations with the Metropolitan Electric Supply Co. be continued. The matter still awaits final confirmation by the Vestry, who discussed the report last week, but arrived at no decision. A motion was down for consideration last night, and it was announced that Dr. Fletcher Little would bring forward an amendment of a somewhat startling character. He will suggest that the County Council be petitioned to take over the Metropolitan Electric Supply Co.'s undertaking, lock, stock, and generating works—buying the Company out—that is to say, at a price to be determined, presumably by arbitration. After the London County Council shall have obtained possession of the works Dr. Little proposes that it should let out portions to those vestries which come within the radius of the company's operations.

The Glasgow Tramways.—As briefly announced in our last issue, the Govanhill extension of the Glasgow tramways was passed by the Board of Trade inspectors on Wednesday last week, and opened to the public on the following day. In *The Electrician*, Vol. XLII., p. 104, we published a description of the power-house and the first section of tramway opened from Mitchell-street to Springburn. On January 23rd last the extension from Parliamentary-road to Glasgow Cross was opened, and the line opened last week increased the total length of double electric tramway track in Glasgow to about five miles at present. The line is similarly equipped to the former ones, except that considerably more use is made of span wires fastened to rosettes on the house fronts. On the occasion of the opening ceremony Councillor Paton drew attention to the fact that the Glasgow Corporation was the only one in this country that had powers to suspend the wires from buildings whether the owners of the buildings consented or not. The Corporation had first tried to do so without powers, but they found difficulty in obtaining permission from more than 95 per cent. of the owners, and they had therefore made a representation to Lord Morley, and in their last Act had obtained compulsory powers to suspend wires from building to building. The new extension is supplied from the same power-house as the remainder of the line, and the only material alteration that has been made in it since our description was published has been the addition of a third Babcock-Wilcox boiler.

"A Simple Method of Re-establishing Telegraphic Communication over Short Distances."—The following letter from Dr. Oliver Lodge was published in Tuesday's *Times*:—

It is rash unasked to offer suggestions to practical telegraphists such as no doubt exist inside and in the vicinity of Ladysmith, but perhaps it might be worth while by cable to request them to try to communicate by the following method:—Lay a wire across Ladysmith, or other invested station, east and west, and earth the two ends thoroughly, so as to get as long a base as possible. Insert in this wire a powerful battery, or a dynamo, and a signalling key (sharper signals can be got by breaking the current under alcohol or between the poles of a strong magnet); insert also, by an alternative switch, a pair of low resistance telephones, and a condenser to keep out steady earth currents. Then let another party, south of the above district and as near as is consistent with military exigencies, lay or utilise another east and west wire, of greater length than the other, and likewise thoroughly well earthed at each end in damp soil, employing salt if necessary, or, still better, utilising a river; and let them likewise insert a pair of telephones (with a condenser) to receive signals, and a dynamo or battery with a signalling key to send them. It matters little where the outside actual station is, but its two "earths" should be as near and as much one on each side of the invested station as is practicable. Unless the soil is hopelessly dry for all accessible depths, slow signalling by this method of earth-tapping can certainly be achieved, provided strong enough currents are used, even without the use of special apparatus, the short and the long signals of the Morse code being marked by the beginning and end of the current, or by the interval between two successive reversals, and being readable by an operator skilled in the use of the "sounder." Earth-current disturbances will be heard, but can usually be recognised and disregarded. An alternating dynamo would be preferable to a continuous-current dynamo if it were of high frequency, and sometimes the harmonics of an ordinary alternator are sufficiently strong for the purpose; or a revolving commutator can be made to carve an ordinary battery current into rapid intermittencies, producing a hum in the distant telephone, as in the arrangement applied under the direction of Sir W. Preece in the sea near Cardiff. A great number of refinements could be applied if there were plenty of time, but my object is to point out that a slow kind of telegraphy can almost certainly be re-established, if it be considered worth while, with apparatus probably already on the spot. (The possible use of the line of rails as a semi-connector, or earth substitute, should not be overlooked.) To avoid difficulties about "calling," or asking for a change from "send" to "receive," it is natural to suggest that each station should "receive" for every alternate hour, and then the skilled operator rest. The "sending" demands much less skill than the "receiving." A telephone held to the sender's ear, and connected, if necessary, to a couple of iron pegs in the earth in his immediate vicinity, or to a yard of wire running parallel to his line wire, will tell him if he is sending siganls in an intelligible manner or not.

But we fear that the distances in question are not short enough for the employment of this method. And why does Dr. Lodge send his suggestion openly to the *Times* instead of privately to the War Office?

Wireless Telegraphy.—The daily papers report that an equipment of wireless telegraph apparatus and skilled assistants arrived at Cape Town in the "Carisbrook Castle" on Tuesday, and that both have been sent on to Durban. The apparatus and assistants sent out by the Wireless Telegraphy and Signal Co. are on board the "Servia," and not due to arrive for a few days. On their arrival we understand that the assistants with the instruments will also at once proceed to the front.——Mr. Marconi arrived from America on Wednesday evening, on board the "St. Paul." When the ship was some 50 miles distant from the wireless signalling station at the Needles, a message was transmitted by Mr. Marconi, which was received in time to be published in the evening papers actually before he arrived in London. An interesting incident occurred in connection with Mr. Marconi's installation on the "St. Paul"—viz., the publication of a miniature newspaper, which was printed by the ship's compositor and sold at $1 per copy for the benefit of the Seamen's Fund. The following is a reprint of its contents:—

Published on board the "St. Paul," at sea, *en route* for England, November 15, 1899. One dollar per copy, in aid of the Seamen's Fund. Mr. W. W. Bradfield, editor-in-chief, Mr. T. Bowden, assistant editor, Miss J. B. Holman, treasurer, Mr. H. H. Maclure, managing editor. Through the courtesy of Mr. G. Marconi, the passengers on board the "St. Paul" are accorded a rare privilege—that of receiving news several hours before landing. Mr. Marconi and his assistants have arranged for work the apparatus used in reporting the yacht race in New York, and are now receiving despatches from their station at the Needles. War news from South Africa and home messages from London and Paris are being received. The most important despatches are published on the opposite page. As all know, this is the first time that such a venture as this has been undertaken. A newspaper published at sea with wireless telegraph messages received and printed on a ship going 20 knots an hour! This is the fifty-second voyage eastward of the "St. Paul." There are 375 passengers on board, counting the distinguished and extinguished. The days' runs have been as follows:—November 9, 435; November 10, 436; November 11,

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425; November 12, 424; November 13, 431; November 14, 414; November 15, 412. 97 miles to Needles at 12 o'clock, November 15. Bulletins:—1.50 p.m. . . .—First signal received, 66 miles from Needles. 2.40.—Was that you, "St. Paul"? 50 miles from Needles. 2.50.—Hurrah! Welcome home! Where are you? 3.30.—40 miles. Ladysmith, Kimberley, and Mafeking holding out well. No big battle. 15,000 men recently landed. 3.40.—At Ladysmith no more killed. Bombardment at Kimberley effected the destruction of one tin pot. It was auctioned for £200. It is felt that period of anxiety and strain is over, and that our turn has come. 4.0.—Sorry to say the U.S.A. cruiser "Charleston" is lost. All hands saved. The thanks of the editors are given to Capt Jamieson, who grants us the privilege of this issue.

An installation of wireless telegraphy for signalling purposes is to be fitted to the battleship "Canopus," which commissions at Portsmouth on December 5th to relieve the "Hood" on the Mediterranean station.

The Pacific Cable Scheme.—According to a Washington news agency, the report of the committee appointed to investigate the advisability of a Pacific cable has been handed to the President. It urges that the cable be begun as soon as the necessary preliminaries can be attended to. The route laid down in the report runs from San Francisco to Hawaii, then to Wake Island and Guam, and from there to Manila. It is also suggested that the cable be further run to Yokohama. The report will be submitted to Congress, and will, it is believed, be fully approved. In the *Engineering Magazine* for the present month there is an interesting article, by Mr. Harrington Emerson, on "The Proposed Pacific Cables," written largely from the point of view of the United States. Mr. Emerson refers to four routes: the so-called "all-British"; the San Francisco line, referred to above; what he styles "the great-circle cable," from Sitka in Canada (with extensions to a point in the south of Canada and to San Francisco) to the western point of Alaska, and thence to the Philippines and Hong-Kong *viâ* the Aleutian and Kurile Islands and Japan; and lastly, "the overland route *viâ* the Yukon river." Of these routes he appears to favour the third, to be carried out by arrangement between the United States and Canada; but it is perhaps only necessary to say here that the project of cables *viâ* the Aleutians was rejected in this country many years ago, on account of the high northern latitudes in which the sections would lie. And as to an overland route *viâ* the Yukon, the scheme appears, on this side of the Atlantic, to be somewhat "previous." The all-British plan has been fully discussed in our columns and elsewhere, and need not at present be further referred to. There only remains the San Francisco, Hawaii-Wake Island, Guam, and Manila scheme, referred to in the Washington telegram mentioned above. But Mr. Emerson admits that the mention of Wake Island is an indication that the promoters do not intend to proceed beyond Honolulu: because Wake Island is uninhabited, is nowhere more than 20ft. above high-water mark, and both from local indications (according to some, though not all authorities), and from knowledge of tidal waves in the Pacific, "it seems impossible that this island should not frequently be submerged." In fact, it has even been suggested that a high tower should be built—no tidal waves, of course, occurring while the work was proceeding—in which the operators might take refuge. It is also insisted by the same authority that a ship should visit the island every few months to replace the employés, who would by that time probably be insane! It may be noted, too, that the depths of water round Guam (Ladrones), which was captured from the Spaniards during the late war, are very great—3,400 fathoms (nearly four miles) being quite a possibility; and that the island is surrounded by coral reefs.

Wireless Telegraphy Tests in the United States Navy.—The practical value of the Marconi system of wireless telegraphy, as a means of communication between ship and ship and shore, has been tested under the auspices of the United States naval authorities. The cruiser "New York" and the battleship "Massachusetts" were equipped with apparatus by Mr. Marconi. The two vessels lay at their anchorage in the North River, 480 yards apart, or about the distance that would separate vessels steaming in squadron formation. The sending instrument was operated on the "New York" by Mr. Marconi personally, with an assistant, and directed by two members of the Naval Board. The receiving was done on the "Massachusetts," the instrument being operated by one of Mr. Marconi's assistants under the inspection of a member of the Bureau of Equipment. The particular object of the first test was to determine the practicability of using the system for short signalling while squadrons are at sea. The first test was the sending of the contents of a newspaper article of about 1,500 words. This was sent and received without a single error, at the rate of eleven words a minute. The message, after being sent to the "Massachusetts," was repeated back to the "New York," the words being registered on tape which was taken by the inspectors and duly filed away. The second test was the sending of a series of numbers of varying lengths, which were ticked off with a little more rapidity that the previous message. Test No. 3 was the sending of a series of letters written, drawn at random. The fourth test was the sending of a series of short messages. The fifth and sixth tests were the transmitting of a series of code messages. These were enough to tax the skill and patience of the operator, the words having to the uninitiated absolutely no sense or meaning. There were one or two errors discovered in these tests, but Mr. Marconi explained that these, as well as the speed, were purely tests of the ability of the operator. The "New York" and "Massachusetts" then left for a trip to sea, to test the system further. A storm, however, interfered, and the test was deferred until a later day. On Wednesday, November 1st, the two warships made their way to sea. At a point about five miles off the Highlands the "New York" came to anchor, while the "Massachusetts" continued on her way to sea and exchanged signals with the "New York" at intervals of ten minutes. At a distance of 36 miles the messages sent by the "New York" to the "Massachusetts" failed to carry, and the battleship came back and anchored a few hundred yards from the "New York." In order to test the possibility of interference with the signals, a station was established at the Highlands. It consisted of a 150ft. vertical wire triced up on the pole. At the lower end of the wire the telegraph apparatus was connected, so that when a message was sent from the Highlands station it would interrupt any messages being sent at the same time within the radial circumference of the electrical waves produced by the sending of the message. At regular intervals during the time the messages were being sent between the two warships the land station sent out interference signals, and the result was that the messages between the ships were rendered unintelligible. An incident of the test was the falling overboard of a man from the "Massachusetts" while on her way to sea. The fact was telegraphed to the "New York" ten minutes before it could be wig-wagged by the signalman, and the man was rescued by a cutter from the latter ship. Before beginning the experiments, Mr. Marconi wrote to the Commission stating that he had an instrument which would render interference practically impossible. It is stated that the tests were satisfactory to the Commission, and what course of action the Navy Department will now take in the matter remains to be seen.

MEETINGS OF SCIENTIFIC AND ENGINEERING SOCIETIES, &c.

SATURDAY, November 18th.

INSTITUTION OF JUNIOR ENGINEERS.

3.30 p.m. Visit to the City and South London Railway Depôt at Stockwell.

TUESDAY, November 21st.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Papers to be further discussed: (1) "The Waterloo and City Railway," by H. H. Dalrymple-Hay; (2) "The Electrical Equipment of the Waterloo and City Railway," by Bernard M. Jenkin.

WEDNESDAY, November 22nd.

INSTITUTION OF ELECTRICAL ENGINEERS.

7.30 p.m. First Students' Meeting of the Session, at 28, Victoria-street, S.W. Paper to be read: "Switch Gearing," by Mr. Nixon.

THURSDAY, November 23rd.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary General Meeting. Papers to be read: (1) "The Cost of Steam Raising," by John Holliday; (2) "Influence of Cheap Fuels on the Cost of Electrical Energy," by R. E. Crompton.

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THE NEW CABLE-SHIP "VON PODBIELSKI."

On Wednesday last week the cable ship "von Podbielski" was launched at Messrs. David J. Dunlop and Co.'s shipbuilding yard, Port Glasgow. The event is of interest chiefly owing to the fact that this cable steamer is the first vessel of this class owned by Germany. She was built for the Norddeutsche Seekabelwerke Aktiengesellschaft of Cologne, and bears the name of the present chief of the German postal and telegraph administration.

The ship has been built more with a view to meet the requirements of a modern cable-repairing steamer than of a cable-laying steamer, and with a good speed, twin screws, a light draught, and the latest designed cable machinery, she should in every way prove satisfactory. From a shipbuilding point of view, the von Podbielski is built to meet all the requirements of the highest class of the Germanscher Lloyd. The following are her chief measurements: Length between perpendiculars, 255ft.; breadth (moulded), 35ft.; draught (loaded), 16ft. 6in. Her two sets of engines will give her a speed of 13 knots when loaded, and the builders believe that she will be the fastest cable steamer afloat.

Messrs. Johnson and Phillips are sub-contractors to Messrs. Dunlop and Co. for the cable machinery, which is of the most modern description, with several improvements in detail. Of greatest interest is the double combined picking-up and paying-out machine forward. It is fitted on the main deck, just aft of the foremast, the drums standing through hatches in the spar deck. The starting levers and stop-valves for the engines, as well as the brake-screws, are situated near together, conveniently for working on the spar deck. The machines are built on three steel frames, and are being arranged side by side, the paying-out machine to port and the picking-up machine to starboard. They are driven by two high-pressure twin engines with 8in and 8in. cylinders and 8in. stroke, developing 110 H.P. at 300 revolutions per minute with steam at 150lb. per square inch. Either engine can drive either machine (or both machines if required, so that one drum could be paying out while the other is picking up), and for an exceptionally heavy load both engines can be coupled on to one drum. The crank-shafts of the engines are parallel with the centre line of the ship, and are geared by double helical bevel gear to the first motion shaft, the engine pinions being of phosphor bronze and the remaining wheels all of cast steel. In order to put one engine out of gear the bevel wheel is drawn along its shaft by means of a large screw-nut concentric with the shaft and working on a screwed shoulder. A "tommy bar" is employed for this purpose. The nut serves to take the thrust when the machine is working. Each machine is arranged for two speeds and powers—the picking-up machine either for 25 tons lift at one knot per hour, or 10 tons lift at 2½ knots, and the paying-out machine for 10 tons lift at 2½ knots, or 6¼ tons at four knots.

Each of the main cable drums, its gearing, and brake drum is combined by gearing the main drum internally and employing the outside of the guide ring as brake drum. Thus, when it is desired to pay out without the engine, this combination drum is the only part of the machine running (except, of course, the holding-back sheave), and the speed is controlled by the brake. The drums run loose on a shaft common to both machines, which is fixed to the frames and serves as a good tie for them. Fine adjustment of the brake screws is obtained by working them by means of a worm gear. Messrs. Johnson and Phillips have made an improvement in these brakes by fitting them with an adjustable lock-nut. After the brake has been regulated to any desired tension, the nut is screwed up into position, and then the brake can be released and re-applied as often as necessary without it being possible to increase the tension beyond the amount to which it was originally adjusted. The brake blocks are all attached to steel brake straps, and the cooling water is led round each brake band by a pipe fitted with nozzles at intervals, so that the water is distributed all round the face of the drum during working. A small Worthington steam pump is employed for pumping the water. The brake drums are suspended on springs, in order that the bands may leave the drums equally all round when released, and these springs are, of course, adjustable to allow for the wear of the blocks.

A steel driving chain, from the intermediate shaft of the machine, actuates the hauling-off gear. This chain is connected to the shaft by means of a ratchet gear which drives it for hauling off when picking up, but when paying out allows it to run free, thus making the arrangement automatic and saving a clutch. The main frames are of wrought steel, and the first and second machine shafts are carried in a self-contained steel frame to which the engine bedplates and the main frames are attached. This makes a very rigid arrangement. It may be added that the cable drums are 5ft. 6½in. diameter on the tread, and 1ft. 7in. wide between the flanges; the brake rings are 6ft. 5¼in. diameter and 10½in. wide; and the whole machine weighs 31 tons.

The paying-out machine for long lengths of cable is fixed aft. It is placed on the spar deck near the stern of the vessel, and a working platform is provided above the machine frames. The various levers are arranged conveniently for operating from this platform, and the attendant there can watch the cable as it leaves the ship. This machine is single, with only one cable drum and one double-cylinder engine, erected on heavy cast-iron frames. The drum overhangs the frames, and a large gear wheel and two brake pulleys are placed on the same shaft between the two frames. According to the usual practice, the brake pulleys of this machine run in water tanks to keep them cool. The brake bands are exactly similar to those of the forward machine, except that they are fitted with weighted levers, which is also according to usual practice. A modification has been made in these, however, which may be considered an improvement. Instead of the weights always occupying the same position on the lever, and the only adjustment of brake power being by adding or deducting weights (often requiring a second hand), the weights can be moved along the levers to a certain extent by means of a hand-wheel and screw. In this way the tension of the cable may be varied through a considerable range without the necessity of adding or removing the weights. By means of another hand-wheel and worm gear the brakes can be released bodily, and they can be adjusted to act simultaneously or one after the other. The rod at the end of each brake lever ends in a dash-pot to steady the movement and prevent violent oscillations of the levers. The holding-back gear for this machine has double jockey sheaves, with brake wheels attached. These run in a water tank made of cast iron, which also serves as the frame gear. The shaft of one of the sheaves is connected to the pinion shaft of the machine by means of a steel pitch chain, wheels and clutch, so that it will form a hauling-off gear if it is required to haul the cable back again for any purpose. The cable drum is 5ft. 8½in. in diameter on the tread, and 13in. wide between the flanges. The brake pulleys are 4ft. 6in. in diameter and 12in. wide. The total weight of the machine is 15½ tons. The driving engine has the same sized cylinders and the same stroke as the forward machine, but a reducing valve is also provided, so that it only receives steam at a pressure of 90lb. per square inch (as also do the ship's winches, &c.), and develops 60 B.H.P. at 200 revolutions per minute.

The bow sheaves are arranged in accordance with the practice which we believe originated with Messrs. Johnson and Phillips. The three sheaves run in bearings on girders built into the vessel, and each sheave is provided with cast-iron whiskers or guards to prevent the cable from jumping the sheave. The plating of the stem of the vessel is worked up to meet these whiskers, and thus the contour of the head of the vessel is preserved. At the stern there is only one sheave, the bearings of which are attached to girders built into the ship in the same way.

Two sets of dynamometers and leads are provided forward, one for each cable drum, and there is also one set aft. These appliances are of the firm's latest design, the sheave and its carrier sliding upon a central tubular column. This latter acts also as a dashpot, being partially filled with oil or soapy water, in which work a piston and rod attached to the sheave.

Opening bell mouths are provided on each cable tank to guide the cable. Thence the cable is led to the picking-up and

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paying-out machine through a series of opening bell mouths carried on small standards about 18in. above the deck. There are three cable tanks, the first and second being arranged forward, and the third aft. Their capacity is about 20,500 cubic ft.

Messrs. Johnson and Phillips are supplying the complete equipment of stores, which includes rock-cutting and mud grapnels, buoys, mushrooms, anchors, &c. They are also supplying the testing outfit for the installation, for which Mr. H. W. Sullivan will be responsible.

The testing and speaking instruments are of the most recent design, including two Sullivan galvanometers (with the special form of universal shunt described and illustrated in *The Electrician*, Vol. XLIII. p. 197), high resistances of manganin, Wheatstone bridges, a Siemens Morse ink-writer, keys of the Tonking and other patterns, and all the necessary accessories and tools. In general there is of necessity little of novelty to record in connection with the instruments, but it may be mentioned that great attention is being paid to points of detail, such as facility of manipulation, perfect insulation, &c.

One of the most noteworthy features, however, is a 300-volt battery of storage cells in place of the time-honoured Leclanché or the more recent dry cell. The type of cell employed has been recently introduced into England by Mr. Sullivan, it being of German construction—the only piece of German apparatus in the whole equipment. It consists of a small glass bottle 3½in. high by 1¾in. external diameter, containing the lead and lead peroxide electrodes in the form of square rods about ½in. side and 1½in. long, with slightly corrugated surfaces. These rods are formed around lead strips, the upper ends of which project through the seal at the top of the bottle, while the lower ends dip into small porcelain cups resting on the bottom of the bottle which are filled with a special wax composition covering also the bottom of the bottle. The electrodes are thus held firmly in place, and kept at a distance of about ⅜in. from the bottom. A glass tube passing through the centre of the sealed top enables the gases to escape and provides a means of adding acid. For the sake of rigidity this tube passes to the bottom of the vessel, but there is a hole in the tube near the top to allow for the escape of the gases. The weight of the cell with acid is 7½oz., and its capacity is about one ampere hour. A charging current of 0·1 ampere is recommended, and a discharge rate not exceeding 0·2 ampere. The internal resistance of the cell is 0·15 ohm.

The ship is flush decked, is fitted throughout with electric light, has a powerful searchlight and other "latest improvements." She will be principally engaged in the repairing and laying of the German Government cables in the North Sea, Baltic, and Channel. The company has a factory in course of construction at Nordenham, near the mouth of the Weser, the technical control of which will be in the hands of Messrs. Felten and Guilleaume, of Mülheim-on-Rhine, who are well known as manufacturers of copper wire and of cable for electrical and other engineering purposes.

THE INDUCTANCE OF A PORTION OF AN ELECTRIC CIRCUIT.

BY H. N. ALLEN, B.SC.

It appears at first as if all that is necessary to determine the inductance of a portion of an electric circuit is a sufficiently sensitive alternating-current voltmeter, an alternator of suitable frequency, and an ammeter to measure the current. As a matter of fact, however, it is only in certain rather special cases that an electrostatic, electro-dynamic, or hot-wire voltmeter will give the true value of the virtual volts between two points in a circuit. Fortunately, these special cases are those which are of general practical importance; but it is well to have some idea of the difficulties which may arise, so as to be able to avoid them, if possible. The inductance of a single loop is often defined as the number of tubes of induction which are linked with the circuit when unit current flows in it, and more accurately as twice the energy stored in the medium with the same current, the latter definition also holding for any whole number of turns. As the ends in this case come together, the voltmeter wires can be twisted, so that both the inductance of the voltmeter connections and the mutual induction between the main circuit and the voltmeter circuit will be small. This is the case which occurs most commonly in practice; but it will be seen that it is in reality a special case of the more general problem. When the inductance of part of a loop is considered, it is necessary to decide which of the induction tubes and how much of the energy are due to the current in that portion of the circuit. In some cases, as with two infinite parallel wires conveying equal opposite currents, or a circular loop of wire, this is easily done from considerations of symmetry, but in others there is much greater difficulty.

The flux of induction through a closed curve is equal to the line integral of the vector potential taken round that curve. If the point where the vector potential is supposed to have the value zero is properly chosen, it seems that the inductance of a portion of a circuit may be defined as the line integral of the vector potential along that portion when unit current flows. In the case of a circular loop the vector potential must be taken as zero along a line through the centre, perpendicular to the plane of the circle. With two equal parallel wires conveying equal currents in opposite directions, it is zero on a plane perpendicular to that containing the axes of the wires and midway between them. If the wires are thin this definition will give a fair approximation to the correct result. The vector potential, however, has not the same value throughout the section of a conductor. This is well seen in the accompanying diagram (Fig. 1), taken from a Paper by the

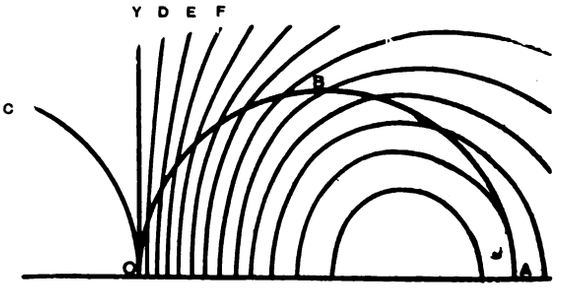

FIG. 1.

author on "The Graphic Representation of Vector Potential,' *The Electrician*, April 3, 1896. The semicircle OBA represents half the section of one of two equal cylindrical wires, the axes of which are parallel, and which are almost in contact at O. The section of the other wire is indicated by OC. They are supposed to carry equal currents in opposite directions. The lines Y, D, E, F, &c., may be taken as representing either the boundaries between induction tubes or vector equipotential surfaces. The vector potential being taken as zero along Y, it is unity along D, two along E, and so on. All values of the vector potential from zero up to a certain maximum value occur within the section of the wire in this case, and there is no way of deciding which is the correct one to take in calculating the inductance.

It appears to be necessary to make use of Maxwell's equation:

$$T = \tfrac{1}{2}\iiint(Fu + Gv + Hw)\,dx\,dy\,dz,$$

where T is the energy stored in the medium
F, G, H are the components of the vector potential,
u, v, w are the components of the current.

We have also $T = \tfrac{1}{2}LC^2$

where L is the inductance

and C is the current.

Thus $$L = \frac{1}{C^2}\iiint(Fu + Gv + Hw)\,dx\,dy\,dz.$$

This equation holds in general for a closed electric circuit, and if the point where the vector potential is taken as zero is properly chosen, it is applicable to any part of a circuit.

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Let ABCD in Fig. 2 be a circuit conveying an alternating current, B and C two points the virtual volts between which are to be determined experimentally. It seems as if the inductance of the voltmeter circuit, and the mutual induction between the main and the voltmeter circuits, could be made small by leading one of the voltmeter wires from B to E, a point near C, keeping as close as possible to the main circuit, and then leading the two wires to the distant voltmeter with a very small interval between them. This, however, is quite incorrect, and the position indicated is the very worst that could be chosen. If the two wires BC and BE are close enough together, the voltmeter, instead of giving the true virtual volts between B and C, will indicate only a little more than the quantity required to send the current through the mere ohmic resistance of BC, and the effect of the inductance of the main circuit on the voltmeter reading will be almost nil. Suppose that the resistance of BC is very small as

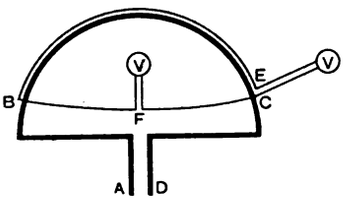

FIG. 2

compared with its reactance, and let the current at a certain instant have its maximum value in the direction BC. Then as it diminishes the induction tubes surrounding the conductor will shrink in, cutting into BC at a certain rate at each instant, and producing an electromotive force tending to keep up the current in the direction BC. The wire BE is also cut by most of these tubes, and if it could be brought so close to BC though remaining insulated from it, that no tubes could pass between them, and if the tubes which exist in the interior of the wire could be neglected, the E.M.F. produced in this wire in the direction BE would be exactly equal to that produced at the same instant in BC by the reactance. In the circuit BEVC there would be two equal and opposite electromotive forces, and so no current through the voltmeter.

It is theoretically possible in any case to arrange the voltmeter wires in such a way that the value of the impedance

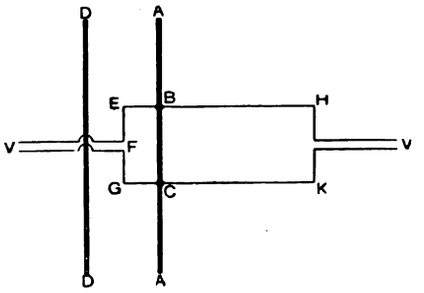

FIG. 3.

can be obtained. Practically the correct position can only be found easily in certain special cases. Let the line BFC in Fig. 2 form a boundary between the tubes which shrink into the portion BC of the conductor when the current is reduced to zero, and those which pass into other portions of the circuit. The voltmeter wires are led from B and C along this line to meet at any point, F, upon it, and thence as close together as possible to the voltmeter. No tubes will cut the wires BF and CF, and there will be no counter electromotive force in the voltmeter circuit to resist the current due to the difference of potential between B and C. As an example the case of two infinite parallel wires may be taken, one serving as a return to the other. In Fig. 3 D and A are the two wires, B and C are two points on one of them the virtual volts between which are to be determined. The voltmeter wires CG and BE are led out at right angles to BC, and then bent round to run along a line EG, parallel to A and D and midway between them. The two wires almost meet at F, and run very close together to the voltmeter. The line EG need not be in the same plane with A and D; the wires might indeed be led out along BH and CK, but it would be necessary to make them run parallel to a great distance before completing the circuit through the voltmeter, so as to enclose nearly all the tubes which pass into BC when the current dies away. Any that are outside HK, between the productions of the two lines BH and CK, will cut through HK and give a counter electromotive force lowering the reading of the voltmeter. There would be a danger in the increase of the inductance of the voltmeter by the spreading out of the connecting wires, and this would have to be considered in each case. The preceding problem would be of practical importance if it were desired to measure directly the drop of voltage between two points on an overhead alternate-current line, and attention would have to be paid to the position of the voltmeter wire. The problem also admits of easy treatment with a circular circuit. If the voltmeter wires are led from B and C along radii of the circle to the centre, and then close together to the voltmeter, they will not be cut by the contracting induction tubes, and correct readings can be obtained.

In other cases there would be as much difficulty in finding the proper position of the wires as in calculating the inductance of BC, so that practically it is impossible to determine the virtual volts by means of any form of alternating-current voltmeter. This, of course, does not imply the non-existence of a definite inductance for every portion of the circuit, or that there is not a definite virtual potential difference between its terminals. This last could be determined if necessary by means of a Joubert contact maker attached to the alternator, and an electrostatic voltmeter. If the E.M.F. of the alternator varies according to the sine law, the maximum value of the volts will be sufficient.

It follows from all that has been said that in a branched circuit it is not easy to define the inductance of one of the branches, or the mutual inductance between two of them. In the case of a main circuit and a voltmeter circuit, where the impedance of the second is high, the mutual inductance M may be defined as the number of tubes due to the main circuit which cut through the voltmeter circuit when the current in the main conductor is reduced from unity to zero; M being positive when the direction of cutting is such as to check a corresponding reduction of current in the voltmeter circuit.

Let R_1 be the resistance of the main circuit.
R_2 that of the voltmeter circuit.
L_1 the inductance of the portion of the main circuit between the voltmeter terminals.
L_2 that of the voltmeter circuit.
$e = E \sin pt$ the instantaneous volts between the terminals.
$C_1 = \dfrac{E}{\sqrt{R_1^2 + p^2 L_1^2}}$ the maximum current in the main circuit.
$c_1 = C_1 \sin(pt - \epsilon)$ the instantaneous value of the current where $\tan \epsilon = \dfrac{pL_1}{R_1}$.

The differential equation for the current c_2 in the voltmeter circuit is

$$c_2 R_2 + L_2 \frac{dc_2}{dt} + M \frac{dc_1}{dt} = E \sin pt,$$

the solution of which is

$$c_2 = C_2 \sin(pt - \theta),$$

$$C_2 = \frac{E \sqrt{(R_1^2 + (L_1 p - Mp)^2}}{\sqrt{(R_1^2 + p^2 L_1^2)(R_2^2 + p^2 L_2^2)}},$$

and $\tan \theta = \dfrac{R_1 R_2 Mp + R_1^2 L_2 p + L_1^2 L_2 p^3 - ML_1 L_2 p^3}{R_1^2 R_2 + R_2 L_1^2 p^2 - R_2 ML_1 p^2 - R_1 ML_2 p^2}$. *

(To be concluded.)

* See Paper by F. Bedell on "The Division of an Alternating Current in Parallel Circuits with Mutual Induction." British Association Report, 1896, p. 733.

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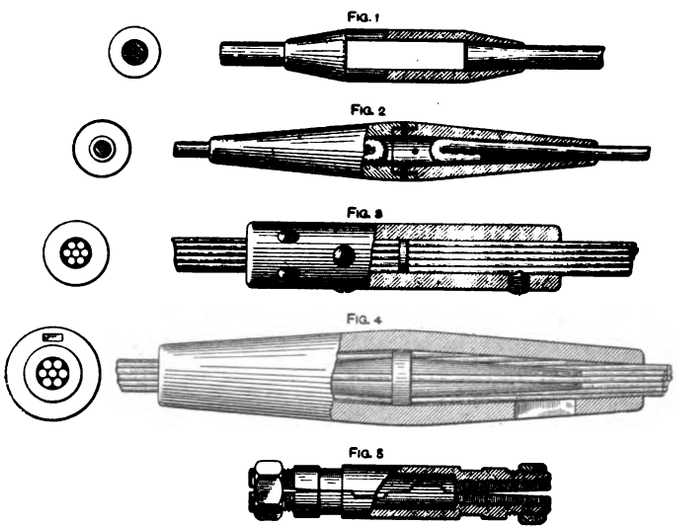
JOINTING ALUMINIUM WIRE.

A German firm is putting on the market the joints for aluminium, which we illustrate below. Fig. 1 is a slotted tube of aluminium, whose ends are slightly tapered. The ends of the wire are passed in from the outside, bent round through the slot, and their ends then "upset" by means of a hammer and hand-vice. After this the wire is drawn back into the position shown in the illustration. Fig. 2 practically explains itself. The clamp is in two halves, and after these have been screwed together, it is fastened by means of a pin driven through the thread.

Fig. 3 is an arrangement for cables, and is merely a short tube with set screws in it. Fig. 4 is a coned aluminium tube. The round conical wedge, with a hole through its axis, is threaded over the middle wire of each cable end. The two wires are then thrust into the opposite ends of the coupling and the butts of the two wedges meet, driving the wedges home and expanding the cable to fit tight in the tube. Fig. 5 is a screw coupling with expanded ends and made in two longitudinal halfs. It is intended for larger wires and cables and is said to work satisfactorily.

The *Electrical Review* of New York, commenting on these couplings, says that none of them seem any more satisfactory than tube unions employed in America. A good example of a satisfactory



joint, it says, can be made as follows:—Take a sheet of aluminium, of a thickness of about one-quarter the diameter of the wire, and cut strips of it so that each edge may be rolled around a mandrel toward the middle, to form, when this is done, a sort of twin tube. One wire end inserted in each of these tubular channels, and the whole then vigorously twisted with two pairs of pliers or monkey-wrenches, makes a good, solid and substantial, if unsightly joint.

A PORTABLE PHOTOMETER FOR INCANDESCENT LAMPS.*

BY PROF. ARTHUR J. ROWLAND.

In the industrial photometry of incandescent lamps, one of two things is always the object of measurement—*i.e.*, the candle-power which an incandescent lamp has at any applied E M F., or the E.M F. which should be applied to produce a given candle-power. The first is the one with which users of lamps have to do; the last is a determination which the manufacturer of incandescent lamps has to make for his whole product. Strange as it may seem, the last is much the harder to obtain if ordinary photometric methods are used. There are many sorts of photometers and many methods of using them. What I shall say will have reference to but one sort, a Bunsen photometer, and to a certain plan of using one which makes it especially easy to work with.

A Bunsen photometer is a familiar instrument. In its simplest form it consists of a graduated bar, at the ends of which are located the lights to be compared, one of them being of known candle-power. Along the bar one moves the car, which holds, in a plane perpendicular to a line joining the lights in question, a paper with a grease spot on it. When a position is reached where the spot cannot be distinguished from the surrounding paper, one knows that the illumination of both sides of the sheet is alike; that is, since the illumination of a surface falls off the square of the distance from the light source, by taking ratios of distances to lights from the car position squared, one has obtained the ratio of the candle-power of the lights.

In practice one has many obstacles to overcome in getting this simple result. In matters photometric there are such as:

(*a*) Too large a ratio between the candle-power of the light measured and that of the standard light. This causes a slight inaccuracy in the setting of the car to make a very disproportionate inaccuracy in the resulting candle-power calculated.

(*b*) A difference in the colour of the lights which are being compared. This makes it impossible to find a place along the bar where the grease spot disappears.

(*c*) Reflection from surrounding objects. A distortion of the illumination of the paper in the car results, so no *true* ratio can be found.

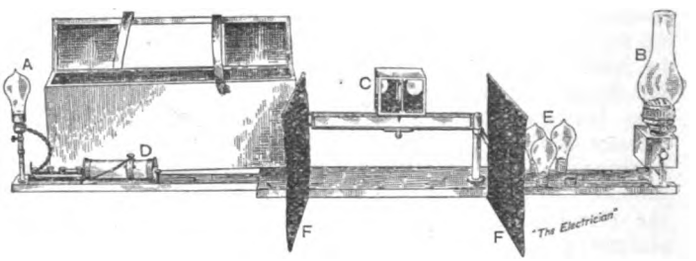
(*d*) A difference in the quality of the sides of the paper with the grease spot on it. If the paper be turned side for side, quite a different setting of the car for "equal illumination" will be found.

(*e*) A difference in eye-sensitiveness. If one stood on the other side of the bar, a different determination would have been had.

(*f*) A difference in mirrors used to enable one to see both sides of the paper at the same time, and so distortions, similar to those last mentioned, are produced.

In matters of manipulation there is the difficulty in keeping the E.M.F. on the lamps steady: in adjusting the E.M.F. within very close limits; in knowing the exact E.M.F. sending current through the lamp, due to the inaccuracy of voltmeters which have not been especially calibrated for the work. Any of these not right, and errors in the results are found, so they become utterly unsatisfactory and unreliable. An inexperience in making readings or poor choice of conditions causes results to be procured which are equally valueless.

In getting results in the usual way one has to labour through the tedious process of taking ratios of distances which must be squared, and must take enough readings to eliminate errors already mentioned by taking averages of candle-powers determined from a number of car settings.



So many of the difficulties are met and mastered in a portable photometer which has been loaned me by the Electric Motor and Equipment Co, Newark, N.J., that I will use it as a text in considering the special method of measurement I want to describe. In this photometer a grease spot car is used, and the standard is an 8-c.p. oil lamp, which practice shows to be of more than required constancy over a period of twenty minutes or more at a time.

The illustration shows this photometer ready for use. The different parts may be described by reference to letters placed directly below them in the cut. At A is put the incandescent lamp whose candle-power is to be determined. Provision is made on each photometer for lamps having Edison, Westinghouse, or Thomson-Houston bases. At B, at the other end of the instrument, some five feet from A, is the oil lamp. This holds enough oil to burn for four hours in use, and for an hour at a time with practically no change in its candle-power after once warming up and being set. Since the standard is of fixed value, a direct-reading scale can be used. It is shown directly below the car at C, and is marked off on celluloid from 7-c.p. to 34, marks being made for each half candle-power. In the car one can see the screen with grease spot, and the reflections of the two sides of the paper in the mirrors. The index for reading candle-power at any car setting shows on the scale just under the grease spot.

The screens F F are to shield the eyes of the observer from direct light from either source. His eyes must be protected thus so they may be adapted to distinguish small differences in tint of spot and field as he views the reflections in the mirrors. This arrangement makes "taking readings" much less fatiguing than the common and older plan of using an eye screen fast to the car, such as is used with fluoroscopes. At E is a rack to hold the standard lights. They are here out of the way, and yet conveniently placed to carry about or use.

A very refined adjustment of the E.M.F. on the lamp terminals is provided for by the rheostat shown at D. This is a solenoid of resistance wire along which a contact piece is arranged to be moved, so varying the E.M.F. on a 16-c.p. lamp through a range of 15 or 20 volts steps so small as not possible to detect with a first-class

* Paper read before the Franklin Institute.

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voltmeter. Thus one has at command the adjustment of the E.M.F. on the lamp under test to the exact value required, and a cause of errors of considerable magnitude is eliminated. At its marked E.M.F. a 16-c.p. 110 volt lamp will vary in candle-power as much as 6½ per cent. for a 1 per cent. change in E.M.F. applied, it must be remembered. Between the incandescent lamp and rheostat there are some simple switching devices provided, and the connecting cords to use at them to bring current to the photometer and to connect voltmeter, ammeter, wattmeter, or all of them at once to the circuit, as one chooses.

The 8-c.p. oil lamp is set to the value it must keep through a set of readings in a fashion which at once eliminates nearly all the difficulties in making satisfactory photometer measurements which I have mentioned. The method of proceeding to a candle-power measurement is as follows :—The oil lamp is lighted and warmed up. A standard incandescent lamp at an E.M.F. about like that on the circuit to be used is put in its "standard position" (that for which its candle-power is known), and its terminal difference of potential made that demanded on its label. It is now 16 c.p. from a direction down the photometer bar. The car is next set at the 16-c.p. mark and the light from the oil lamp adjusted until the grease spot disappears. The standard incandescent lamp is next removed and others, whose candle-power it is required to know, put in its place, one after the other, the car being shifted to a point where the grease spot disappears for each one, and their candle-power thus read directly. After a little practice one can make such readings on a 16-c.p. lamp so that the widest range of values determined will not be more than four-tenths of a candle-power. And if all are averaged, no reading differs from this value by more than two-tenths of a candle-power. In other words, an accuracy in a single reading will be within 1½ per cent. of the truth. This a very satisfactory result for a determination of candle-power on a commercial photometer. It is to be understood as applying to readings made at different times upon the same lamp. Or, for other purposes, the car is left at 16-c.p., for example, and the E.M.F. on the lamp varied until the spot is gone. The determination of this last can be made by a practised observer with quite remarkable accuracy considering the shortness of the bar. The oil-lamp standard can be checked at any instant by a return to the incandescent standard at the other end of the bar, setting the index on the car at the 16-c.p. mark and observing whether the grease spot is now invisible, as it should be.

Without going into a detailed explanation, one has, by this method, done away with all difficulty due to reflection, difference in quality of the sides of the greased paper, difference of eye sensitiveness, &c., and done away with them all to such an extent that a real dark room is not required to get satisfactory results. If only the light is not shining in the observer's eyes, a room not so dark but that common newspaper print can be read in it is satisfactory for ordinary work. By putting the real standard at the same end as the lamp whose candle-power is measured, all distortions come into every measurement in exactly the same way, and so are negligible. I am not informed whether or not this plan of working is original with the company above named, but it is certainly a plan of greatest possible value to anyone who has many measurements of candle-power to make, and wants them procured in as rapid and yet accurate a way as possible.

It will be seen that really the candle-power of the oil lamp never becomes known. It is simply a steady light, the value in candle-power of which need not concern one. The oil-lamp flame is not noticeably different in colour from many incandescent lamp filaments, especially if the incandescent lamps are not perfectly new and burning at high incandescence; and, by using it, rather than a second incandescent lamp, one does away with the necessity for a second voltmeter and its separate and accurate calibration. It cannot be denied that, if there are incandescent lamps at both ends of the bar, having the same efficiency and candle-power, any fluctuations of E.M.F. on the circuit after that on both lamps has been set will not interfere with the candle-power determinations, since the ratio of candle-powers will keep the same. But any advantage so obtained is more than offset in most commercial work by the necessity of having voltmeters for both lamps, and accurate ones, too.

Since the photometer I am using to illustrate these remarks is a portable one, it lacks certain accessories like a rotating socket, by the use of which the mean horizontal or rated candle-power becomes known at once. The instrument can be packed in the carrying case shown in the background. There is no question as to the exceeding portability of the instrument, not only because it can be used without a dark room, but also because it can be put together so compactly to carry around. Considering the purpose for which it was designed, therefore one can forgive the lack of a rotating socket.

I have described the instrument, not because it is a perfect one for *all* requirements of up-to-date photometry, but because it seems to me, a disinterested party, to embody very many points which must make a commercial photometer a satisfactory instrument, and so to be worthy of presentation to the members of the Institute.

THE ELECTROLYTIC TREATMENT OF COMPLEX SULPHIDE ORES.*

BY SHERARD COWPER-COLES.

(Continued from page 83.)

THE COWPER-COLES PROCESS.

The author's process briefly consists of—

1. Roasting the ore sweet in a specially constructed furnace.
2. Washing out the soluble zinc sulphate with water, and leaching out the remaining zinc with sulphuric acid and zinc sulphate.
3. Depositing metallic zinc or zinc sponge on aluminium cathodes.
4. The production of zinc white.
5. Leaching out the lead with caustic soda.
6. Deposition of the lead.
7. Production of white lead from the sodium plumbite solution.
8. Production of litharge and lead sulphite.
9. Leaching and deposition of the silver.

One of the first difficulties encountered was in roasting the ore sweet, and, secondly, difficulty after difficulty arose in the leaching of the ore; and when the zinc had been leached out from the ore it was found that good metallic zinc could not be obtained with any certainty, and the residue that remained, containing the lead and silver, could not be economically treated by any dry method.

Crushing and Roasting the Ore.—The mechanical difficulties met with were also very considerable. The ore, when crushed to 60 mesh, was found on the whole to give most satisfactory results. The ore, after crushing, was roasted in a specially designed furnace. The form of roasting-furnace must largely depend upon whether the sulphurous acid formed is to be utilised for the manufacture of sulphuric acid. There is great difficulty in making sulphuric acid from sulphurous acid vapours mixed with such large quantities of air as are obtained from the roasting of such ores as Broken Hill. In America the Brown-O'Hara horseshoe furnace, the Kop, the Pearce, and other furnaces having for their object the mechanical rabbling and conveyance of the ore from one part of the furnace to the other, are much used.

The furnace first employed by the author was an ordinary step reverberatory furnace, the products of combustion passing over the ore. This was found to be costly, a dead roast being obtained with difficulty. The object to be aimed at in roasting zinc-bearing sulphide complex ores is not so much to convert the metals into oxides as into sulphates, so as to reduce the consumption of sulphuric acid, if that acid is to be used as the solvent. British Broken Hill ore contains on an average 20 per cent. of sulphur. Prof. Schnabel has succeeded in converting about 40 per cent. of the zinc sulphide contained in the ore into sulphate, the usual amount obtained in a reverberatory furnace when the ore is roasted at a cherry-red heat being from 4 to 5 per cent.

The next furnace tried is shown in Figs. 1, 2, and 3, Fig. 1 being a sectional side elevation, Fig. 2 a plan, and Fig. 3 a sectional end elevation. This was found to give better results, and greatly to reduce the cost of production. The furnace is composed of four decks. The ore is first placed on the upper deck, where it is dried and heated. It is then fed on to the third deck A, and so on to the second and first decks C and D, Fig. 1. The products of combustion are allowed to pass over the ore, hot air being drawn through the tubes E, the supply of air being regulated by placing caps over the ends of the tubes. A furnace constructed on these lines is found to effect a considerable saving in coal. If mechanical rabbling were resorted to in place of hand rabbling, so as to keep the ore constantly turned over and fed from one deck to another, no doubt still greater economy would be effected. The following table gives the comparative results of a trial made with the ordinary reverberatory furnace and the new furnace :—

—	Old furnace.	New furnace.
Area of hearth	216 sq. ft.	150 sq. ft.
Amount of coal consumed	37 cwt.	29 cwt.
Number of charges	12	10
Amount of ore per charge	16 cwt.	24 cwt.
Amount of ore roasted	9 tons 12 cwt.	12 tons
Cost of coal per ton	3s. 1d.	1s. 10d.
Amount of sulphur as sulphide in ore after roasting	3·37 per cent.	3·05 per cent.

Another trial gave the following results :—

—	Old furnace.	New furnace.
Consumption of coal	8¾ cwt.	5 cwt.
Time of roast	24 hours	24 hours
Amount of ore roasted	21⅓ cwt.	24 cwt.

The efficiency of the furnace has been still further increased by reducing the area of the grate surface and placing another grate at

* Abstract of a Paper read before the Society of Engineers, Nov. 6.

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the other end of the furnace, so as to get a more even distribution of heat.

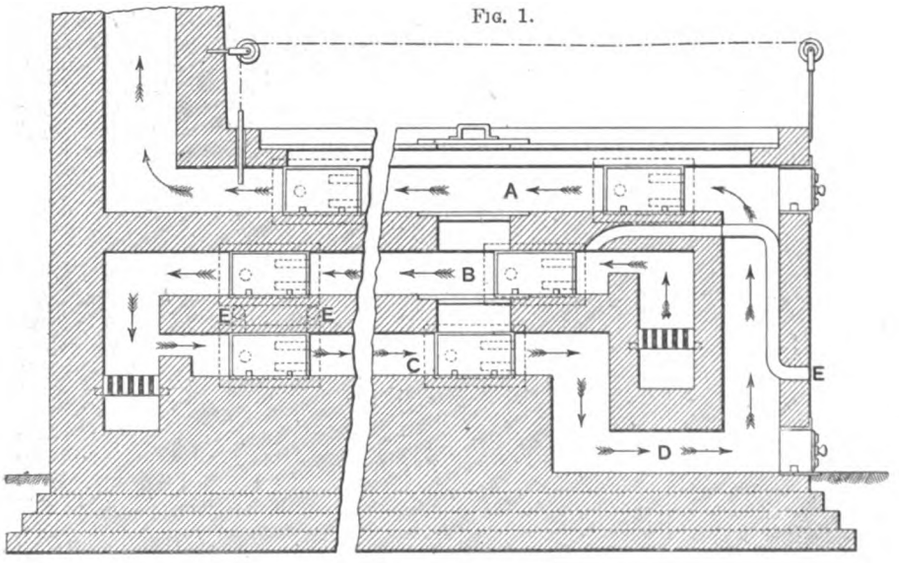
Some experiments have been carried out to see whether results of commercial value could be obtained by reducing the ore after roasting by passing coal gas or producer gas over the ore. The experiments carried out on a small scale do not warrant experiments on a larger scale. Attempts were made to recover the reduced metal by washing, but without success, nor could the metal be melted from the gangue without a flux.

The sulphide ore for the Ashcroft process was roasted at Cockle Creek in hand-rabbled reverberatory furnaces, with hearths 60ft. by 12ft. (equal to 7,200 sq. ft.). The furnaces were worked very slowly at a low heat, 500°C. to 600°C., the roasting ore being scarcely visible red in the daylight. It was found that if the temperature was raised beyond 600°C. sulphuric anhydride was driven off, leaving zinc oxide and basic zinc sulphate. Ordinarily 5 tons were roasted per 24 hours, with 25 per cent. small coal, which cost $1 per ton at the works, which is equal to 0·7 ton per 100 sq. ft. of hearth area.

fastened to the framework of the bin. A wooden hopper is placed outside the canvas shoot, to prevent the canvas bagging and retaining the ore. The screened ore is discharged through a shoot. Satisfactory results have been obtained by using an upper screen of 30 mesh and a lower screen of 80 or 90 mesh, and projecting an air blast into the bin, the fine dust being driven direct into a leaching vat containing the zinc sulphate solution with the necessary amount of free acid for dissolving the zinc. In the fine dust the percentage of lead is decreased, the silver and zinc remaining about the same. Some fines which had been put through an 80 sieve gave on analysis:—Lead 18·25, zinc 20·71 per cent., silver 11·98oz. per ton of 2,240lb.

Zinc Leaching.—Considerable quantities of tailings have been leached at Broken Hill with hyposulphite of sodium solution between 3¼ and 1½ per cent. strength, with and without the addition of blue stone, the ore being previously subjected to a chlorodising roasting. The results have not proved entirely satisfactory on a commercial scale. The great difficulty experienced with sulphuric

FIG. 1.



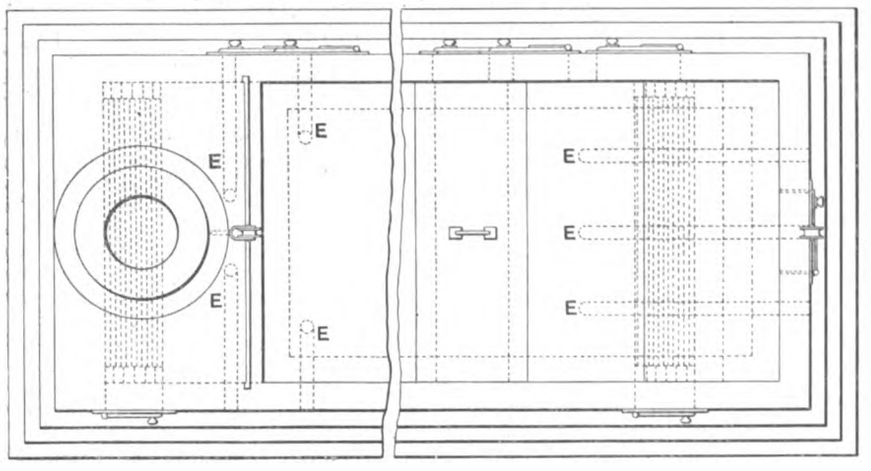


FIG. 2.

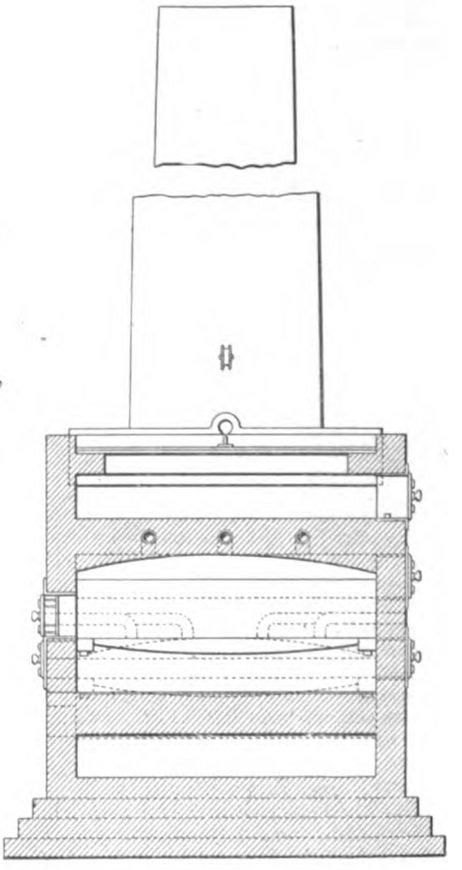


FIG. 3.

According to Mr. R. W. Ingalls, zinc blende can be hand-rabbled in reverberatory furnaces of similar size in Kansas and Missouri, with a consumption of about 100 per cent. of coal, the usual performance being about 0·25 ton per 100 sq. ft. of hearth area. Perhaps a saving in the near future will be effected by the adoption of coal-dust fuel, which is especially suitable for this class of work, as the load is constant. Some recent experiments made with firing with coal dust under forced draught are set down as effecting a saving of 25 per cent., the coal dust being ground to pass a sieve of 3,225 to 3,875 mesh per square inch.

Screening.—Certain portions of the ore during roasting are found to cinter, it is therefore found advantageous, after roasting, to screen the ore. The most suitable apparatus for this purpose is a reciprocating screen. This screen can be fitted with either one, two, or more screens for grading the ore. The screen is reciprocated by means of an eccentric, and is suspended on four links, the number of reciprocations being about 150 per minute. The screening apparatus is fitted with hinged lids, so as to retain the dust. To the frame of the screen is attached a canvas shoot, which is securely

acid leaching is due to the zinc silicate being split up and gelatinous silicate set free. Some experiments have been carried out on a small scale which tend to show that this difficulty can be overcome if the ore is moistened with concentrated sulphuric acid and heated until fumes are evolved, so as to dehydrate the gelatinous silica and form a granular silica; the ore being then leached with water and allowed to stand for four hours in the cold. A good extraction of zinc was thus obtained, the zinc in the residue being 3·987. There was no formation of gelatinous silica.

After a great number of experiments the best results were found to be obtained by leaching the ore on filter beds, the ore being first of all crushed to about 60 mesh, then roasted sweet and screened, the coarse screenings being re-crushed and re-roasted. The roasted ore is then dumped on to filter frames composed of wood gratings covered with cocoanut matting, on which is placed a thin layer of ashes from the furnace, the ore being levelled down to a thickness of about 18in. The ore is then washed to remove the soluble zinc sulphate, which on an average varies from 5 per cent. to 7 per cent, and the manganese, which is usually about 0·9 per cent. It is then leached with

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a solution of zinc sulphate, containing not less than 30oz. of zinc sulphate to the gallon and varying proportions of free acid. After leaching for about 12 hours the ore is washed with hot water and removed from the vats, when it is found to contain about 4 per cent. or 5 per cent. of zinc, the original percentage being about 20.

If the zinc is leached out with sulphuric acid, considerable difficulties are experienced from the formation of gelatinous silica, but this does not occur to the same extent when a strong solution of zinc sulphate is used. Ashcroft found it advisable not to have more than 100 grams of zinc sulphate per litre (equal to 16oz. of $ZnSO_4$ per gallon), so as to prevent trouble with gelatinous silica. The author has found that an electrolyte containing from about 35oz. to 40oz. per gallon deposits good zinc, and leaches well without the formation of much gelatinous silica.

Treatment of Fines.—The fines are leached in a revolving barrel mounted on a hollow trunnion, through which steam can be passed for

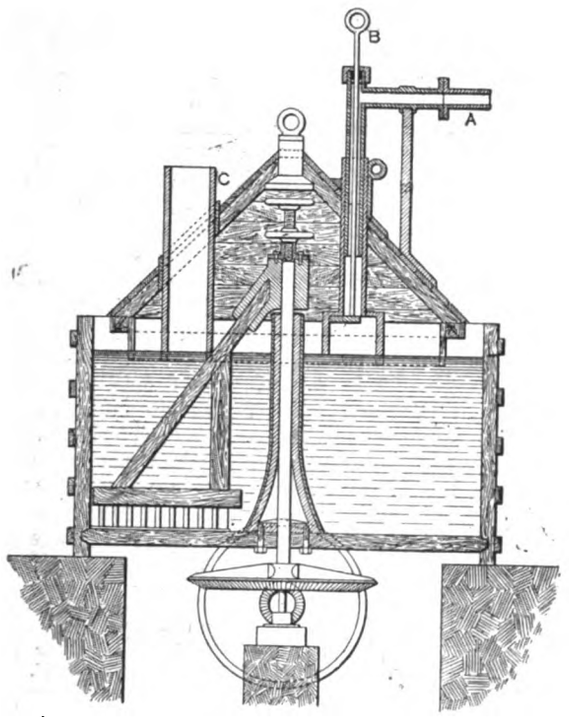

FIG. 4.

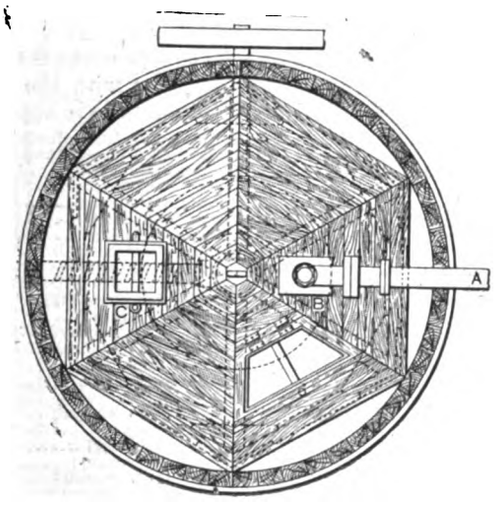

FIG. 5.

heating the solution, or air for obtaining pressure. The barrel is slowly rotated at from two to three revolutions per minute. The inside is fitted with baffle-plates. The ore is discharged on to a filter frame as previously described, washed, and allowed to dry, air being drawn from beneath the filter frame by a suitable pump, so as to facilitate the drying of the ore. The zinc sulphate solution thus obtained is neutralised by passing it over fresh beds of ore, and is then ready for gravitating into the epuration tanks.

As already mentioned, the fines or very fine dust are separated from the ore during screening by an air blast, and projected direct into a vat constructed as shown in Figs. 4 and 5, which are respectively a sectional elevation and a plan. This method can be substituted for the revolving barrel leach. The air charged with the dust is led into the vat through a pipe A which is fitted with a clearing rod B. If the pipe is not provided with some such arrangement it is found to choke very rapidly. The mouth of the pipe is adjustable, so that it can be lowered or raised as desired. The air finds its way out under the edge of the cover, being forced through the water. An extra exit, C, is also provided. The vat is fitted with a stirring apparatus, so as to keep the solution well agitated, a manhole being provided for adjusting the height of the stirrer blades. It is important that the ore should be ground as fine as possible, as on this depends to a very large extent the perfect leaching. A sample of ore containing 6 per cent. of zinc in the residue, when re-ground and re-leached was found to contain only 3 per cent.

Some experiments to determine whether sulphide ore which had been mixed with lime and placed in fused caustic soda was readily soluble in water, showed that it could not be lixiviated except with considerable difficulty. If, however, the ore is free from lime it is easily lixiviated.

Epuration Tanks.—When the electrolyte contains much copper it is passed through a tank or sump filled with crude zinc scrap, on which the copper is thrown down and the zinc goes into solution. It is then run through a second tank filled in a similar manner with iron scrap and carbon, any remaining copper being thrown down on the iron and the iron going into solution. It is found that small traces of copper cause the zinc to come down in a spongy form.

Electrolysing Cells.—The solution is then drawn from the sumps by means of a centrifugal pump and circulated through open launders or channels which supply a number of cells, the solution being discharged from an upper channel placed near the top of the vat. Cast iron discs are provided, which are rotated at the rate of from two to three revolutions per minute. The body of the tank is constructed of wood, bolted together with galvanised iron bolts passed through the centre of the woodwork. The tanks are coated with asphaltum, or micacious iron paint, known as "ferrodor," which are both practically insoluble in sulphuric acid. The anodes are made of sheet lead, and are bolted between two iron strips, which are fixed in gun-metal shoes, which are again bolted to cross brass pieces. The cathode connection is made through the spindle, to which the revolving discs are keyed, either by means of a mercury cup or by rubbing contacts. The mercury cup is found to answer very satisfactorily.

A series of experiments has been made to determine the result of revolving the discs slowly and rapidly, with interesting results. It was found that when the disc was revolved rapidly, say from 10 to 15 revolutions per minute, the solution not having time to drain from the disc, such good results were not obtained as when the disc was revolved slowly, from one to two revolutions per minute, the deposited zinc having time to get almost dry—anyhow, sufficiently dry to allow the air to come into intimate contact with it. In place of the revolving cathode aluminium sheets have been used with excellent results, thin aluminium sheets being placed in a detachable wood frame. The zinc that is deposited on the aluminium is readily detached, owing to the formation of a loose film of aluminium hydrate.

Anodes.—The author first used carbon anodes, but these were found to disintegrate rapidly. Iron anodes were then substituted for carbon. These reduced the electromotive force required from about 2 volts to 1. The iron was found not to dissolve at the theoretical rate. The iron anodes had to be eventually abandoned, both on account of the cost due to the heavy consumption of iron and the difficulties experienced in dealing with such large quantities of iron in the electrolyte. Lead anodes have proved, taking everything into account, to give the best results, although a larger electromotive force is required. The peroxide formed on the surface is fairly adhesive.

Zinc Deposition.—At Cockle Creek it was found the free sulphuric acid must not be allowed to accumulate in the depositing cells to an amount exceeding from 3 to 5 grams per litre (equal to 0·48oz. to 0·80oz. free H_2SO_4 per gallon), the amount of zinc sulphate in solution being 120 grams per litre (equal to 84·6oz. $ZnSO_4$ $7H_2O$ per gallon). The presence of copper in the electrolyte is found to be very detrimental. With a current density of 15 amperes per square foot, and 1 grain of copper per gallon of solution, good deposits of zinc were obtained; with two or more grains per gallon, under the same conditions, zinc was thrown down in a black and loose form. Zinc produced by the author's process gave, on analysis, the following result:—

Insoluble	0·005
Iron	0·016
Tin	0·008
Arsenic	trace.
Lead	absent
Copper	0·281
Zinc (by diff-rence)	99·690
	100·000

(To be concluded.)

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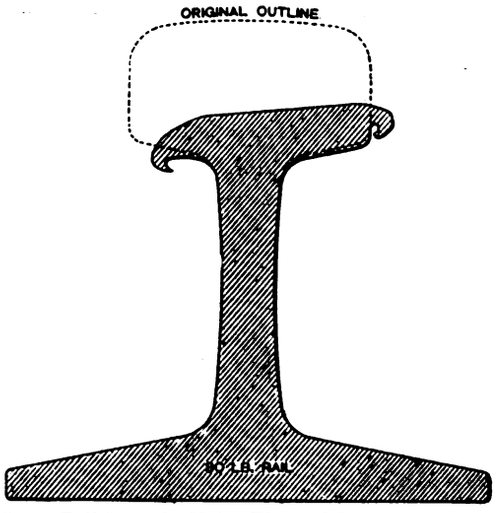
RAIL WEAR ON AN ELECTRIC OVERHEAD RAILWAY.

The wear of rails under heavy traffic is illustrated to a somewhat remarkable degree by the accompanying section of a worn rail taken out of the track of the Union Elevated Loop Railway, at Chicago, after a service of about eight months, during which period it had carried approximately 6,000,000 wheels. This road carries the trains of the Chicago elevated railways, and each train consists of a motor passenger car, with two or three trailers, so that only one-third to one-fourth of the wear can be attributed to the heavy motor cars. The rail was of the section recommended by the rail committee of the American Society of Civil Engineers, and weighed 80lb. per yard. It was of commercial make, with about 0·48 per cent. carbon, but these rails are being replaced with others of special make, having about 0·60 per cent. carbon. It was on the high side of the curve



Worn Curve Rail from the Union Elevated Loop Railway, Chicago.
(One-half size.)

at Fifth-avenue and Lake-street, the curve elongation being 3in. The section of the rail and the above particulars of the service are from the *Engineering News* of New York, to whom they were supplied by Mr. S. S. Neff, Superintendent of the Union Elevated Loop Railway.

ELECTRICITY WORKS ACCOUNTS.

Edinburgh Municipal Electric Supply Works.

The rapid progress and economical working of the Edinburgh municipal electric supply business had won for the undertaking a pre eminent position at an exceptionally early stage of its career.

It is now our pleasant duty to chronicle, in respect of the year ended at May 15th last, not a mere maintenance of but a phenomenal acceleration in the rate of progress which has always been such a satisfactory characteristic of the undertaking. The following table is of interest, as furnishing an idea of the growth of the business since its commencement:—

From these figures it will be seen that in the acquisition of new business last year completely surpassed any previous year. The lamp connections show an increase of nearly 43 per cent., while the output marked an advance of close on 45 per cent. over the number of units sold in 1897-8. A most interesting point in the above table is the column showing the load factor. It is to be noted how steadily this factor increases—a satisfactory feature, due chiefly to the increasing motor load on the station.

The Edinburgh undertaking stands as an excellent example of the effect of a low tariff on the development of an electric supply concern, and it is gratifying to find that the Electricity committee have found it possible to make further substantial reductions in the prices charged.

Owing to a slight increase in the items of fuel and distribution costs, works costs show a slight rise, though in consequence of a reduction in the management and property charges the total costs also show a sensible drop since 1897–8.

The year's working profit was £23,730, representing 6·95 per cent. of the mean capital. Nothing has this year been placed to the depreciation fund, but the joint capital charges of interest and sinking fund amounted to 5·2 per cent. of the mean capital, thus leaving a net profit of £5,886.

As will be noticed, the average price obtained for electricity supplied has dropped from the extremely low figure of 2·49d. to 2 24d., while the average total revenue is now only 2·77d. per unit sold—an unparalleled achievement, and especially gratifying in view of the associated financial results.

The Norwich Electricity Co.

The accounts of the Norwich Co. for 1898, which are set forth in our usual form, are clearly indicative of continued and increasing prosperity. During 1898, 371 additional consumers were secured, and the lamp connections were raised from the equivalent of 30,256 to 51,392 8-c.p. lamps—an increase of about 70 per cent.

The year's output at 741,200 units sold is an advance of nearly 30 per cent. upon the business of 1897, and was productive of a total revenue of £14,041, representing 4·55d. per unit.

To the revenue, the total costs bear a ratio of 49 per cent., and the result was a working profit of £7,162, representing 8·09 per cent. of the mean capital. Out of this sum £2,500 was carried to the depreciation fund, which now stands at £9,000, £478 was the allocation to the sinking fund, while the interest charges amounted to £1,192. The balance, with that brought forward from 1897, amounted to £3,445, and permitted of an ordinary dividend of 6 per cent. being paid.

In addition to the £478 from the revenue account £1,523 premiums on shares has also been carried to the credit of the sinking fund, which has now a balance of £3,000. Thanks to the liberal manner in which they have been dealt with, the company's reserve funds are in a very satisfactory state. There are slight increases to be noticed in both the works costs and the management and property charges, while the aggregate costs have risen from 2d. to 2·23d. per unit. Even now, however, the figure for the total costs is below what might fairly have been expected of works situated as Norwich is. In the table below we give some figures relative to the concern since 1895.

Year.	No. of consumers.	Lamp connections.	Output. Units sold.	Plant capacity. KW.	Maximum supply demanded. KW.	Total cost's per unit.	Total rev. per unit.
1895.....	450	19,456	299,650	545	428	...	...
1896.....	675	22,303	436,050	650	545	2·13d.	5·29d.
1897.....	896	30,256	572,000	890	659	2·00d.	4·86d.
1898.....	1,267	51,392	741,200	1,098	871	2·23d.	4·55d.

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

Aberdeen (Municipal)	Jan. 6,	1899	
Ayr (Municipal)	Sept. 22,	,,	
Bedford (Municipal)	May 19,	,,	
Belfast (Municipal)	Sept. 15,	,,	
Birmingham (Company)	Sept. 15,	,,	
Blackpool (Municipal)	Sept. 29,	,,	
Bournemouth (Company)	April 29,	,,	
Bolton (Municipal)	Dec. 9,	1898	
Bradford (Municipal)	April 14,	1899	
Brighton (Municipal)	May 12,	,,	
Bristol (Municipal)	July 14,	,,	
Burnley (Municipal)	Aug. 25,	,,	
Burton-upon-Trent (Mun.)	April 21,	,,	
Bury (Municipal)	Sept. 22,	,,	
Cambridge (Company)	Mar. 10,	,,	
Cardiff (Municipal)	Jan. 6,	,,	
Charing Cross (Company)	Mar. 17,	,,	
Chelsea (Company)	Mar. 31,	,,	
Cheltenham (Municipal)	Nov. 10,	,,	
Chester (Municipal)	June 23,	,,	
City of London (Company)	May 12,	,,	
Clerkenwell (Company)	Aug. 18,	,,	
Derby (Municipal)	Dec. 9,	1898	
Dewsbury (Municipal)	Nov. 25,	,,	
Dover (Company)	June 2,	1899	
Dundee (Municipal)	Nov. 4,	1898	
Eastbourne (Company)	July 22,	,,	
Edinburgh (Municipal)	Oct. 14,	,,	
Exeter (Municipal)	Aug. 5,	,,	
Glasgow (Municipal)	Sept. 1,	1899	
Guildford (Company)	May 5,	,,	
Halifax (Municipal)	July 21,	,,	
Hammersmith (Vestry)	May 26,	,,	
Hampstead (Vestry)	Aug. 25,	,,	
Hanley (Municipal)	April 28,	,,	
Harrogate (Municipal)	Oct. 20,	,,	
Harrow (Company)	June 16,	,,	
Hast'gs & St. Leonards (Co.)	April 29,	1898	
H'use-to-H'useCo.(K'ns'gt'n)	Mar. 31,	1899	
Hove (Company)	Mar. 10,	,,	
Huddersfield (Municipal)	Oct. 6,	,,	
Islington (Vestry)	Oct. 17,	,,	
Kensi'gton & Knightsbr'(Co.)	Mar. 3,	,,	
Kingston-upon-Hull (Mun.)	June 9,	1899	
Kingston-on-Thames (Mun.)	April 21,	,,	
Lancaster (Municipal)	Oct. 21,	1898	
Leeds (Company)	Mar. 3,	1899	
Leicester (Municipal)	Jan. 20,	,,	
Leyton (Municipal)	Sept. 8,	,,	
Liverpool (Municipal)	June 9,	,,	
Manchester (Municipal)	Aug. 11,	,,	
Newcastle and District (Co.)	Oct. 6,	,,	
Newcastle-upon-Tyne (Co.)	April 14,	,,	
Northampton (Company)	Oct. 20,	,,	
Norwich (Company)	Dec. 2,	1898	
Notting Hill (Company)	Mar. 17,	1899	
Nottingham (Municipal)	July 21,	,,	
Oldham (Municipal)	Nov. 18,	1898	
Oxford (Company)	May 19,	1899	
Pontypool (Company)	May 5,	,,	
Portsmouth (Municipal)	July 14,	,,	
Preston (Company)	Sept. 29,	,,	
Reading (Company)	Oct. 13,	,,	
Richmond (Company)	Oct. 13,	,,	
Scarborough (Company)	Nov. 3,	,,	
St. James' & Pall Mall (Co.)	Feb. 24,	,,	
St. Pancras (Vestry)	May 26,	,,	
Sheffield (Company)	Dec. 16,	1898	
Shoreditch (Vestry)	Oct. 27,	1899	
Southampton (Municipal)	Nov. 10,	,,	
Southport (Municipal)	July 7,	,,	
South Shields (Municipal)	July 7,	,,	
Stafford (Municipal)	Oct. 21,	1898	
Sunderland (Municipal)	July 28,	1899	
Taunton (Municipal)	June 16,	,,	
Tunbridge Wells (Mun.)	Sept. 1,	,,	
Walsall (Municipal)	June 23,	,,	
Wandsworth (Company)	Aug. 18,	,,	
Westminster (Company)	Feb. 24,	,,	
Whitehaven (Municipal)	July 28,	,,	
Windsor (Company)	Dec. 30,	1899	
Wolverhampton (Municipal)	June 30,	1899	
Woolwich (Company)	Jan. 13,	,,	
Worcester (Municipal)	April 7,	,,	
Yarmouth (Municipal)	Nov. 3,	,,	

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	EDINBURGH.		NORWICH.	
Undertaking Worked by	Edinburgh Corporation.		The Norwich Electricity Company.	
Date of Commencement of Supply	April, 1895.		October, 1893.	
System of Supply	3-wire continuous and H.T. alternating current.		3-wire continuous current with batteries.	
Chief Engineer	Frank A. Newington.		F. M. Long.	
YEAR ENDED	MAY 15, **1898.**	MAY 15, **1899.**	DEC. 31, **1897.**	DEC. 31, **1898.**
QUANTITIES—				
Units generated	3,313,460	4,625,367	702,000	897,000
„ SOLD (TOTAL)	2,894,437[a]	4,174,541[h]	572,000	741,200
„ sold to consumers	2,059,777	3,129,808	572,000	741,200
„ sold for public lighting, &c.	834,660	1,044,733	nil	nil
„ used on works	158,816	231,152	87,033	—
UNITS SOLD PER 8 C.P. LAMP CAPACITY	28·1	28·4	20·6	21·6
Maximum supply demanded	2,388 kilowatts	3,116 kilowatts	669 kilowatts[a]	871 kilowatts
Number of public lamps	500 arc	702 arc	nil	nil
Number of consumers	1,630	2,514	896	1,267
Connections to mains in 8-c.p. lamps	158,900	226,737	30,256	51,392
CAPACITY OF PLANT IN 8-C.P. LAMPS	103,100	147,000	27,800	34,300
CAPACITY OF PLANT IN KILOWATTS	3,300	4,705	890	1,098
CAPITAL—	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.
AUTHORISED (TOTAL)	— —	— —	£100,000 £112	£100,000 £91·0
Share	— —	— —	50,000 56·2	50,000 45·5
Loan (including Debenture charges)	— —	— —	50,000 56·2	50,000 45·5
RECEIVED (TOTAL)	£210,000 £63·6	£390,000 £83	71,150 79·9	86,128 78·4
Share	— —	— —	45,650 51·3	50,000 45.5
Loan (including Debenture charges)	210,000 63·6	390,000 83	25,500 28·7	36,128 32·9
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	— —	— —	28,850 32·4	13,872 12·6
Share (unissued)	— —	— —	4,350 4·89	— —
Share (uncalled)	— —	— —	— —	— —
Loan (including Debentures)	— —	— —	24,500 27·5	13,872 12·6
REPAID (TOTAL)	— —	— —	— —	— —
RESERVE OR SINKING FUND	18,787 5·69	28,353 6·03	1,000 1·12	3,000[k] 2·73
DEPRECIATION FUND	8,126 2·46	8,352 1·78	6,500 7·30	9,000 8·20
EXPENDED (TOTAL)	287,466 87·1	395,357 84·0	79,502 89·3	97,761 89·0
Lands and buildings	35,357 10·7	51,928 11·0	14,621 16·4	15,035 13·7
Plant	99,966[b] 30·3	138,611[i] 29·5	35,493 39·9	42,279 38·5
Mains	149,705 45·4	202,381 43·0	29,388 33·0	38,258 34·3
Miscellaneous	2,437 0·739	2,437 0·52	— —	2,189 1·99
BALANCE OF CAPITAL ACCOUNT	−77,466[c] −23·45	−5,357[c] −1·14	−7,492[b] −8·41	−11,633[b] −10·6
REVENUE—	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.
TOTAL	£38,049 3·156d.	£48,238 2·773d.	£11,578 4·862d.	£14,041 4·548d.
Revenue from supply	30,015[d] 2·490d.	38,983[j] 2·240d.	11,423 4·793d.	13,047 4·227d.
„ meters, &c.	— —	10 0·001d.		534 0·173d.
„ public lighting	7,993 0·663d.	9,198 0·529d.	— —	— —
„ sale of lamps, &c.	— —	28[k] 0·002d.	12 0·005d.	63 0·020d.
„ miscellaneous sources	41 0·003d.	19 0·001d.	142 0·060d.	396 0·128d.
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	£17,401 1·444d.	£24,508 1·409d.	£4,776 2·003d.	£6,879 2·227d.
WORKS COSTS	13,014 1·080d.	19,015 1·094d.	3,550 1·490d.	4,852 1·572d.
Generation of electricity	*8,561 0·710d.*	*12,777 0·734d.*	*3,550[e] 1·490d.*	*3,947 1·279d.*
Fuel (including cartage, &c.)	4,176 0·347d.	7,366 0·424d.	1,819 0·764d.	2,176 0·705d.
Oil, waste, water, stores	677 0·056d.	862 0·050d.		155 0·050d.
Wages at station	2,077 0·172d.	2,537 0·146d.	1,011[d] 0·424d.	926 0·300d.
Repairs and maintenance at station	1,632 0·135d.	2,012 0·116d.	720[e] 0·302d.	660 0·214d.
Distribution of electricity	*1,544 0·128d.*	*2,830 0·163d.*	— —	*822 0·266d.*
Wages, &c.	897 0·074d.	1,674 0·096d.	— —	822 0·266d.
Repairs, renewals of mains, &c.	647 0·054d.	1,156 0·067d.		
Public lighting	*2,909 0·243d.*	*3,408 0·196d.*	— —	— —
Attendance	1,627 0·135d.	2,281 0·131d.	— —	— —
Renewals	1,281 0·106d.	1,128 0·065d.	— —	— —
MANAGEMENT AND PROPERTY CHARGES	4,387 0·364d.	5,493 0·316d.	1,226 0·514d.	2,027 0·657d.
Royalties	— —	— —	— —	— —
Rent, rates, taxes	*1,866 0·155d.*	*2,219 0·128d.*	*272[f] 0·114d.*	*255 0·083d.*
Management	*2,521 0·209d.*	*3,274 0·188d.*	*954 0·400d.*	*1,772 0·574d.*
Salaries	400 0·033d.	413 0·024d.	718 0·301d.	1,397[l] 0·453d.
Stationery, &c.	144 0·012d.	170 0·010d.	144 0·060d.	81 0·026d.
Establishment charges	635 0·053d.	853 0·049d.		134 0·043d.
Law charges, &c.	1,342[g] 0·111d.	1,838[l] 0·106d.	92[g] 0·039d.	160[m] 0·052d.
FINANCIAL RESULTS—	Total / % to mean cap. exp'nded	Total. / % to mean cap.exp'nded	Total. / % to mean cap.exp'nded	Total. / % to mean cap.exp'nded
WORKING PROFIT FOR YEAR	£20,648 7·97%	£23,730 6·95%	£6,801 9·36%	£7,162 8·09%
Sum carried to Depreciation Fund	4,000 1·54%	— —	2,500 3·44%	2,500 2·82%
Sum carried to Reserve or Sinking Fund	7,686 2·97%	9,566 2·80%	1,000 1·38%	478 0·54%
Net interest on loans (incl. Debenture charges)	5,937 2·29%	8,278 2·42%	805 1·11%	1,192 1·35%
BALANCE FROM LAST ACCOUNT	— —	— —	441[h] 0·612%	452 0·51%
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	3,024 1·17%	5,886 1·72%	2,940 4·05%	3,445 3·89%
Deficit	— —	— —	— —	— —
ORDINARY DIVIDEND PAID	— —	— —	— 5½%	6% —
PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE	45·75%	50·8%	41·2%	49%
Expenditure per kilowatt capacity	£5. 5s. 7d.	£5. 4s. 2d.	£5. 7s. 5d.	£6. 5s. 4d.
REVENUE PER KILOWATT CAPACITY	£11. 10s. 0d.	£10. 7s. 0d.	£13. 0s. 0d.	£12. 16s. 0d.
Expenditure per 8-c. lamp capacity	3s. 4½d.	3s. 4d.	3s. 5½d.	4s. 0d.
REVENUE PER 8-C.P. LAMP CAPACITY	7s. 4½d.	6s. 6½d.	8s. 4d.	8s. 2½d.
REVENUE PER 8-C.P. LAMP CONNECTED	4s. 9½d.	4s. 3d.	7s. 7½d.	5s. 5½d.
Price charged for lighting, per unit	4d.[g]	3½d.[m]	7d. to 3½d.[i]	7d. to 3½d.
Price charged for power, per unit	2d.	1½d. net	3d. to 2d.[j]	3d. to 2d.
Price charged for public lighting	£16 per arc per ann.	£14 per arc per ann.[n]	—	—

EDINBURGH.—REMARKS—*a* Including 86,654 units for motor power. *b* Includes £14,417 for arc lamps and columns. *c* Over-expended. *d* Includes £725 for motor power and £32 for private arc lighting. *e* Includes £1,057 to proportion of "General Expenses of Management." *f* Transferred to credit of General Improvements Ordinary Expenditure Account. *g* Less discounts. *h* Includes 222,348 units sold for motor power. *i* Includes £18,041 for arc lamps and posts. *j* Includes £1,403 for motor power at 1½d. per unit. *k* In respect of arc lamps for private lighting. *l* Includes £1,602 proportion

NORWICH.—REMARKS—*a* At consumers' terminals. *b* Over-expended. *c* Includes distribution costs. *d* Includes salaries and wages in respect of distribution. *e* Includes repairs and maintenance of mains, &c. *f* Includes also insurance charges. *g* Includes auditing £1 and Board of Trade fees £24. *h* After deducting directors' fees £300. *i* 7d. per unit during hours of heavy load; at other times, 3½d. *j* 3d. per unit for first 500 units per quarter; 2d. per unit after. *k* This fund is swelled by premiums on shares £1,523. *l* Includes

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THE SPRAGUE MOTOR SUSPENSION PATENT.

The patent action heard last week, and on which judgment was delivered last Tuesday, will have no direct influence on the electric traction industry in this country, for the patent alleged to be infringed expired on August 10th of this year, so that the action was merely one for damages. From the historical point of view, and from its bearing on the question of master patents in general, the matter is one of extreme interest, however. If the broad claim of the patent had been allowed, it would have covered practically every type of motor car employed for electric tramways. In our last issue we published the text of the patent; and a perusal of it will show that the inventor aimed at securing a broad patent on journalling an electric motor at one end upon the car axle, and supporting the other end of the motor flexibly either from the car body or the truck of the vehicle. This so-called invention is practically embodied in the first claim of the patent, and the defendants (the Imperial Tramway Co. and the British Thomson-Houston Co.) had little difficulty in showing that the idea was no new one. In a patent granted in 1859 to Longstaff and Pullen for a steam road waggon practically the same construction is indicated, the motor being journalled at one end upon the driving axle, with intervening gears, and at the other end being flexibly supported. It is obvious that the substitution of an electric for a steam motor cannot in any way render novel the employment of a sleeve suspension; and some 14 other British patents, dating as far back as 1833 and down to 1884, as well as a number of United States patents, may be cited to show that this method of suspension was well known, and was naturally applied to electrically driven vehicles as soon as engineers turned their attention to them. We may mention that the precise suspension illustrated and described in the patent in question has never, to our knowledge, actually been used. According to present practice, the motors are supported on the axle by an attachment to a neutral portion of the field-magnets, and suspended in a similar way at the other end. As can be seen from the figure illustrating the patent, the arrangement there described is actually to suspend the motor from the axle by an attachment to its pole-pieces, and the armature is also carried by the pole-pieces, a construction which is not only peculiar, but bad engineering as well. An attempt was made by the plaintiffs'

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counsel to show that the first and third claim of the patent were practically identical, and that the former, as well as the latter, were intended to cover spring suspension and not the broad idea of "centreing" or "sleeving" the motor upon the driving axle. The judge, however, refused to be convinced of this, and ascribed to the first claim that broad meaning we have already indicated, with the inevitable conclusion that the invention had been frequently anticipated, and that the whole patent therefore was invalid.

The Sprague patent (referred to during the case as the Handford patent, T. J. HANDFORD being the agent in this country), although making its first appearance in the English law courts, is an old friend on the other side of the Atlantic, and we may quote a very clear decision as to the want of novelty in a device of this kind from the judgment in the case of the Adams Electric Railway Co. *v.* the Lindell Railway Co. delivered some time ago by Judge SAMBOURNE, of the Court of Appeal for the Eighth Circuit in the United States. "The matter of elastic suspension by springs and of otherwise giving either entire or partial independent support is so common in the arts, and has taken on such innumerable forms, that it cannot easily be perceived that any method not heretofore used remains. The presumption is therefore against patentability in any mere form of elastic suspension unless under exceptional circumstances."

The electrical industry has seen many master patents. In a few cases these have been for epoch-making inventions which have given fresh impetus to its progress. More often, however, it has found them a serious burden and impediment. We do not wish to imply that the owners of these master patents have not frequently deserved the reward they have reaped, although in some instances, even if the invention may have received no more than its due, those who have financed and assisted the inventor have done the reaping, retained the grain, and handed him the husks. But an attempt to create a master patent out of "a novel combination of old instrumentalities" deserves absolutely no sympathy.

REVIEWS.

Copies of any of the undermentioned works can be had from *The Electrician* office post free, on receipt of published price.)

Manual of Electrical Undertakings. Compiled under the direction of EMILE GARCKE, M.I.E.E. Vol. IV. (Donington House, Norfolk-street, London, W.C.) 12s. 6d. net.

Mr. Garcke's book grows apace, and contains well over a thousand pages of statistical matter relating to telegraphs, telephones, electricity supply, traction, &c. Compared with previous issues, there is an absence of the district maps, caused presumably by the difficulty experienced by all who have in the early days of the industry endeavoured to show in graphic form the progress of electricity supply. It appears from the preface that there are upwards of 500 undertakings engaged in electricity supply owned by companies and municipalities, besides a further 500 electrical trading concerns. In the section devoted to telegraphs a summary is given of the report presented to Parliament in 1899 on the Pacific cable scheme, which report has recently undergone severe criticism from Sir Charles Todd (*The Electrician*, Oct. 20, 1889, p. 920, and Nov. 3, 1899, p. 46). Under the head of telephones possibly the most interesting matter is that relating to the Mutual Telephone Co., which was registered in 1898 to enter into a contract with the New Mutual Telephone Syndicate (Limited) to take over its "business," and to obtain a licence from the Postmaster-General to construct and maintain a telephone system in Manchester and other places. Neither that company nor its parent syndicate have made much progress towards accomplishing this task since the registration of the latter in 1896. It is interesting to find that the business taken over by the Mutual Co. is that of a company "limited by guarantee with a membership of 20, each liable up to £100 in the event of winding up."

The particulars relating to electric lighting and traction are, as far as we have had time or opportunity for checking, full and accurate, although matters electrical move so rapidly, and the changes occurring at the extreme end and the beginning of the year are so numerous and important, as to quickly put out of date statistics and information compiled in the summer months. Certain errors and misdescriptions are almost inseparable from such a compilation, but these are for the most part by no means aggressive in Vol. IV. of Mr. Garcke's book, which bears evidence on every page of conscientious work and painstaking efforts to ensure accuracy and completeness. It is needless, therefore, to call attention to several slight inaccuracies noticed in turning over its pages, but we feel bound to point out one item, in the short chapter "Telephony," which is distinctly misleading. The text of the Telegraph Act, 1899, given in full, is preceded by the Treasury Minute issued in May, 1899, when the Telegraphs (Telephone Communication, &c.) Bill was merely in the form of a general Bill enabling local authorities to borrow money for establishing telephone exchanges. In its final form, however, the Act clearly supersedes the Treasury Minute, and this should either have been stated in the book, or, better still, the misleading Minute omitted.

The Valuation of Gas, Electricity, and Water Works for Assessment. By THOS. NEWBIGGING, M.Inst.C.E., and WM. NEWBIGGING, A.M.Inst.C.E. (London: Walter King.) 2nd Edition. 5s.

This little manual, which issues from the office of the *Journal of Gas Lighting*, deals, as might be expected, almost exclusively with the rating of gas works. But the fact that similar principles apply to electric supply works has justified the authors in adding the word "electricity" to the title of their second edition, although this has involved an addition of hardly more than a single page to their work. The originators of our rating system, in founding it upon a rental basis, were not troubled by having to deal with railways, gas works, or even water works, much less with electric supply stations. They would have been puzzled to know how it could be made applicable to such undertakings, and certainly can never have foreseen the anomalous structure which has imperceptibly grown up on their foundations. The authors shortly explain, in pleasantly large type, how this budget of paradoxes holds together, and present such apologies as can be found for the fiction of the "hypothetical tenant" who is always supposed to be a competitor for ratable premises. A specimen form is given stating all the details for computing a gas works assessment, and each of the items is commented on in the text. This form is easily adaptable to an electrical undertaking. There is also an appendix, in which the judgments of the court in several important rating cases are set out in full.

Arc Lamps and How to Maintain Them. By H. SMITHSON and E. R. SHARPE. (London: Whittaker and Co. 1899.) 1s.

This is an unpretentious little book of about 50 pages, giving simple directions as to the management of various kinds of arc lamps. It is somewhat difficult to know what class would benefit by such a work. We fear that the ordinary shopkeeper who uses arc lamps would hardly be able to derive much help from a book of any kind on the subject. The only class we can think of to whom such a little handbook might be of service are those ironmongers and wirers who too frequently undertake to install and "put right" arc lamps. The authors attempt the description of four or five makes of arc lamps without the help of any drawings or diagrams, and naturally the result is a poor one. We cannot agree with the implication made that it is usual to use (even "a thin, clear") oil to lubricate arc lamp movements, or that the enclosed arc burns in a "partial vacuum." Otherwise what is written is more than usually accurate for a book of this character, and many useful hints are given.

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CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

Magnetic Shielding.—For a long time it was the custom to use extremely thick iron shells to protect suspended magnetic systems from outside disturbance. The advantage of using concentric shells separated by non-magnetic interspaces was pointed out by Rücker and by Du Bois, the former giving a general solution, in spherical harmonics, of the general problem of multi-lamellar shielding with spherical shells. A. P. Wills maintains that the practical advantages of cylindrical shells are much greater than those of spherical shells. Convenient cylindrical shells may be made by rolling up thin sheet-iron strips of proper width, and the same amount of shielding may be obtained as with ten times the material in a single shell. The author gives a mathematical determination of the shielding ratio—*i.e.*, the ratio of the external field to the field within the shield, for the case of infinitely long cylinders—but he also shows that the condition of infinity is closely approximated to in the central portion of a cylinder whose length is not less than three or four times its radius. The best ratio of the two radii of an air space between the shields is 1·5 or 1·6 in case of cylinders, and it is possible, by the use of three shields, to reduce the external field five or six thousand times. The author works out a special case in detail by a graphic method.

[A. P. Wills, *Phys. Rev.*, October, 1899.]

Magnetic Variation of Peltier Effect.—The most complete experiment on the influence of a magnetic field upon the thermo-electric properties of metals is undoubtedly that of Houllevigue, who found that the E.M.F. of an iron-copper couple is modified by a magnetic field, increasing at first to a maximum and then returning to its normal amount in a field of 350 units, after which it decreases. A. Pochettino has investigated the influence of the magnetic field upon the Peltier effect, taking the precaution of allowing for the variation of thermal conductivity exhibited by magnetic metals on magnetisation. He employed a copper-iron couple consisting of copper and iron tubes soldered to an intermediate silver tube. The temperature was determined by another thermo-couple, made of very thin silver and argentan wires to avoid the influence of the field. The author found that the Peltier effect varies with the magnetisation in an irregular manner. In a field of 98 units it reaches a maximum value of $8{,}968 \times 10^{-6}$, and then it decreases, passing through its normal value in a field of 345 units. Houllevigue's formula, taken in conjunction with that of Thomson, only gives the values correctly for fields of more than 700 units. The variation of the Peltier effect is independent of the direction of magnetisation.

[A. Pochettino, *Nuovo Cimento*, October, 1899.]

Resistance of Moving Electrolytes.—Edlund found in 1875, by two independent methods, that the resistance of a liquid, such as water or a mixture of water and alcohol, diminishes when it moves with the current and increases when it moves against the current. Bosi found the same result to a more pronounced extent in solutions moving at the rate of 11cm. per second as against Edlund's 10m. per second, but only in electrolytes which concentrate at the anode, the effect being the opposite for electrolytes which concentrate at the cathode, and no effect being observed in electrolytes which undergo no concentration. Doubt has been thrown on the whole phenomenon by Hayward's experiments, but A. Amerio has repeated Bosi's experiments, confirmed his observations, and given a very plausible explanation of the effect. He points out that the various solutions employed by Bosi all increase in conductivity when concentrated. If the electrolyte concentrates about the anode, and the liquid flows from the anode to the cathode, it is evident that the anodic concentration will be made to affect a larger portion of the liquid in the tube, and the resistance will fall. Whereas, if the electrolyte concentrates about the cathode, the concentrated portion is rapidly washed away by the flowing liquid. Mere motion has no traceable effect, the change of resistance observed being altogether a concentration phenomenon.

[A. Amerio, *Nuovo Cimento*, October, 1899.]

Ions of the Electric Wind.—It is a generally accepted theory of what happens when a sharp point discharges electricity through a non-conducting gas on to a smooth metal plate, that the strong field at the point dissociates the gas into positive and negative ions, and that a one-way flow of the ions of like sign to the point thereupon ensues from point to plate. Rutherford has measured the velocity of ions dissociated in gases by Röntgen and by uranium rays, and finds that for air the sum of the positive and negative velocities in a field of 1 volt per centimetre is 3·2cm. per second. Zeleny has since shown that the ratio of the velocity of the negative to that of the positive ions is 1·25 for air in the same field. A. P. Chattock propounds the question as to whether the ions produced by the electric wind from a point discharge. Knowing the field, the current, and the volume density of the ions, the author calculates the pressure which the ions must exert upon the plate and the drag they must exert upon the gas owing to its viscosity. The formula obtained is used for determining the velocity of the ions in terms of the pressure on the plate, which, though small, is distinctly a measurable quantity. The velocity obtained is very close to Rutherford's value, and the ratio is 1·31. The author concludes that the Röntgen ray ions and the wind ions are identical.

[A. P. Chattock, *Phil. Mag.*, November, 1899.]

Resistance of Amalgams.—R. S. Willows describes the results of some experiments undertaken for the purpose of investigating the alteration in the electrical resistance of amalgams with temperature. Among the amalgams tested were those of zinc, tin, cadmium, and magnesium. Cadmium and tin amalgams showed a sudden rise in resistance at about 95deg., the resistance remaining higher after cooling than it had been at the same temperature before heating. Zinc amalgams show a very extraordinary behaviour. Most of them yield curves in which the resistance rises gradually at first with the temperature, then more slowly, after which there is a sudden drop in the neighbourhood of 65deg., and then another gradual rise. On cooling, there is a gradual fall, which continues nearly in a straight line down to 20deg. or 25deg., after which there is a somewhat sudden rise. The author supposes that the amalgam consists of a mixture of several different compounds of mercury and zinc, together with zinc and mercury in the free state. At 35deg. one of these compounds melts, and at a higher temperature we reach the melting point of another, which causes the sudden drop of resistance. On cooling, the liquid which has the higher melting point persists down to a certain point at which the whole mass becomes solid.

[R. S. Willows, *Phil. Mag.*, November, 1899.]

THE HIGH VOLTAGE LAMP.

So many new stations have recently been erected for the supply of electrical energy to consumers at 200 to 250 volts, and so many existing stations previously supplying at 100 and 110 volts have doubled their "declared" pressure, that a general improvement in the quality of high voltage lamps has come as a matter of course. We need offer no apology, therefore, in reviewing the present types of these lamps now on the market, as, through the courtesy of most of the leading lamp manufacturers in this country, we are able to place some interesting particulars before our readers.

Commencing with the forms now assumed by the lamps of various makers, our illustrations show that these have in most cases undergone considerable modification during the past two or three years since we published an article of a similar character,* while in one instance the shape of lamp (and also, in fact, the lamp itself) has undergone no change. This lamp is the ordinary lamp of the Zurich Incandescent Lamp Co., shown in Figs. 1 and 2. Fig. 1 is the lamp with the sinuous filament, and Fig. 2 that with the two M-shaped

* See *The Electrician*, Vol. XXXVIII., p. 613.

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filaments. Mr. Stearn prefers the former, but many users specify the latter by preference. For the 16-c.p. lamp of the Fig. 1 type, a larger bulb, 2½in. in diameter, is often preferred, as this will not appear so black after it has been long in use, although the amount of light absorbed by the blackened globe is the same in either case. A smaller pattern of the double filament type in a globe corresponding approximately in size to that of the standard 100-volt lamp of the Ediswan and other types is also made by the Zurich Co. by placing the filaments in parallel planes, but this is not recommended when the lamp is to be used in other than a "pendant" position. A 5 or 6-c.p. lamp is made in round globes still smaller than the 8-c.p., and Figs. 3 and 4 show two types of fancy lamps.

The Ediswan lamp is now made with a single filament for all candle-powers, the double filament being only retained for the "Queen" reflector lamp owing to its peculiar shape. Fig. 5 shows the 8 and 16-c.p. lamp in the ordinary bulb, 2¼in. diameter, but some prefer the No. 1 bulb shown in Fig. 6. A smaller bulb, No. 3, 1¾in. diameter, is made for 8-c.p. lamps intended for candle fittings, but then a sinuous filament is employed as seen in Fig. 7. Figs. 7 and 8 show the advance made in diminishing the size of the bulb in "crinkled" lamps.

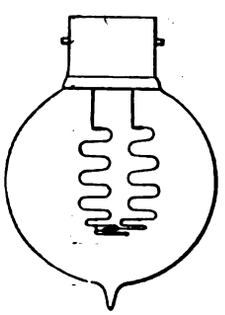

Fig. 1.
100 to 250 volt 8 and 16-c.p. "Stearn" Lamp, with Sinuous Filament.

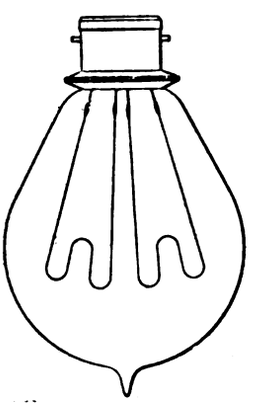

Fig. 2.
200 to 230 volt 6, 8, and 16-c.p "Stearn" Double-Filament Lamp.

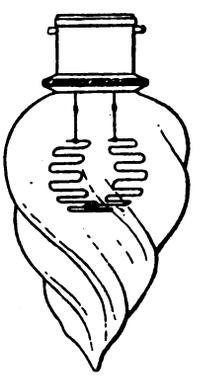

Fig. 3.
"Stearn" Lamp, 200 to 230 volts, 16-c.p.

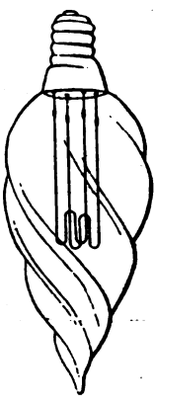

Fig. 4.
"Stearn" Lamp, 200 to 230 volts, 6 or 8-c.p.

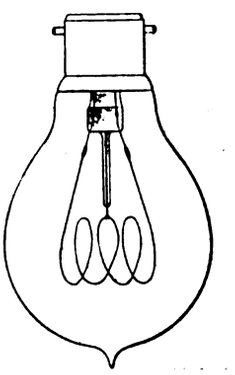

Fig. 5.
'Ediswan" Ordinary High pressure 8 or 16-c.p. Lamp.

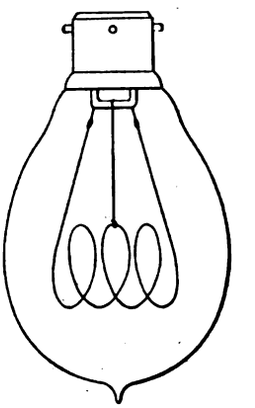

Fig. 6.
'Ediswan' Lamp with No. 1 Bulb.

ALL LAMPS ARE SHOWN HALF ACTUAL SIZE.

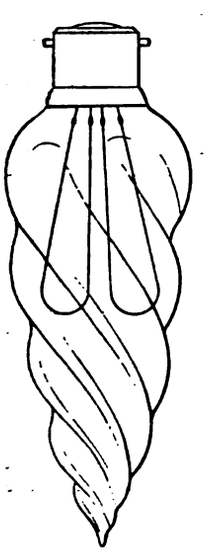

Fig. 7.
Original Type of "Ediswan" 200 volt 8-c.p. Crinkled Lamp.

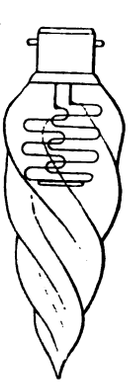

Fig. 8.
Latest Type of "Ediswan" 200 volt 16-c.p. Crinkled Lamp.

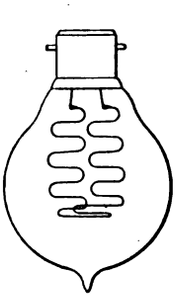

Fig. 9.
"Ediswan" 200 volt 8-c.p. Lamp, with Sinuous Filament.

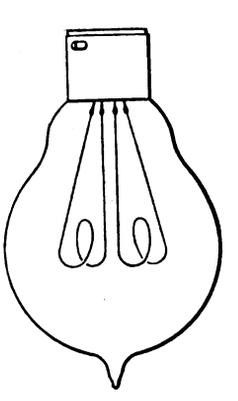

Fig. 10.
"Robertson" High-voltage Lamp.

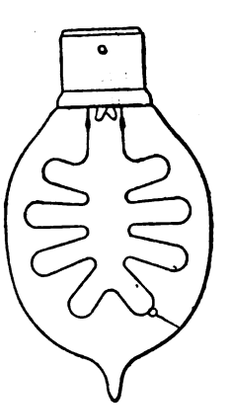

Fig. 11.
"Sunbeam" 230 volt 16-c.p. Lamp.

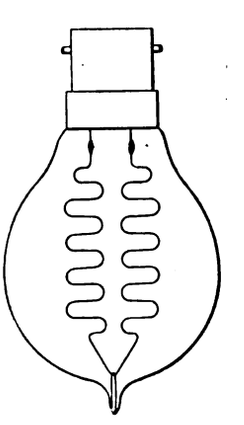

Fig. 12.
"Pope" 200-250 volt Lamp, 5, 8, or 16-c.p.

The latest type of standard "Ediswan" high-voltage lamp, exemplified in Fig. 5, has a filament supported by a platinum wire at the end of a glass tube, while in the lamp with the larger bulb (Fig. 6) a nickel wire with a platinum end is employed for this purpose.

The "Robertson" high-voltage lamp has retained its two filaments, as shown in Fig. 10. All sizes of it are now reduced to the same outside dimensions as the corresponding lamps for 100 volts pressure.

Fig. 11 shows the latest form of the "Sunbeam" lamp. It will be seen that the bulb is slightly different in shape to the standard, caused, no doubt, by the manner in which the filament is zig-zagged. The Pope lamp, made by Messrs. E. Goosens, Pope and Co., in their factory at Venloo, Holland, differs from this in the method of supporting the filament, as seen in Fig. 12. The Pope Co. make several other shapes of lamp for "fancy" purposes. The lamp supplied by the British Thomson-Houston Co. is a doubly-anchored two-curl single-filament in an oval globe of the "Edison" shape, *i.e.*, rather longer in proportion to its diameter than the usual English lamps.

The Berrenberg Co. employ a double filament, and their high-voltage lamps are of the same size as their low-voltage type—viz., 8-c.p., 41mm. diameter × 60mm. long; 10-c.p., 45mm. × 70mm.; and 16-c.p., 55mm. × 80mm.

(To be concluded.)

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THE CAPE TO CAIRO TELEGRAPH.

It has for some time past been known that negotiations were proceeding between the German Government and the African Trans-Continental Telegraph Co., Limited, of London (the British South Africa Co., Limited, being interested parties), with a view to a settlement of the terms upon which the Trans-Continental Co. are to be permitted to carry their "Cape to Cairo" overhead telegraph line through German East Africa. This line has come to be regarded by the British public as in some way fulfilling the demand for what it is customary to call an "all-British" line. It will be seen, however, from the chief provisions of the treaty which has been signed by the parties to the above-mentioned negotiations, that a section of the line passes through German territory, while before reaching this point in its route it will have already passed through a Portuguese possession. The only alternative course would have been through the Congo Free State, so that an all-British line was clearly impossible. Differences of opinion naturally exist as to which party to the treaty, or agreement, set out below, has secured the best of the deal. Shareholders in the great cable companies may rest assured of one thing—that, taking into account the "paid-outs" involved, this route is not likely to seriously compete with their property, but is much more likely to serve as a feeder to submarine cable traffic.

The following is the text of the treaty, as published in *The Times*:—

1. The construction of the telegraph line will be carried out by the company at its own cost, and must be completed within five years.

2. The company has to erect, at its own cost, between the two stations of Rhodesia and of British East Africa nearest the German frontiers, a wire intended for the telegraphic service of German East Africa.

3. The German Government reserves the exclusive right of establishing and working telegraph stations in German East Africa, and of introducing for such stations the tariffs for German East African messages.

4. The German Government has secured control within its territory by the unlimited right to connect the wires of the line with the stations in Rhodesia and British East Africa at any point between the two stations mentioned in Article 2 of this agreement. Furthermore, the company has to pay a tariff of 10 centimes per word to the German Government.

(The two last-mentioned conditions may, according to the agreement, be dropped in exchange for the concession by the company of advantages of equal value in some other sphere.)

5. On the expiration of 40 years after the completion of the telegraph line through German East Africa the German Government has the right to take over the German East African section of the line without payment. The cost of maintenance will then fall upon the Government. The company will, however, have to pay the Government a yearly transit charge amounting to the whole of the annual cost of administration, provided always that this payment shall not exceed the amount of one halfpenny per word.

6. The company is bound to transmit over its lines at its general tariff charges all telegrams received by it for and from German East Africa; and the company has further declared its willingness to accord, in favour of all telegrams transmitted to or from German East Africa, any reductions of tariff which it may accord to third parties.

7. Detailed provisions have been incorporated in the agreement with a view to safeguarding German sovereign rights and the jurisdiction of the Governor of German East Africa with reference to the company and those in its employment. For one thing, the Governor can, at his own discretion, grant the employés and workmen of the company a military escort, the expense of which shall be borne by the company in so far as it does not exceed £1,000.

8. All differences arising out of the interpretation of the treaty shall be settled by a court of arbitration. In the first instance, one of the two arbitrators shall be chosen by each of the two parties. In the case of non-agreement on the part of the arbitrators, a third arbitrator (umpire?) may be appointed by the President of the German Imperial Court of Justice on the application of both parties.

BOOKS RECEIVED.

(Copies of any of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price.)

"The Official Gazette of the United States Patent Office." No. 5. Vol. LXXXIX. Published by authority of Congress. (Washington: Government Printing Office.)

"Transformation et Extension du Réseau des Tramways de Marseille." By M. H. Dubs. Reprint from the Bulletin de la Société Scientifique Industrielle de Marseille, 1898. (Marseilles: Barlatier.)

"*Proceedings* of the Royal Society." No. 420, Vol. LXV. (London: Harrison and Sons.) 1s. 6d.

THE WATERLOO-CITY RAILWAY.

At the ordinary meeting of the Institution of Civil Engineers, on Tuesday, two Papers, dealing with the construction and equipment of the Waterloo and City Railway, were read. The first Paper, by Mr. H. H. Dalrymple-Hay, M.Inst.C.E., was devoted to a description of the general features of the line and the methods used in its construction. Since the opening of Waterloo Station, in 1848, various schemes had been considered for extending the London and South-Western line into the City, but none were feasible until the Greathead system was proposed in 1891. The new line was 1½ mile long, and, with the exception of a short length at Waterloo, consisted of two iron tunnels with a station at each end approached by stairs and inclines. The route taken from Waterloo was by Stamford-street, Blackfriars Bridge, and Queen Victoria street, to the City. A stage with temporary shafts in the river at Blackfriars was first constructed, and on completion shields were set to work in both directions. Where the new line passed under the South Eastern Co.'s viaduct at the centre of a 30ft. arch, the abutments were underpinned to the level of the proposed tunnels below, and a cross trench was sunk between the abutments, and both tunnels driven towards Waterloo from that point. The tunnels between Waterloo and the river shafts were 12ft. 9in., and those between the latter point and the City 12ft. 1¾in. internal diameter. The larger diameter admitted of the carriages passing round 5-chain curves, of which there are four towards Waterloo.

The method of tunnelling in the London clay and in water-bearing strata was the well-known Greathead system, except in the case of a short length of tunnel which was driven by a new method not requiring the employment of a heading or timbers outside the shield. At the City station, where the tunnels are 23ft. internal diameter, there was a scissors crossing near the west end to admit of trains arriving at or departing from either platform. At Waterloo there was a tail siding at the south end of the platforms, instead of a scissors crossing as at the City.

The average rate of working in the small tunnels was 10ft. every 24 hours where the tunnels were in clay. In the larger tunnels at the City station, which were also in the clay, 6ft. was completed regularly in the same time. In water-bearing strata, however, the speed varied greatly, depending upon the character of the ground and the depth of ballast and head of water at the face. The iron segments of the small tunnels were erected by manual labour, but those of the large tunnels were erected by hydraulic machines fixed to the shield. The small tunnels were grouted with blue lias lime (three parts) to sand (one part), but the large tunnels were grouted with neat cement for the lower half and equal parts of cement and blue lias lime for the upper half.

The work at Waterloo consisted of underpinning the existing piers of the arched viaduct upon which the South Western Station is built. The new station occupied two of the arches, and directly to the south of the platforms, but still under Waterloo Station, it was necessary to introduce a cross-over road for the tail line, as there was not sufficient space for it between the south side of the station and the end of the company's property. This necessitated the removal of the central pier of the viaduct, and the substitution for it of a 40ft. arch with spandril walls to carry the old arches above. The repairing and cleaning sidings were in a depôt directly to the south of Waterloo. On the northern side of Waterloo a short length of tunnel joining the up line with a lift had been constructed, and by this means the rolling stock and coals were lowered from the South Western sidings to the tunnel below.

The second Paper, by Mr. Bernard M. Jenkin, Assoc.M.Inst.C.E., gave an account of the electrical equipment of the line, which was the second underground railway that had been built to be worked electrically. The electric energy was generated at the power station, at the Waterloo end of the line, by high-speed engines coupled direct to two-pole dynamos. The energy was transmitted to the trains by feeders connected to an insulated rail, or conductor, placed between the two running rails of the permanent way. This central conductor consisted of an inverted steel channel, carried on porcelain oil insulators, the top service being level with the top of the running rails. The feeders and central conductor for the up and down lines were independent of each other, and should an accident occur on one line or in one of the tunnels, it did not affect the supply of current to the other line or tunnel. There was an independent system of feeders and distributing mains for lighting the tunnels and stations. The trains were lighted from the circuit supplying power to the motors. The current from the motors and lamps was carried back to the power station by the running rails of the permanent way, which were bonded and connected in parallel throughout.

Each train consisted of two motor carriages, one at each end, and two trailer carriages in the centre between them. The motor cars were fitted with collector shoes, which rubbed on the top surface of the central conductor rail and carried the current from it to the motors driving the train. Each carriage was carried by two four-wheeled bogies, and one bogie on each motor carriage was fitted with

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two series-wound motors. Thus each train was driven by four motors in all, two on the front bogie and two on the last bogie in the train. The armature of each motor was built directly on the axle of the driving wheels, with the field magnets surrounding it fixed in position so that they moved in a horizontal plane with the bogie but could not rotate. No reduction gearing was used. There was a driver's cab in each motor carriage, placed over the bogie carrying the motors, in which was placed a controller and the necessary instruments for regulating the current to the four motors driving the train, and for reversing or connecting them as required, either all in series, or two in series in parallel with two in series, or all four in parallel. The two controllers were so made that it was not possible to have more than one in use at the same time. The cables connecting the motors and controllers at opposite ends of the train were carried along the top of the cars outside the roof, and were connected by couplers between the cars.

The trains were fitted with Westinghouse compressed air-brakes, which could be worked from both ends of the train by valves placed in the driver's cabs. The pumps compressing the air were placed in the power station, and could be worked continuously to charge a reservoir from which the supply for charging reservoirs on the trains could be drawn as wanted. The reservoirs on the trains consisted of steel cylinders hung beneath the floor of the carriages, and were placed both on the trailer and motor carriages.

Experiments and tests had been made on completion of the line to ascertain the time and power taken to drive a train from one station to the other under different conditions and with different limits of speed on the sharp curves. The time in which a train could traverse the whole of the distance from one station to the other depended mainly upon the maximum speed which could be allowed on the sharpest curves. There were some very sharp curves at the bottom of the dip in the line where it passed under the river, and it was originally intended that the speed on these curves should be limited to 24 miles an hour. Before the line could be opened it was inspected by the Board of Trade, and Sir Francis Marindin decided to limit the speed round the sharpest curves to 15 miles an hour instead of 24 miles an hour, for which the whole of the electrical equipment of the line had been designed. This alteration had naturally a very great effect on the whole working of the traffic on the line, the brakes having to be applied to the train on the down gradients, as the speed which would be attained by gravity alone would very much exceed the limit of 15 miles an hour by the time the curves were reached. The switchback principle of working the line could not therefore be adopted, as it might otherwise have been with the particular arrangements of gradients and the absence of intermediate stations which was the peculiarity of this line.

A complete system of block-signalling had been provided, and the shortness of the line made it necessary to place signals near the bottom of the dip close to the sharp curves referred to above. The position of these signals had an effect on the working of the line similar to the reduction of speed on the curves, as the speed on the down gradients had to be checked in order to enable the train to be brought to a standstill should the signal be against it.

PHYSICAL SOCIETY.

Ordinary meeting, held in the Physical Laboratory of the Central Technical College (by invitation of Prof. Ayrton), November 10, 1899, Prof. Lodge, F.R.S. (President), in the chair.

Mr. F. S. SPIERS read a Paper on

"Contact Electricity."

The object of the Paper was to determine, in a more satisfactory manner than has hitherto been attempted, the part played by the medium in the potential difference which arises when two dissimilar metals are put in contact. The first experiments were made with a piece of apparatus used by Profs. Ayrton and Perry about 20 years ago. This apparatus, in which the metals in contact are capable of a rotation of 180deg. about a vertical axis, and are placed between two vertical inductors connected to a quadrant electrometer, was afterwards considerably improved, and the compensation arrangement of Lord Kelvin was introduced so as to measure the potential differences by a null method. The metals first used were platinum and zinc, but on account of the low melting point of the latter metal it was replaced by aluminium. In order to try and remove the air sheets which cling to the surfaces of the metals, the tube was repeatedly heated and exhausted. The potential difference between the plates was found to fall gradually as this was done. It was proved that this was due to the oxidation of the aluminium, for on cleaning its surface the original effect was again obtained. Attempts were then made to remove the oxygen by displacing it with hydrogen; but, after four washings with pure dry gas and at low pressures, there was still enough oxygen left completely to oxidise the aluminium. The oxide of aluminium is not decomposed by hydrogen at a light red heat. It was therefore decided to substitute iron, and burn out the oxygen with hydrogen by encasing the lower part of the apparatus in a copper tube and heating to bright redness with a blowpipe flame. By this means the value of the Volta effect between iron and platinum in an atmosphere of hydrogen was found to be 0·6 of a volt, the platinum being positive to the iron. This result is different both in magnitude and sign to that obtained when air is the medium.

The CHAIRMAN said he had given the subject of contact electricity some attention during the last 15 years, and the author had performed a valuable series of experiments which he should like to have seen done several years ago. He had always felt that a vacuum would never get rid of the condensed air films. The burning-out process used had provided the most reliable results upon the subject.

Dr. LEHFELDT pointed out that the action of hydrogen upon ferric oxide was a limited one, and that it was impossible to bring about complete deoxidisation in that manner. At a dull red heat the ratio between the water vapour and oxygen present was about 20 to 1.

Prof. PERRY expressed his interest in the experiments, but said that they had not affected his opinion upon the nature of the Volta effect.

Prof. ARMSTRONG said he was not wholly satisfied with the results, although a substantial approach to a solution had been made. The author had fully realised the difficulties of the experiments, but he had treated the matter as a surface gas effect and had not guarded against moisture. Gases must be both dirty and moist before chemical action could take place, and they could not expect to arrive at a solution of the problem until not only the oxygen but also the dirt and moisture had been removed. It was impossible to exhaust the apparatus completely, and a number of molecules must always be left more than necessary to produce the Volta effect. Moisture could never be got rid of by exhaustion. The method of Dewar of using liquid oxygen or liquid hydrogen would get rid of gases and water vapour, and in this manner it would be possible to perform experiments which could be regarded as final. If the effect disappeared at low temperatures, it might be urged that the temperature was too low for it to be produced. The author must have been dealing with combination effects, for it had been proved that hydrogen alloyed both with platinum and iron at a dull red heat.

Mr. COOPER said he would like to see the experiments repeated after precautions had been taken to remove nitrogen from the apparatus.

Prof. S. P. THOMPSON said he had recently taken part in a discussion upon the subject with some earnest followers of the old contact theory. They upheld that the property of metals which determined the potential difference when two are put in contact was as fixed and definite as other physical properties, such as density, and that the potential difference observed in air was approximately the same as the true potential difference. It had been agreed to call the former the apparent potential difference. Continuing, Prof. Thompson said that the real Volta effect was near to the effect observed in air. In circuits formed of metals there were other electromotive forces of the order of a millionth of a volt. The chemical electromotive forces in a circuit were of the order of a volt. The value of the Volta effect derived from thermo-dynamical considerations concerning the Peltier effect was much smaller than observed chemical potential differences. If, however, we took into account not only the Peltier effect, but also the Thomson effect, we would have other terms entering into the equations which might tend to give a value more nearly equal to a volt. In observing chemical E.M.F.s the Peltier effects did not come into the question, because of their smallness compared with the value of the chemical effect.

Prof. PERRY pointed out that the Peltier effect was not distinct from the Volta effect, but was simply the differential coefficient of it.

The CHAIRMAN said that if a circuit containing Peltier effects were treated thermodynamically, as if it were a reversible heat engine, we could arrive at an equation connecting the value of the Peltier effects with the rate of change of the whole electromotive force in the circuit with temperature. The electromotive force which changed was not necessarily the Volta effect.

Prof. PERRY said he thought it was.

Prof. AYRTON suggested that an advance might be made in the theoretical side of the question if the Chairman were to put in writing his objections to the statement that the E.M.F. concerned was the true Volta effect. The extent of the Peltier effect proved the variation of the Volta effect with temperature, but because it was small it did not necessarily follow that the Volta effect was small. Where the Volta effect was a maximum or a minimum the Peltier effect vanished. The experimental work of the Paper did not go far enough to convince him of the nature of contact electricity. Before we could hope to prove anything with respect to the two theories, we must be able to get a cyclic change of events. That is to say, we must be able to change our surfaces and media in a perfectly definite manner, so as to be able at any time to return to the particular state from which we started.

Prof. EVERETT said that as the variation in the potential difference between two metals in a medium was probably due to slow chemical action, which caused the metals to become less and less susceptible, he should expect that changing backwards and forwards from one medium to another would give to the potential difference an oscillatory variation gradually becoming smaller and smaller.

The CHAIRMAN said he would like to see experiments showing a cyclic effect similar to that mentioned by Prof. Ayrton. The difficulty in these experiments was to avoid chemical action. Chemical action was not necessary to get the Volta effect. The effect would be greatest in dry gas. Moisture tended to reduce the effect, and that was why its presence was unimportant.

Prof. CALLENDAR expressed his interest in the surface character of the effect and its independence of the manner in which the plates were touched.

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Dr. STANSFIELD suggested gold as a suitable metal to be experimented on, because of its non-oxidisability.

Mr. SPIERS, in replying, referred to Dr. Lehfeldt's assertion that the whole of the oxygen could not be removed by hydrogen. In his experiments, however, there was very little ferric oxide and a large quantity of hydrogen; and although it was possible that all the oxide was not reduced, still a large portion of it had been. The experiments were to be carried on, and attempts would be made to get a cyclic effect.

A Paper on "The Heat of Formation of Alloys" was postponed until the next meeting.

MOTOR STARTING RHEOSTATS.*

BY OTTO MATTICK.

Whenever the machinery operated by an electric motor becomes stalled or greatly overloaded, the operator in cutting out resistance when again starting up may move the rheostat lever too fast, causing a damaging current to be sent through the motor unless an independent circuit breaker is present to open the circuit as soon as the current exceeds a predetermined maximum. The old type single lever rheostat does not have this important feature, and cannot have it.

When there is an independent circuit breaker in circuit, the operator soon learns how fast to move the lever so as to properly start the motor without causing the circuit breaker to operate because of excessive current. In the case of the old-fashioned single-arm rheostat, the motor is subjected to damaging strains every time the rheostat arm is moved too fast, and in this way the operator can, and usually does, send an excessive current through the motor every time it is started. Even if the motor does not burn out immediately when so treated, its life is greatly shortened. A first-class motor starter will automatically educate the operator how to properly start the motor, as it will not allow him to start it in any other way. The circuit breaker should be beyond the control of the operator, so that if the motor is absolutely stalled, he cannot send a damaging current through the motor.

A frequent cause of damage to motors is due to improperly connecting the motor's armature and field circuits to the supply line, and then trying to start the motor. The old-fashioned single arm rheostat offers no protection against this risk. But if the rheostat has, combined with it, an automatic overload circuit breaker which opens the circuit independently of the rheostat lever, no harm can come to the motor, even though the operator should try to start it up while it is improperly connected with the supply line. Whenever the supply of current fails, as, for example, when the power plant in a factory is shut down at noon and at 6 p.m., the rheostat lever should be automatically moved back to its initial position, so that when the current supply is again established no current can pass through the rheostat and motor until the operator manipulates the starting rheostat. Of course, the rheostat lever should be similarly moved automatically to its starting position whenever the E.M.F. fails from any other cause, such as the opening of a switch in the motor circuit, the opening of the circuit breakers at the main switchboard or the blowing of a fuse in the circuit leading to the motor.

When the E.M.F. gradually dies down to zero, as when the engines are shut down, the residual magnetism of the underload holding magnet frequently amounts to so much that this magnetism, together with the "friction of rest" between the rheostat lever and the contacts upon which it rests, will prevent the spring from starting the lever, which, consequently, remains in its final or short-circuit position. If the rheostat has an overload circuit breaker acting independently of the operating arm of the rheostat, this circuit breaker will automatically and instantaneously open the circuit and no harm will be done. With the old type of single arm rheostat, if the operating arm of the rheostat should stick because of the friction of the contacts, residual magnetism, &c., the overload device is useless, since it merely actuates the underload device which has already failed to perform its functions.

In order to make the underload release positive in its action, it is necessary to overcome the "friction of rest" above referred to, and to do so a sharp hammer-like blow should be given to the rheostat arm to start it against this friction. Otherwise the action of the underload release will be unreliable, especially in the case of rheostats having large currents to carry. The underload release of all contact arms having more than 80 amperes to carry should be provided with this hammer blow attachment or some equivalent device.

The rheostat operating arm should cause the closing of the circuit breaker whenever the resistance has been all inserted and the rheostat circuit opened, and it should be impossible for the operator to close the circuit breaker, except under these conditions. This absolutely prevents the possibility of closing the circuit breaker except when the rheostat is in its starting position and with the circuit open.

* From the *Electrical World* of New York.

The circuit breaker should be one in which a strong spring acts against a latch, and the overload device should not only release the latch, but should also simultaneously deliver a hammer blow to start the switchblade from rest.

The circuit breaker should have an auxiliary break in multiple with the switch so that the final opening of the circuit will occur upon renewable contacts designed for the purpose. In this way all arcing at the switch contacts is avoided.

In the old-type single-arm rheostat having underload and overload attachments, whenever the overload device operated, the rheostat operating arm was caused to move backward over the resistance contacts while an excessive current was flowing through the resistance. This comparatively slow movement of the operating arm backward inserting resistance while a heavy overload current was flowing caused destructive arcing upon the lever and rheostat contact plates, roughening the contact so as to cause excessive heating of the contacts and causing greatly increased friction, which prevented the movement of the lever backward, the next time the underload release was called upon to act.

A motor starting rheostat whose underload release fails to operate is a bad fire risk, as is also one whose overload device fails to work; hence it is very important to have them entirely independent, so that if the underload release should fail to insert the resistance and open the circuit, the overload device will not be affected thereby, but will act entirely independently to open the circuit in the presence of excessive current.

A starting box is not intended to be used for operating a motor at reduced speeds, and if by improper usage or because of failure of its own protective devices, it should be subjected to a current for so long a time as to burn the rheostat out, the design of the rheostat should be such that the melting of the resistance shall not give rise to danger from fire. All rheostats in which coils of wire are placed inside of an open work, box-like case, so that when the wire is melted it can uncoil and continue arcing, are an extremely bad fire risk, and their only excuse for existence is that they are cheap.

The resistance material of rheostats should have an extremely low temperature coefficient; that is, the "resistance hot" should not differ materially from the "resistance cold." A motor starter made of copper wire will in practice have its resistance doubled; if made of iron wire the resistance in practice will increase 300 or 400 per cent. If made of carbon or a mixture of carbon with clay or similar binder, its resistance will be halved. There are scores of high-grade resistance alloys on the market, and users of motors should insist upon rheostats made from such alloys, if they wish to obtain a first-class motor starter.

As all protective devices are liable to occasional failure, and can be made inoperative if a person maliciously attempts to do so, the design of every starting box should be such that even if the resistance be burned out no fire could possibly result. It is therefore desirable to have the resistance enclosed in an infusible material which will not combine chemically with the resistance material under the influence of an electric arc, and that there shall be no communication between the arc and the outside air. Moreover, there should be such a large mass of infusible material surrounding the resistance that even though the resistance be fused the sensible temperature at the exterior of the rheostat will not be raised enough to make it a possible fire risk. Coils of wire depending upon their own tensile strength to hold them in position and merely mounted in an open box are a serious fire risk, as the underwriters' statistics clearly show.

In connection with the above Paper, the following letter from Mr. Ward Leonard to the *Electrical World* is of interest:—

SIRS: I have read with much interest the article by Mr. Mattick on "Motor Starting Rheostats," and while I agree with Mr. Mattick on most of the points he makes as to the requirements of a first-class motor starter, it seems to me that he is too strong in his criticism of the use of copper and iron for rheostats. These materials can, in certain cases, be satisfactorily used, although, personally, I have never employed either, except experimentally, as they certainly are not so good as the alloys of the German silver type, and the saving by their use does not compensate for the objection that well-informed engineers are likely to raise against their use.

The best point made by Mr. Mattick is, in my opinion, that every motor starter should have an electromagnetic circuit breaker as an essential feature of its design, and that the circuit breaker should be entirely independent of the operating arm of the rheostat. I do not know of any insurance so cheap as the insurance of the value of the motor and rheostat which the trivial first cost of such a circuit-breaker attachment affords, and in this connection I beg to say that I was the first one to place such a rheostat on the market, and that I have urged its use for many years past. The New York fire department, about two years ago, made such a device obligatory in the case of motors of 1 H.P. To day its use is not obligatory; but, nevertheless, the use of such rheostats made by various manufacturers is rapidly becoming universal in the principal electrical centres, and I feel confident that the fire underwriters will eventually insist on such a protective device in connection with all motors, except very small ones.

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A modern enclosed fuse is a good protective device, but unfortunately it will only act once, and in the case of most motors the overload protective device is called upon to act frequently. The practical result of this, as we all know, is that the engineer decides that the fuse which would really protect the circuit properly is "too small," and he proceeds to put in a much heavier fuse and his protection is almost entirely done away with. If an extremely heavy and dangerous overload should blow the heavier fuse once or twice, the old familiar link of copper wire would soon be in evidence and the next time a severe overload occurred a new armature, and possibly the fire department, would be in order.

I agree with Mr. Mattick that a circuit breaker arm which the operator holds in his hand while starting the motor is ineffectual, as such action prevents the circuit breaker from acting in the presence of a dangerous current. The circuit breaker portion should be absolutely independent of the operator while he is starting the motor, otherwise you are relying upon the operator for your protection instead of the circuit breaker which should be uncontrollable except automatically by excessive current in the circuit.

It seems almost unnecessary to emphasise Mr. Mattick's criticism of the open coil type of rheostat. Like the exposed winding on the surface of armatures and the open fuse, it belongs to the early days, before we knew better. All advanced rheostat builders, both in this country and abroad, have long ago abandoned the types of rheostats in which the wire is kept in position merely by its own strength and could uncoil if melted or broken by strain. The enclosed type of motor starter has come to stay just as surely as the enclosed fuse and the enclosed armature winding.

CORRESPONDENCE.

FOREIGN COMPETITION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: As the question of foreign competition is now very much to the fore in this country, we think the following facts may have some interest for your readers, as showing how it is that some contracts are placed abroad. In October, 1897, we, with other electrical cable makers, were invited by the Dublin United Tramways Co. (Limited) to tender for the cables required in connection with the conversion of their tramways from horse to electric haulage. The specification —written by the Tramways Co.'s consulting engineer, Mr. Parshall (an American)—was issued to us, providing, among other things, that the price quoted for the cables was to be inclusive of the drawing into the conduits in Dublin and the jointing up and putting to work, and that delivery was to be made of the whole of the cables within nine months of the date of the order. We tendered to the specification, in due course, offering to carry out the whole of the terms and conditions set forth, in every particular, but received a notification from the secretary of the Company on January 29, 1898, to the effect that our tender had not been accepted.

So far we had, of course, no ground of complaint, but we subsequently heard that the order had been placed with an American firm, the National Conduit and Cable Co., for paper-insulated cables, and, as we held the patents for this class of material for this country, we entered an action for infringement as soon as the first cables were delivered. This action has recently been tried, and has resulted in our favour. During the proceedings it was necessary for the tramway company to produce a copy of the contract they had made with the American firm, and it is particularly to this contract that we wish to draw attention.

We attach a copy of the contract herewith, and it will be noted that its conditions differ in many respects from those to which the English manufacturers were asked to quote. Notably, the contract is made in America, and the Tramways Co. took delivery of the cable in New York, this step being obviously an attempt to deprive the English manufacturer of the rights under his patent. The Tramways Co. loaned to the National Conduit and Cable Co. the services of their engineer (Mr. Parshall) to supervise the drawing in and jointing, so that this work, although carried out at the contractor's expense, has not been effected by him, as provided for in the original specification.

We understood that we were to provide over the lead sheathing of the cables a layer of compounded jute yarn, although for cables that are to be drawn into "ways" it is our practice to provide a plain lead covering only. We find that the American firm have provided plain lead-covered cables, thereby, of course, effecting a considerable saving in the cost. We would then draw particular attention to the remarkable fact that blanks have been left in the contract both for the quantities of cable and the sizes and prices at which they are to be supplied. No time for delivery is stated, and, as a matter of fact, the American firm has largely exceeded the time allowed to the English manufacturers. The guarantee clause expressly excludes electrolytic damage, although we were asked to include this possible cause of damage in our undertaking.

Our view of this matter is that such favoured treatment to a particular contractor can be neither to the credit of Mr. Parshall (the consulting engineer) nor to the interests of the shareholders of the Dublin United Tramways Co., but we are content to leave the matter to the judgment of the public.—Yours, &c.,

THE BRITISH INSULATED WIRE CO. (LIMITED).

Prescot, Nov. 14.

[COPY.]

This agreement, made by and between the National Conduit and Cable Co., a corporation organised and existing under and by virtue of the laws of the State of New York, United States of America, with its principal business office in the City of New York, party of the first part, and the Dublin United Tramways Co., a corporation organised and existing under and by virtue of the laws of the United Kingdom of Great Britain and Ireland, and having its principal business office in the City of Dublin, Ireland, party of the second part.

Witnesseth: That whereas the party of the first part is the manufacturer of and dealer in certain electrical conductors or cables known as "Paper-covered Cables," and whereas the party of the second part is a common carrier, operating and propelling its tramcars by means of electricity, and is desirous of purchasing said cables from said party of the first part for the purpose of transmitting electricity from the power station to said tramcars and otherwise.

Now therefore, in consideration of the sum of $1, each to the other paid, the receipt whereof is hereby acknowledged, and of the covenants and promises hereinafter contained, the parties hereto covenant and agree as follows:—

The party of the first part agrees to sell to the party of the second part, and the party of the second part agrees to buy from the party of the first part, feet, more or less, of the cable manufactured by the party of the first part, to be delivered to the party of the second part on board ship at the port of New York, said ship to be designated by the party of the first part. The size and price of the cable which the party of the first part agrees to sell to the party of the second part is as follows:—

The party of the second part agrees to pay for the said cable on the certificate of their consulting engineer, in New York Funds, through Comptoir National d'Escompte de Paris, London, as follows:—50 per cent. upon the arrival of the shipment in London, 40 per cent. when the circuit is jointed up in the subway, and the balance of 10 per cent. upon the completion and the acceptance of the cable in the subway.

It is further understood and agreed that the aforesaid cable shall be laid, installed, and connected up, under the direction of the engineer of the party of the second part, but at the cost and expense of the party of the first part.

It is further understood and agreed that the party of the first part shall furnish the party of the second part its guaranty and bond, guaranteeing the durability of the cables furnished by it as aforesaid, except as against the act of God, the public enemy, mechanical injury or electrolysis, for a period of ten (10) years from the date of acceptance, and that the said party of the first part shall also furnish its guaranty and bond for the purpose of indemnifying the party of the second part against damages incurred for infringement, because of the use of the cables purchased as aforesaid from the party of the first part: the party of the first part, however, to be notified by the party of the second part so soon as and as often as any action or proceeding is threatened involving the patentability of said cables.

In testimony whereof, the party of the first part has caused its corporate name to be hereunto signed by its and its corporate seal to be hereunto affixed with the attest of its on the day of March, 1898, and the party of the second part has hereunto caused its name to be signed by its president and its corporate seal to be hereunto affixed with the attest of its secretary on the eleventh day of March, 1898.

THE DUBLIN UNITED TRAMWAYS CO.,
Seal. By WM ANDERSON,
Attest Secretary and Manager.
R. S. TRESILIAN, Assistant Secretary.

Seal. The National Conduit and Cable Co.
Attest: By EDWD. S. PEROT, President.
GEO. J. JACKSON, Secretary.
In the presence of Jas. H. Warner.
State of New York, } SS.
City and County of New York. }

On this eleventh day of March, 1893, before me, Henry B. Heylman, a notary public in and for the County of New York, appeared Edward S.

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Perot and George J. Jackson, to me known and known to me to be respectively the president and secretary of the National Conduit and Cable Co., and who, being by me duly sworn, deposed and said that they were the president and secretary respectively of the said The National Conduit and Cable Co., and had been duly authorised by the Board of Directors of said company to execute the foregoing instrument in the name of and for the aforesaid company and acknowledged that they executed the within instrument and affixed the corporate seal thereto for the purposes and intents therein expressed, HENRY B. HEYLMAN,

Notary Public (198),
N. Y. County.

ELECTRIC LIGHTING IN THE CITY OF LONDON.

The annual report for 1898 of Mr. A. A. Voysey, electrical engineer to the Corporation of the City of London, and Electric Inspector under the City of London Electric Lighting Orders, 1890 and 1891, has been presented to the Streets Committee of the Corporation, and is this week being issued to members of the Court of Common Council.

The report deals with (1) electric testing, (2), public electric lighting (main streets), (3) public electric lighting (side streets), and (4) private electric lighting. (The words "the company" throughout means the City of London Electric Lighting Co.)

Under the first heading, Mr. Voysey states that 46 instruments have been submitted to him for testing. The bulk of these were meters, and were submitted by consumers who doubted the accuracy of their registrations. The test of these meters resulted as follows:—19·35 per cent. were slow, 25·8 per cent. were fast, and the remaining 54·85 per cent. were approximately correct. The maximum percentage error in the slow meters was 9·0, and the mean percentage error 5·3. The corresponding errors in the fast meters were 13·1 and 7·6 respectively. These results do not differ greatly from the results recorded during the previous year.

On terms approved by the Corporation, Mr. Voysey has carried out the testing of certain wires, fittings, and instruments, which is not provided for in the Provisional Orders. The testing fees amounted during the year to £31. 7s. 6d., making for the first three and a-half years' establishment of the testing laboratory a total of fees received of £192. 2s. Not only have the fees received been small, but the supervision of the accuracy of meters for the measurement of the supply to private consumers has remained chiefly in the hands of the company instead of in the hands of the Electric Inspector, as would naturally result from the carrying out of the provisions of the City of London electric lighting Orders. One reason for this is to be found in the fact that the Board of Trade have not been able to approve of a type of meter for use on the City alternating current curcuits. Since this report was written, the Aron meter has been so approved, and Mr. Voysey anticipates that the usefulness of the electrical testing laboratory will be thus greatly increased, while its cost ought in time to be covered by the fees received.

With regard to the Public Electric Lighting (Main Streets), the following table is a comparative statement for the years 1895, 1896, 1897, and 1898 of the interruptions and delays which have taken place in the lighting of the public electric lamps, based on the reports of the police, supplemented by those of Mr. Voysey:—

	1895.	1896.	1897.	1898.
Total No. of arc lamps in lighting on Dec. 31	486	493	493	502
No. of lamp failures reported by police	551	609	1,306	558
No. of lamp failures reported by Mr. Voysey ...	38	150	160	88
Totals	589	759	1,466	646
No. of occasions on which group failures occurred	7	12	24	6
Penalties inflicted on the company for failures ...	£136 17 2	£362 11 3	£352 1 0	£156 7 3

The arc lamps used for the public lighting are of two types, and the figures given below show approximately the relation between the percentage of failures of each type of lamp for the last three years. Failures of lamps in groups are excluded from the statement, because they have almost always been due to causes outside the lamps. The two types of lamps are respectively designated "A" and "B."

Type of lamp.	Figures showing relation of percentage of failures.		
	1896.	1897.	1898.
"A"	1·35	1·65	1·82
"B"	1·00	2·05	3·20

Endeavours have been made during the year to obtain the establishment of proper instruments to enable the Corporation to know whether or not it is getting the value of the supply to the public lamps for which it pays. After much delay, some instruments have been submitted by the company to the Board of Trade, whose approval of some type of instrument is, in Mr. Voysey's view, necessary.

A comparison of the figures given in the foregoing table for the year 1898 with those for 1897 shows that the failures of groups of lamps have greatly decreased, and this fact Mr. Voysey takes as an indication of the importance of the changes which have been made in the cables which during 1897 caused so much interruption with the public lighting.

In the third division of the report—Public Electric Lighting (Side Streets)—Mr. Voysey states that the question of lighting the side streets has been delayed for another year, in the endeavour to obtaining a legal settlement of the differences between the Streets Committee and the company as to the meaning of the agreements for public lighting. The final settlement of these differences must necessarily precede the completion of the public electric lighting arranged for in the agreements. Two interruptions in the private supply were notified during 1898, one being due to damage done to an electric main by a pavement contractor.

Serious defects in the pressure of supply occurred on eight different occasions, but Mr. Voysey concludes his report by saying that the explanation by the company of the circumstances causing these defects justifies the hope that defects were temporary.

LEGAL INTELLIGENCE.

Electric Construction Co. (Limited) v. Imperial Tramway Co. (Limited) (British Thomson-Houston Co. (Limited) third parties).

JUDGMENT.

The trial of this action was fully reported in *The Electrician* for Nov. 10, pp. 85–88. On Tuesday Mr. Justice COZENS-HARDY delivered the following judgment:—

In this case the plaintiffs sued as assignees of a patent for improvements in motors for electric railways, granted on January 10, 1885, the alleged inventor being Mr. Sprague, an American. In the course of the present litigation the patent had expired, and the plaintiffs therefore had been obliged to limit their claim to one of damages. The defendants had clearly infringed this patent, assuming it to be valid, and the only issue really tried before him had been as to the validity of the patent. Defendants alleged want of novelty, and relied upon a large number of anticipations. The evidence of the scientific witnesses on both sides mainly dealt with the alleged anticipations. It was not required, except to a very slight extent for the purpose of assisting him (the judge) to construe the specifications, that he should go through them in detail. He apprehended that a specification ought to be regarded in the same manner as any other document which had to be interpreted by the court. It must be looked at as a whole. The claims must not be looked at as if they stood alone. Strained and unnatural interpretations must be avoided. The true meaning and extent of the claims must be looked for without reference to the effect that they may have upon the validity of the patent. The patentee began his specification by describing the object of his invention, and he then proceeded to describe how that object was to be accomplished. His lordship quoted passages on these heads from the specification, and said it seemed to him to show that heavy springs were prescribed when, and only when, there was a truck upon the car, and that where the car had no truck, yoke, or back-piece, might be hung from the car body itself and the springs were not needed. He might add that the evidence satisfied him that what he took to be the view of the patentee was mechanically correct. The patentee then proceeded to describe other parts of the invention, and next indicated the mode by which the dead weight of the motor on the driving axle could be relieved. He (the judge) thought that the plaintiffs' counsel were right in saying that that was an optional arrangement, and that it did not refer to springs attaching the yoke or the back-piece to the truck. These "supporting springs" might be used with a truck or without a truck. The patentee then pointed out that the mode of gearing by toothed wheels was not essential, and next referred in detail to the figures annexed to the specification; and he might observe that all the figures showed trucks, and that there was no figure of a car body without a truck. It was not necessary to read all that part of the specification, and he would pass on to the three claims, which required very careful consideration. The first claim was for "the motor of an electric railway car or carriage, having (*a*) its field-magnet centred or sleeved upon a driving axle, (*b*) its armature supported directly upon the field-magnet, (*c*) and having a shaft separate from the driving axle, and (*d*) communicating motion from the armature shaft to the driving axle, substantially as hereinbefore described." He was of opinion that that claim was for a motor having all the four elements, which he had called *a*, *b*, *c*, *d*, in combination, each of them being "substantially as hereinbefore described." It had no reference to a spring suspension. It applied to a case where the car body had no truck and where springs were not described. It also applied to a case where there was a truck, but where belts were used and when springs would not be needed. The second claim was verbally identical with the first claim, except that the optional supporting springs were added—"supported partly or wholly by springs from the car body, carriage body, or truck." It followed that, in his view, this had no reference to the spring suspension. With reference to the third claim, there for the first time was mention made of what he (the judge) called "spring suspension." He was asked to hold that the last claim was practically identical with the first claim. He was unable to do so. It seemed to him to be an essentially different claim: it added something which was not found in the first claim, and which he believed was intentionally omitted from that claim. His lordship concluded:—This being the construction which I place upon the specification, it was faintly, if at all, argued that the patent could be supported. The first claim, as I read it, was plainly not new, and the action therefore fails. Had I adopted the plaintiffs' contention that spring suspension is to be found in the first claim, it would have been necessary for me to consider in detail several of the alleged anticipations. But in the view which I take I think it would be a waste of time to do so. Suffice it to say that my opinion is adverse to the plaintiffs on this point also. The action must be dismissed with costs.

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Mr. CRIPPS, Q.C. (for defendants) asked for a certificate that the particulars which had been referred to, with the exclusion of Garland's, were reasonable.

His LORDSHIP replied in the affirmative. The shorthand notes would show what the particulars were.

Mr. GRAY (for plaintiffs) asked his lordship not to grant so general a certificate, on the ground that several of the specifications put in by the other side only related to small parts.

His LORDSHIP said he could not see his way to give any such direction. He went on to say, in answer to Mr. Cripps, that he did not mean to charge the plaintiffs with anything more than one set of costs. He had treated the defendants as only one defendant.

Mr. GRAY said his clients might think it desirable to take the matter further, but they were not desirous of staying execution if an undertaking were furnished as to the return of costs. Mr. Gray said he understood that the defendant company was at present in liquidation—(Counsel on the other side: Not yet)—and he therefore asked for the usual undertaking from the solicitors.

His LORDSHIP said he could not impose any terms. He had dismissed the action with costs.

Heyl-Dia v. Edmunds.

In the Chancery Division Mr. Justice Kekewich heard an action by G. B. George Edward Heyl-Dia, electrical engineer and chemist, of Manchester, seeking to obtain a declaration that he was entitled to the benefit of an invention and secret process for recovering from indiarubber waste a commercial indiarubber which was utilisable for various purposes, and called "Heyloid," and an injunction to restrain the defendants, Henry Edmunds, James Edgar Baxter, and G. B. Samuelson, from in any way disclosing particulars of the said invention and secret process. The plaintiff also alternatively asked that it might be declared that the plaintiff and the defendants, or some of them, were partners with regard to the invention and secret process. He further asked for dissolution of the partnership and the usual inquiries and accounts.

Defendants in their statement of defence admitted that the plaintiff invented the secret process, but denied that he was the sole proprietor. It was said that the plaintiff had disclosed to all the defendants the mode of carrying out the invention, and the defendants affirmed that he was bound to do so under the terms of the agreement with them. For the purpose of testing the invention, Mr. Baxter spent large sums of money in erecting works at Leyland for that purpose. The defendant Samuelson, it was said by the defence, subsequently made an arrangement between himself and Edmunds whereby all his interest in the invention became the property of Edmunds. As Baxter had spent a larger sum of money than was contemplated, a rearrangement of the shares was effected, under which plaintiff, Edmunds, and Baxter would be each entitled to one-third. The three parties proceeded to form a company for the purpose of taking over and working the process, and on July 12, 1898, a company called the Caoutchouc Co. was registered for that purpose. Shortly after the registration of the company the agreement dated August 3, 1893, and made between the defendants Edmunds and Baxter and the plaintiff, should, said the defendants have been rescinded, and the defendants claimed that they equally with the plaintiffs would be entitled to the use of the secret process and invention. The statement of defence further set out that the defendant Samuelson did not now claim to be interested in the said invention and secret process.

In the result his Lordship, after hearing evidence, decided that although there was no partnership between Baxter, Edmunds, and the plaintiff, Baxter and Edmunds were entitled to the benefit of the invention. If they were all co-owners, the plaintiff was entitled to one-third share of the invention under the new arrangement made between himself, Baxter, and Edmunds. His lordship came to the conclusion, looking at the whole of the evidence, that the plaintiff was entitled to no relief against the defendants, and there would be simply judgment for the defendants, with costs.

On the suggestion of his Lordship, counsel for the defendants gave an undertaking not to disclose (pending a possible appeal) the secret process or manufacture of "Heyloid."

Stegmann v. O'Connor.

This case was originally before the Official Referee against whose decision an appeal was heard so long ago as January, 1899.* In February the Referee's decision was upheld by Justices Bruce and Ridley. Lords Justices A. L. Smith, Collins, and Vaughan Williams yesterday were engaged hearing the appeal of the plaintiff against this decision.

Mr. Tindal Atkinson again appeared for plaintiff, and Mr. Clavell Salter for defendant.

Mr. ATKINSON said he only proposed to ask their lordships' judgment on one point, and that was really a question of construction of the contract which was a question of law. The question was whether the defendant was entitled to the sum of £50 which the Official Referee had given him on his counter-claim, as being a penalty or liquidated damages provided for by the contract. The Official Referee had no right whatever to give that £50. The plaintiff in the case was an electrical engineer, and the defendant was the owner of a house at Clapham. In April, 1898, plaintiff entered into a contract, under specification, to erect an installation of electric lighting at defendant's house, and to put up the fittings to be supplied by the defendant for the sum of £76. 10s., the work to be done to the satisfaction of defendant's engineer; and the contract provided that plaintiff should pay £5 a day by way of liquidated damages for every day's delay exceeding 20. When the work was done defendant said it was so badly executed that it constituted a breach of the contract, and had to be done all over again. Defendant said in doing the work over again he had used certain of the plaintiff's material which was left behind at the house, and then he counter-claimed for £158 penalties. The Official Referee found that the plaintiff had not done the work according to the contract and the specifications, and that the defendant had to call in another electrician to do the work. He found that the material used by defendant, and which belonged to plaintiff, amounted to £2.16s., and allowed plaintiff £9.7s. for extra work which he did, making together £11.19s. The Referee then awarded defendant by way of liquidated damages £50, and after deducting the £11. 19s. which he had given plaintiff, gave his certificate in favour of defendant for £38. 1s. Counsel said there was no evidence to show that defendant had sustained damage by reason of any delay or breach of the contract. The installation put up by plaintiff was completed in the time specified, was found to be perfectly satisfactory, and was delivered over to defendant in that state. Defendant said his complaint was two-fold. It was a term of the contract that plaintiff should put in "Silvertown" wire, which was of a well-known manufacture. It was true that plaintiff did not use that wire, although he had contracted to do so. The reason was that he had not at that time Silvertown wire in his possession, and as it was during the Easter holidays, he was unable to obtain it, but he claimed to have put in another wire equally as good. Defendant also complained that plaintiff had put the wires in the lead tubing tight instead of putting them in loose. For these two reasons defendant said he was bound to do the work all over again.

Lord Justice VAUGHAN WILLIAMS said he noticed that the plaintiff only sued for £56, whereas the contract price was £76. 10s.

Mr. ATKINSON said the contract entered into by the plaintiff was to put up the wires, and also to put up the fittings supplied by defendant, but as defendant never supplied the fittings the plaintiff did not put them up, therefore he only sued for the price of the wiring of the premises.

Lord Justice VAUGHAN WILLIAMS: The Referee found that you were entitled to have nothing for the installation?—Yes.

Lord Justice VAUGHAN WILLIAMS: And nothing for the fittings, because you did not put them up, and therefore on the original contract you were entitled to nothing?

Mr. ATKINSON: That is so. He, however, withdrew that part of the case now. He ought to mention that when the plaintiff went to defendant's house for the purpose of substituting Silvertown wire for that put in, he was refused access to the premises, and was not allowed to do the work he was entitled to do.

Lord Justice VAUGHAN WILLIAMS: The only question now is whether the Referee was justified in giving the £50 damages. I suppose they were damages for not having carried out the contract.

Mr. ATKINSON: Plaintiff was never allowed to complete his contract in its entirety, as he was not allowed access to the premises for the purpose. He contended that defendant could not claim the £50 awarded on the counter-claim when he himself put an end to the contract. The £5 a day provided for by the contract was clearly a penalty, and not liquidated damages, and on the construction of the contract he asked their lordships to say that the penalty could not begin to run until the whole of the contract was completed. The defendant could not claim the penalty when he put an end to the contract himself.

Mr. CLAVELL SALTER submitted that the finding of the Official Referee and Divisional Court should not be disturbed. The evidence proved that the work done by plaintiff was wholly bad and useless. If it was true that a man had to wait until a contractor completed his contract before he could sue for penalties, he might never be in a position to sue, as the contractor might refuse to complete it. Such a construction of the contract would be unreasonable.

Their lordships reserved judgment.

Bersey v. the London Electrical Cab Co. (Limited).

Mr. Justice Byrne, in the Chancery Division on Saturday, heard a motion for judgment on a debenture-holder's action.

Mr. BROOK LITTLE said plaintiff was the holder of first mortgage debentures of £20 each for securing the sum of £15,000. These debentures charged the whole undertaking of defendant company, its rights and assets present and future, including its uncalled capital. The debentures were payable with a premium of £1, and carried interest at 5 per cent., and were to rank *pari passu* as a first charge without any preference or priority. The company had ceased to carry on business, and in two years had lost £11,000. A distress had been put in for rates, and a receiver had been appointed who was empowered by the court to raise a sum of money not exceeding £500. The principal money on the debentures had become payable in consequence of the company having ceased to carry on business.

His LORDSHIP found that the debentures formed a charge upon the undertaking of the defendant company, and gave judgment for plaintiff.

No opposition was raised by the company.

Mr. BROOK LITTLE asked for an order for the sale of defendants' business as a going concern, the proceeds to be paid into court.

Mr. JUSTICE BYRNE: Are you contemplating any actual sale?

Mr. BROOK LITTLE: Yes; negotiations have been going on for some time past.

His LORDSHIP: You must take the ordinary debenture-holder's judgment and declaration. You can apply in chambers for a sale of the defendants' concession.

Chick and Co. v. Groth.

This case came before Mr. Justice Grantham in the Queen's Bench Division yesterday. Plaintiff claimed £773. 16s. money lent and paid to defendant, with interest. Plaintiffs, a firm of foreign brokers, said defendant, the inventor of the Groth system of electric tanning, was introduced to them in 1882, and they agreed to advance certain moneys for the purpose of completing defendant's inventions and maintaining the patents in this country and abroad. The money so advanced was a loan, and was accompanied by an undertaking by defendant that if a company

* See *The Electrician*, January 20 and 27 and February 24, 1899.

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should be successfully floated to work the patents, in addition to receiving their advances back plaintiffs should receive a bonus of shares. The defence was that there was a verbal agreement that the moneys were only to be repaid by defendant out of moneys which he might get from the successful flotation of the company.

Evidence having been given by Mr. ALFRED CHICK in support of the claim,

Mr. LAWRENCE ALBERT GROTH said he never heard from Mr. Chick that he looked to him (defendant) personally for payment until this action was commenced. He had commenced an action against Mr. Chick for breach of agreement in not having paid the taxes on the Austrian patent, and that action was still pending.

Mr. Justice GRANTHAM gave judgment for plaintiffs, with costs, holding that the money was advanced as a loan, for repayment of which the defendant was liable.

Repair and Maintenance of Roadways by Tramway Companies.

On Thursday last, at the Dublin Southern Police Court, the adjourned summons issued by the Dublin Corporation against the Dublin United Tramways Co. for neglecting to keep the tramway and the prescribed space outside the rails in good condition or repair as provided by statute, was resumed. (A report of the previous proceedings was given in our last issue.)

The chairman of the company, Mr. W. M. MURPHY, said that when the tramways were laid they were paved with square setts, and for a long time sanding was not done. After a while, however, the company introduced the system of putting sand down for their own horses. It was done partly because of the stones getting smooth, but chiefly to prevent the wearing of the setts. Mr. Neville, the late engineer of the Corporation, objected to the sanding process. During the whole period he knew of no sanding by the Corporation, except in recent years, when they adopted it in certain places. Nearly all the streets mentioned in the summons had been reconstructed since January, 1893. Wherever they introduced electric traction they had to put down new rails. The assistant of the city engineer was always on the spot at the works, and there was no friction whatever save in one isolated instance, and in that the requirements of the engineer were being complied with. Since the tram system commenced in Dublin the lines and roadways were never in better condition than they were now. The joints used were approved by the Corporation. The question of sanding was in no sense structural. The sanding would always be more effectual after scavenging, and it would be much better to have the entire width of the street sanded.

The MAGISTRATE (Mr. Swifte): The difficulty could be got over by the company contributing something towards the expense.

Mr. MURPHY: The company were perfectly willing to contribute a reasonable amount, whether they were liable or not, if the Corporation were prepared to sand the whole surface. The company spent £7,000 a year on maintenance. The company had put sand on the tracks for the safety of their own horses when the tracks were more dangerous than at present. If the track was in as good a condition now as when laid down, the question was who was responsible for its safety. He contended that as long as the company kept the cubes in good condition they were not bound to do any more. The draught under the electric trams blew away the dust, and had a tendency to make the stones slippery.

Mr. SWIFTE: Do you suggest that there is any change in the legal liability now than what existed before?—No.

Mr. SWIFTE: Then why did you continue for 15 years to sand the tracks, and now cease doing so? If it be a danger to the public, the duty clearly lies with either the Corporation or the company, and hitherto it was discharged by the company.

Mr. GORDON (for the defence) said the company sanded the lines simply for their own purposes, on their own particular places.

Mr. O'SHAUGHNESSY said the company for years had been providing against a common danger, and now when they had given up the horses they took on themselves to give up making provision against the common danger they created.

Ultimately the case was ordered to stand over for a fortnight. In the meantime a proposal in writing to be submitted, confined to the portion of the road over which the tramway company has any obligation. Any proposal to be without prejudice to the legal rights of either party.

Milver Portable Electric Battery Syndicate (Limited) (petition of G. Trenam)

This case was before Mr. Justice Wright on Wednesday as a winding-up petition.

Mr. O. LEIGH CLARE said there was a difficulty in the case. Owing to a printer's error, it was advertised in the *Gazette* as the "Milner" instead of the "Milver" Portable Electric Battery Syndicate (Limited). Petitioner had been approached by the company with the view of paying him off, and he (counsel) would ask that the petition might stand over for a fortnight.

The petition was ordered to stand over for a fortnight.

Madras Electric Tramways Co. (Ltd.) (petition of the Electric Construction Co., Ltd.).

This matter was again before Mr. Justice Wright on Wednesday, when Mr. Herbert Reed, Q.C., said he could not ask for any further adjournment. There were a number of native shareholders.

Counsel for the Electric Construction Co. asked for a compulsory order.

His lordship granted a compulsory order.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers, or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London:—

NOW READY.

"The Electrician" Electrical Trades' Directory and Handbook for 1899.—The *Second Edition* of the "Big Blue Book" for 1899 is now ready. The volume contains the large Sheet Tables of Electricity Supply Stations and Electric Railways and Tramways. The price of the Directory and Handbook is now reduced to 5s. post free 5s. 9d.; abroad, post free, 6s. 6d. (United States 7s. 6d.).

"Electric Motive Power," by Albion T. Snell, contains the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. Price 10s. 6d., post free; abroad, 11s.

"Electrical Testing for Telegraph Engineers."—By J. Elton Young, M.I.E.E. The scope of the book aims at furnishing a fuller treatment of the subject, from the standpoint of the Telegraph Engineer, than it has hitherto received, whilst it endeavours to facilitate a thorough comprehension of the theory of testing as applied to electrical lines in general. Demy 8vo, fully illustrated. 10s. 6d., post free.

"Laboratory Notes and Forms."—We have ready a set of 40 Elementary and Advanced Exercises for use with Electrical Engineering classes. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators and Students. The object of the series is the saving of the time of the Teacher and his Assistants, and to serve as a record of the work done by the Student. Each Form is supplied either singly at 4d., or 3s. 6d. per dozen net; in sets of any three, 1s. net; or the set of Twenty (Elementary or Advanced) Exercises can be obtained, price 5s. 6d. net. The complete set of Twenty Elementary and Twenty Advanced Exercises are price 10s. 6d. net; or in handy portfolio, price 12s. net; or bound in strong cloth case, price 12s. 6d. net. Strong portfolios can be had, price 1s. each.

NOW READY.—The cheaper edition of Dr. J. A. Fleming's "Electrical Laboratory Notes and Forms." These cheaper Forms have been prepared for the use of students and teachers at the Polytechnics and other Science classes throughout the country. The demand for the original set of these Notes and Forms has led to a request for a cheaper set for use at the day and evening classes at many of the technical institutes. These new Forms, which differ only from the higher-priced set in being printed on smaller and cheaper paper and with less space for tabulated records, are issued at half the price of the original set.

"Drum Armatures and Commutators," by Mr. F. Marten Weymouth, also ready. Price 7s. 6d., post free. Prospectus on application.

"The Students' Guide to Submarine Cable Testing."—A new edition of this book, by Messrs. H. K. C. Fisher and J. C. H. Darby, is now ready, price 6s. net; abroad, 6s. 3d. This work is intended to serve as a guide to operators already in the telegraph service, and to those who desire so enter that service. The great cable companies now insist that their operators and probationers shall pass certain examinations in electrical subjects. The book is very fully illustrated.

"Submarine Cable-Laying and Repairing."—By H. D. Wilkinson, M.I.E.E., &c., fully illustrated; price 12s. 6d.

"Practical Notes for Electrical Students."—By Messrs. A. E. Kennelly and H. D. Wilkinson. Price 6s. 6d., post free.

"Electro-Chemistry."—By Dr. G. Gore. Third Edition. Price 2s., post free.

"Wireless Telegraphy: Signalling across Space without Wires by Electric Waves." A Review of the Work of Hertz and his Successors.—By Dr. O. J. Lodge, with a large number of illustrations. ***New and Enlarged Edition nearly ready.***

"Electromagnetic Theory."—By Oliver Heaviside. *Vol. I.*, 12s. 6d. *Vol. II.*, 12s. 6d.

"Magnetic Induction in Iron and other Metals."—By Prof. J. A. Ewing. Price 10s. 6d., post free. *New Edition nearly ready.*

"The Incandescent Lamp and its Manufacture."—By Gilbert S. Ram. Price 7s. 6d., post free.

"The Steam Engine Indicator and Indicator Diagrams."—Edited and enlarged by W. Worby Beaumont. Price 3s. 6d., post free.

"The Art of Electrolytic Separation of Metals."—A second issue of Dr. Gore's book is now ready, price 10s. 6d., post free.

"The Manufacture of Electric Light Carbons."—A Practical Guide to the establishment of a Carbon Manufactory. Fully illustrated, price 1s. 6d.; post free, 1s. 9d.

"The Manufacture of Carbons for all Electrical Purposes."—By Francis Jehl. 10s. 6d., post free.

"The Centenary of the Electric Current, 1799-1899."—By Dr. J. A. Fleming. Price, paper covers, 1s. net, post free 1s. 3d.; strong cloth, 2s. 6d., post free.

"Bibliography of X-Ray Literature and Research."—A valuable compilation. Being an attempt to classify the data relating to X-Ray work. This work contains a quantity of general as well as special information bearing upon the whole subject of electrical discharge research. Edited by C. E. S. Phillips. Price 5s., post free.

"Localisation of Faults in Electric Light Mains."—By F. C. Raphael. Price 5s., post free.

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TENDERS INVITED.

The Council of the county borough of *West Ham*, London, E., invite tenders for (*a*) three 84-kilowatt steam dynamos, boosters, switchboard, steam exhaust and feed-water pipes; (*b*) accumulators; (*c*) water-cooling and condensing plant; (*d*) motors; (*e*) telephones. Plans of the station, specification, &c., can be obtained at the borough electrical engineer's office, Abbey Mills, West Ham, and tenders must be sent in to Mr. Fred. E. Hilleary, town clerk, Town Hall, West Ham, E., not later than 4 p.m. of Thursday, Nov. 30. An advertisement elsewhere sets out some conditions of contract, &c.

The *Manchester* Tramways committee invite tenders for the supply of 5,000 tons of steel girder tramway rails and about 250 tons of steel fish plates. Specifications, &c., can be obtained from the secretary (Mr. J. M. M'Elroy), and tenders (addressed to chairman of committee, Town Hall, Manchester) must be sent in before Saturday, Dec. 2. An alverti ement contains further particulars.

The directors of the *Harrow* Electric Light and Power Co. (Limited) invite tenders for the supply and erection of a 150-kilowatt steam dynamo and extensions to switchboard. An advertisement contains further particulars, and tenders must be delivered at the offices of the company, West street, Harrow-on-the-Hill, on or before Dec. 4. Specifications, &c., can be obtained from the resident electrical engineer, Mr. Arthur H. Shaw.

The *Plymouth* Corporation invite tenders for tramcars, trucks, motors trolley arms, &c. An advertisement contains further particulars, and specifications, &c., can be obtained from the borough electrical engineer (Mr. John H. Rider), Prince Rock, Plymouth. Tenders must be delivered to the town clerk (Mr. J. H. Ellis), Town Hall, Plymouth, by Dec. 8.

The *Woking* Electric Supply Co. invite tenders for the supply and erection of a 150-kilowatt steam alternator and a 75-kilowatt steam alternator. Copies of specifications may be obtained from the consulting engineers (Messrs. Preece and Cardew), 13, Queen Anne's-gate, Westminster, S.W., to whom tenders must be sent by 5 p.m. on Monday, Dec. 11. An advertisement contains additional particulars.

The *Pontefract* Guardians invite tenders for the electric lighting of their workhouse infirmary buildings and premises. An advertisement contains further particulars, and specifications, &c., can be obtained from the consulting engineer (Mr. G. R. Peers), 95, Deansgate, Manchester. Tenders must be sent to the clerk (Mr. W. A. Glover), Poor Law Offices, Pontefract, by 10 a.m. of 24th inst.

The *Newcastle-upon-Tyne* Electric Tramways committee invite tenders for two 1,000-H.P. generators. Tenders (addressed to the committee) must be left at the office of the town clerk (Mr. Hill Motum), Town Hall, Newcastle-upon-Tyne, by noon of Nov. 30.

The *Accrington* Corporation invite tenders for electric cables, wires, street boxes, and connections. Tenders to the town clerk (Mr. A. H. Aitken) by the 18th inst.

Tenders are invited for the supply of 19,100 steel and wrought-iron tie bars and 3,700 bolts, for tramway purposes, by the *Salford* Corporation. Tenders to Mr. L. C. Evans, Town Hall, Salford, by 21st inst.

The *Bury St. Edmunds* Town Council invite tenders for wiring and fixing electric light fittings in certain public buildings. Tenders to the borough surveyor (Mr. J. Campbell Smith), Town Hall, Bury St. Edmunds, by 22nd inst.

The *Wimbledon* District Council require tenders for the supply and erection of two 350-kilowatt steam alternators. Tenders to the clerk to the Council (Mr. W. Whitfield), Council Offices, Broadway, Wimbledon, by 10 a.m. 22nd inst.

The *Battersea* (London) Vestry require tenders for the supply of arc lamps and arc lamp-posts. Tenders to the vestry clerk (Mr. W. Marcus Wilkins), Municipal Buildings, Lavender-hill, London, S.W., by noon of Dec. 4.

The directors of the *North Eastern Railway* invite tenders for telegraph stores for the six months ending June 30, 1900, which must be sent in to the secretary (Mr. C. N. Wilkinson) by noon of 20th inst.

The *Londonderry* Corporation invite tenders for the supply of carbons for the year to Dec. 31, 1900. Tenders to the town clerk (Sir R. Newman Chambers), Guildhall, Londonderry, by 30th inst.

The *Hammersmith* (London) Vestry invite tenders for wiring their stables depôt. Tenders by 22nd inst.

The *Islington* (London) Vestry invite tenders for condensing plant. Tenders to the electrical engineer (Mr. Albert Gay).

The *Swansea* Corporation invite tenders for the supply and erection of five Lancashire boilers, with jet condensing plant, feed pumps, economiser, piping, &c. Tenders to Mr. Jno. Thomas, Guildhall, Swansea, before noon of 20th inst.

The *Greenock* Police Board invite tenders for leasing the lines of tramways within the burgh and converting for electric traction on the overhead trolley system. Tenders to town clerk (Mr. C. MacCulloch) before 23rd inst.

The *East Ham* District Council invite tenders for the construction of tramway track, including the supply of points and crossings, bonding, conduits, junction boxes, &c. Tenders by 25th inst.

The *Blackpool* Tramways committee invite tenders for the construction of the permanent way of a double line of tramway from Springfield-road to the Gynn. Tenders to borough engineer by 20th inst.

The *Blackpool* Corporation also invite tenders until 21st inst. for erecting a brick chimney shaft at their electricity works.

The *Aarhus* (Denmark) Electricity committee require tenders for water-tube boilers, steam dynamos, switchboard, &c., and accumulators. Tenders to the committee, gas works, Aarhus, by Dec. 28.

The Electricity department of the *Glasgow* Corporation invite offers for ten miles of 2in. cast-iron pipes. Tenders to Sir J. D. Marwick, City-chambers, Glasgow, on or before Nov. 20.

The *Glasgow* Corporation require tenders for 4,000 tons steel straight track rails, 400 tons steel curve rails, and 200 tons steel fish-plates. Tenders by 25th inst.

The *Glasgow* Corporation also require tenders for brickwork in connection with chimney shafts and foundations at Port Dundas power station. Tenders by 21st inst.

The *Middlesbrough* Electric Lighting committee invite tenders for condensing plant and pipework. Tenders to Mr. George Bainbridge, Municipal Buildings, Middlesbrough, by 4 p.m., Nov. 22.

The *Chelsea* (London) Vestry require tenders for three motor vans. Tenders to vestry clerk, Town Hall, Chelsea, by 21st inst.

The Governors of *Felsted* School, Essex, invite tenders for the supply and erection of electric lighting plant. Tenders by Nov. 27

The *Cheshire* Lines Committee require tenders for telegraph materials, instruments, wire, &c. Tenders by noon of Dec. 1.

The *Hackney* (London) Vestry require tenders for refuse destructors. Tenders to vestry clerk by 4 p.m. of Dec. 12.

The *Lambeth* (London) Vestry require tenders for 25 arc lamp posts. Tenders to Vestry Hall, S.E., by Dec. 6.

TENDERS RECEIVED AND ACCEPTED.

The following additional tenders have been recommended for acceptance by the Wigan Corporation :—

W. T. Glover and Co. (cables)	£13,732	5	10
Doulton and Co. (conduits)	2,725	0	0
Babcock and Wilcox (boilers)	4,504	0	0
General Electric Co. (steam dynamos)	7,228	10	0
Ditto (balancers, boosters, &c.)	1,959	0	0

For the cables six tenders, varying from £12,326. 18s. 8d. to £15,780 4s. 2d. were submitted. For the conduits six offers, ranging from £2,537. 10s. to £3,250, were also received, but only three firms tendered for the boilers—viz., Babcock and Wilcox, R. Hornsby and Son, and B. R. Rowland and Co. Of the 19 tenders for steam dynamos there were alternative offers for Willans or Belliss engines in 14 cases, four specified Willans engines alone, while the Brush Co. tendered for the Universal engine. The highest tender with Willans engines was by Messrs. Clarke, Chapman and Co. at £9,792. 1s. 8d. and the highest with Belliss engines was by Messrs. P. R. Jackson and Co., at £10,932. 1s. 6d. The lowest tender for both types of engines was submitted by the General Electric Co, the amounts being (as given above) £7,228. 10s. for Willans and £6,081. 10s. for Bellis engines. The contract for the storage battery has not yet been let, though six tenders, varying from £1,488. 15s. to £2,015, are under consideration.

The Islington (London) Vestry have received the following tenders for the supply of a secondary battery of 60 cells, with a capacity of 1,000 ampere hours, for their electricity works :—

Tudor Accumulr. Co. (*accepted*)	£679	Hart Accumulator Co.	£640
Electrical Power Storage Co...	664	Chloride Elec. Storage Synd.	640
Pritchetts and Gold	642	W. C. Horne and Sons...	572

The Tudor Co also submitted an alternative tender of £610.

The Paisley Corporation have accepted the following tenders for the supply of plant at their electricity works :—

Babcock and Wilcox (three water-tube boilers)	£1,635
T. and T. Vicars (mechanical stokers)	430
Daniel Adamson and Co. (Bulkley condenser)	120
Ditto (pump, &c.)	250

The Rotherham Corporation have accepted the following tenders for electric lighting plant :—

Tetlow Bros. (boilers)	£1,240	0	0
W. H. Allen, Son and Co. (engines, dynamos, &c.)	7,702	0	0
D.P. Battery Co. (accumulators)	755	10	0
James White (switchboard)	1,290	18	9
Callender Co. (mains, on the solid system)	4,092	12	11

(Particulars of these tenders were advertised in our issues of Sept. 8-22).

The following tenders have been accepted for the supply of generating plant for the electric lighting of the Winwick Asylum, near Warrington :—C. A. Parsons and Co. (generating plant), Edison and Swan Co. (switchboard), Hart Accumulator Co (storage battery).

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Messrs. C. A. Parsons and Co. have obtained the contract for supplying and erecting the generating machinery for the Aldershot Camp. The plant will consist of three turbo-generators of 250 kilowatts each, and one turbo-generator of 100 kilowatts.

The West Ham District Council have accepted the tender of Mr. A. J. Ellis, Reading, for supplying and fixing wrought-iron principals, cast-iron sashes, stairs, &c., for their electricity supply works.

The tender of Messrs. Willans and Robinson has been accepted by the Great Yarmouth Corporation for a 150-kw. steam alternator at £1,611.

APPOINTMENTS VACANT AND FILLED.

The Urban District Council of Radcliffe (Lancs.) require an electrical engineer with lighting and tramway experience. An advertisement elsewhere gives some further particulars, and applications have to be sent to Mr. James Sharples, clerk to the Council, not later than Dec. 5.

The Buxton District Council invite applications for the position of resident electrical engineer. An advertisement contains further particulars, and applications must be sent to the clerk to the Council (Mr. Josiah Taylor), Town Hall, Buxton, by 28th inst.

The Eccles Corporation require two switchboard attendants for their electricity works. An advertisement contains further particulars, and applications must be sent to the town clerk (Mr. W. H. Hickson), Town Hall, Eccles, by Friday, 24th inst.

The Huddersfield Electricity committee invite applications for the position of electrician-in-charge. Applications to the borough electrical engineer (Mr. A. B. Mountain), St. Andrew's-road, Huddersfield, by 26th inst.

The East Indian Railway require an electrical engineer to superintend the erection and working of the electric light and power plant. Salary 800 rupees per month. Applications to secretary, 28-30, Nicholas-lane, London, E.C.

A mains engineer is required for the electricity department of the Aberdeen Corporation. Applications to Mr. J. Alex. Bell, Cotton-street, Aberdeen, by 20th inst.

The Wimbledon District Council require an assistant engineer. Applications to Mr. F. Barnes Spencer by 20th inst.

An assistant electrical engineer is required at the County Asylum, Whittingham, Preston. See advertisement.

An assistant is required in the electrical engineering department of the City and Guilds Technical College, Exhibition-road, London, S.W. An advertisement contains further particulars, and applications must be sent to Prof. W. E. Ayrton.

Applications are invited for the chair of physics at the University College of North Wales, Bangor, which is vacant owing to the appointment of Prof. A. Gray to the chair of natural philosophy at the University of Glasgow.

A lecturer in mathematics and physics is required for the Derby Municipal Technical College. Applications by 30th inst.

Prof. John Ryan, D.Sc., M.A., professor of engineering at University College, Bristol, has been appointed principal of the Woolwich Polytechnic.

Mr. John R. Crisp, of Stockton-on-Tees, has been appointed clerk of works at Sunderland in connection with the electric tramway scheme.

Mr. D. M. F. McLeod, of Aberdeen, has been appointed chief distributing assistant at the electricity works of the Poplar District Board of Works.

Mr. R. Birkett, hitherto chief assistant at the Burnley Corporation electricity works, has been appointed borough electrical engineer at Burnley in succession to Mr. W. R. Wright, who has obtained a similar appointment at Bootle.

Mr. S. E. Britton, chief assistant at Southampton, has been appointed resident electrical engineer by the Barking District Council in succession to Mr. E. E. Hoadley, who was recently appointed borough electrical engineer (*pro tem.*) at Worcester.

Mr. Robert Blackmore, superintendent engineer of the National Electric Supply Co., Preston, and late on the staff of the St. James's and Pall Mall Electric Light Co., London, has been appointed city electrical engineer by the Wakefield Corporation.

Mr. Theo. Taunton has been appointed secretary of the Consolidated Telephone Construction and Manufacturing Co., (Limited) *vice* Mr. Charles Curtoys, who has resigned through ill-health.

BUSINESS NOTICES.

Messrs. R. G. Tyler and F. B. Nicholson (trading as Nicholson and Tyler) have dissolved partnership. Mr. W. Duncan, A.I.E.E., lately with Messrs. Laing, Wharton and Down (Limited), has joined Mr. Tyler, who will trade at 20, New Bridge-street, London, E.C., as Tyler and Duncan. Mr. Nicholson will carry on business at 53, Victoria-street, Westminster, London, S.W., as Nicholson and Co.

Messrs. W. O. Rooper and G. Robins (trading as W. O. Rooper and Robins), electrical engineers, Victoria-road, Stafford, have dissolved partnership. Debts by Mr. Rooper, who continues.

Messrs. Oliver and Co., arc lamp manufacturers, have removed to Cambridge-place, Burrage-road, Woolwich.

The well-known London firm of advertising contractors, Messrs. C. Mitchell and Co., have removed their offices from Red Lion-court, Fleet street, to 1 and 2, Snow-hill, Holborn Viaduct, London. This firm has been established at the first-mentioned address for over 60 years.

BANKRUPTCIES, LIQUIDATIONS, &c.

The following are the principal creditors in the bankruptcy of Frederick G. W. Adams, electrical engineer (lately trading with C. M. Downie as Downie and Adams, at 24, Newman street, Oxford-street, London, W.C.) :—

G. W. H. Adams	£1,693	W. T. Glover and Co.	£15
Compagnie Generale des Lampes	132	Cardiff Tin Stamping Co.....	14
I. Frankenburg	90	Chard and Co.	13
Wenham and Waters	60	Crypto Works Co.	11
London Electric Wire Co. ...	29		

In the bankruptcy of E. M. Winter, electrical engineer, Amberley House, Norfolk-street, London, W.C., the first meeting of creditors will take place to-day (Friday), and the public examination on Dec. 17, both at Bankruptcy-buildings, London, W.C.

Mr. H. F. Bowman, electrical engineer, &c., 3, Foster-street (late Heaton-street), Gainsborough, has been adjudicated bankrupt.

Claims against E. B. Pym, electrical engineer, 29, Bramham-gardens, South Kensington, London, S.W. (late of Scarborough), must be in by Nov. 29, to Mr. A. H. Wildy, Bankruptcy-buildings, London.

Claims against C. H. Kitching, electrical engineer, 20, St. Hilda-street, Hull, must be in by Nov. 30, to Mr. J. H. Fox (care of Gray and Co.), Chapel-street, Hull.

A receiving order has been made against J. C. Howell, electrical engineer, 24, Queen Victoria-street, London, E.C. The first meeting of creditors will take place on 24th inst. and the public examination on Dec. 21, both at Bankruptcy-buildings, Carey-street, London, W.C.

At a recent meeting of the Medical Battery Co. (Limited) (C. B. Harness, chairman), at 489, Oxford-street, London, W., it was resolved that the company be wound up voluntarily, as it is unable to continue its business by reason of its liabilities.

A meeting of Berry's Electrical Co. (Limited) will be held at the offices of Rowland and Co., 41, Temple-row, Birmingham, on Dec. 21, to receive an account of the winding-up. Mr. A. E. Chatterley is liquidator.

Sales by Auction.—Messrs. Fuller, Horsey, Sons and Cassell will sell by auction (unless previously disposed of by treaty), at the premises of the Maskelyne British Typewriter Co., 64, Hammersmith-road, London, W., on Thursday the 30th inst., at 11 a.m., a quantity of engineers' tools and stock. Some particulars are set out in an advertisement, and catalogues may be had on the premises, or of the auctioneers, 11, Billiter-square, London, E.C.

Messrs. Wheatley Kirx, Price and Co. will sell by auction, on Tuesday, Nov. 21, at 10 a.m. for 10.30 prompt, the entire contents of the Globe Works, Kirkstall-road, Leeds, comprising motive power and gearing, fixed and loose engineering plant, tools, stock and stores, steam engines, electrical installation, six open type motors, lathes, planing machines, &c.; also a large quantity of new stock and stores, and the entire collection of modern patterns and drawings, including standard designs of dynamos and motors. Admission will be by catalogue, which are ready and can be obtained of the auctioneers, 49, Queen Victoria-street, London, E.C., and Albert-square, Manchester, or from the trustee, Mr. Myles Lee, 17, East Parade, Leeds. Some further particulars are given in an advertisement.

Legal Notice.—Claims against the estate of the late Dr. John Hopkinson must be sent in by Dec. 20 to Messrs. Waterhouse and Co., solicitors, New-court, Lincoln's Inn, W.C.

Electric Cooking and Heating Apparatus.—We have received a useful list of "Prometheus" electric cooking and heating apparatus. The "Prometheus" system is claimed to be an important advance in the development of this branch of electrical industry, and to be free from the defects inherent in earlier systems. The system of construction for the "Prometheus" apparatus is said to be extremely simple, and the method of applying the resistances absolutely reliable. The makers give a twelvemonths' guarantee of correct working. The utensils are stocked in most instances for 110 volts, and may be used for any voltage between 90 and 120. By a patent system of regulating the current the apparatus is provided with three contacts, which can be regulated to four degrees of heating—quick, slower, slow, and slight. The articles listed by Messrs. O. Berend and Co. (Limited), Basinghall-avenue, London, E.C., in their new list of this apparatus, include teapots, kettles, coffee-making machines and urns, milk jugs, water cups, saucepans, frypans, stock pots, soup tureens, dish covers, roasting pans, plate warmers, hot water jugs,

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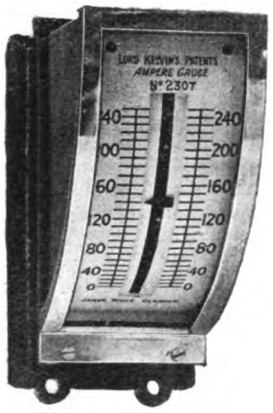
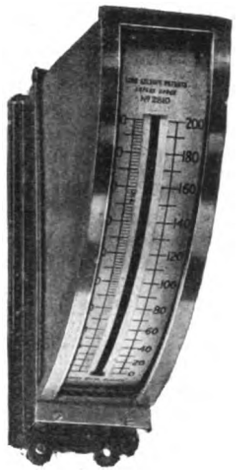
curling and smoothing irons, radiators, glue-pots, &c., and articles not included in the list can be obtained to order.

Lord Kelvin's Patent Edgewise Ampere Gauges and Voltmeters.—The ampere gauges made by Messrs. James White, of Cumbridge street Glasgow, to designs patented by Lord Kelvin, are intended specially for switchboard use in connection with electric light or tramway power stations where space is a consideration. They are fitted in enamelled iron cases with nickel bezels. Owing to the special construction of the coil, which gives a very intense and uniform field, the scale is almost an equal division one. All Kelvin instruments are designed so as not to be affected by external fields, and are provided with a damping arrangement; and by means of

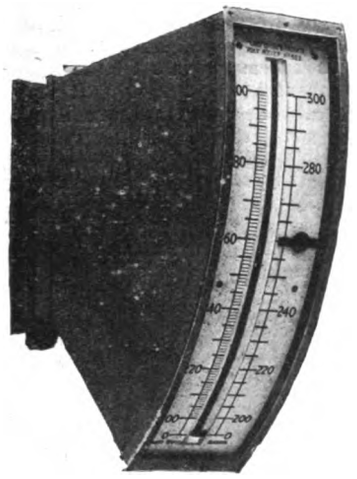


5in. Edgewise Kelvin Ampere Gauge.



10in. Edgewise Kelvin Ampere Gauge.

varying the density of the oil used any degree of dead-beatness can be attained. The angle of the scale is such that these instruments, fitted at a height of 6ft. or 7ft. from the floor line, are in a convenient position for reading. The insulation for all ordinary instruments for circuits not exceeding 500 volts will withstand 2,000 volts alternating, but insulation can be provided for any voltage, enabling an instrument to be put directly in circuits of 5,000, 6,000, or even 10,000 volts. The instruments are made to 5in., 7½in., and 10in. scales (approximate lengths). The instrument measures the current independently of the direction in which it is flowing; but where it is desired to know the direction (as in accumulator or middle-wire circuits) a current direction indicator is fitted at the lower end of the scale.



10in. Edgewise Kelvin Voltmeter.

Voltmeters on similar lines have been designed of the edgewise pattern, although this instrument is of the moving coil type. Its special features are the arrangement of the permanent magnets and the treatment of these to insure permanency. As is usual in all Lord Kelvin's instruments, no pivots are used or easily damaged parts, the movable system being wholly supported on ligaments which also act as the conductors of the current into and out of the movable coil, thereby altogether avoiding the friction due to pivots. Any degree of sensibility can be attained with perfectly dead-beat action, and a scale can be given reading from zero to maximum, or especially open at any desired point.

Mirrors, Lenses, &c.—A catalogue of high-class mirrors, lenses, ships' lanterns, &c., is just issued by Messrs. Estler Bros., 27, Leadenhall-street, London, E.C. These lenses are claimed to be truly dioptric, and are made of the best optical glass, consisting of three, five, six, seven, and nine elements. Illustrations are given of mirrors for searchlight projectors, Fresnel reflectors, &c. This firm supply optically-ground lenses for railway and tramcar head and tail lights.

Continuous-Current Electrical Plant.—Mr. T. Harding Churton, of Great Wilson-street, Leeds, has just issued a new list of continuous-current dynamos and motors for electric lighting and power transmission.

Pearson Automatic Fire Alarm System.—In connection with a note appearing in our last issue on p. 95, we have received the following from Mr. E. E. Bowell, secretary of the Pearson Fire Alarm System (Limited):—

TO THE EDITOR.

SIR: I should like to add a word or two of correction to your comments on the "Pearson Fire Alarm System (Limited)." In the first place, the reason you ascribe as to work in Northampton or Manchester being 'the cause for the singularly regular attention which this company has received from the financial Press' is to us a distinctly original one. The actual cause is far more likely to lie in the fact that the proprietors of the two leading financial papers have our automatic fire alarms installed throughout their works, and are thereby enjoying a considerable reduction in their fire insurance premiums. With regard to the "cry" and "wool," we have in our Cripplegate area at this moment 10,000 points wired to—and all either connected or being connected to our Whitecross-street call station. But this is only, as you say, "so far."

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Nov. 8 to Nov. 14, with the ports of destination:—

Africa—Alexandria, £451; Cape Town, £377; Durban, £1,514 (including £1,419 telegraph material); East London, £263; Port Elizabeth, £114; Port Said, £23. *Argentina*—Buenos Ayres, £93 (telegraph material). *Australasia*—Brisbane, £158 (including £25 telegraph wire); Melbourne, £1,097 (including £974 telegraph wire); Perth, £534; Sydney, £197; Wellington, £448. *Belgium*—Antwerp, £604; Ostend, £249. *Canada*—Halifax (N.S.), £49,000 (telegraph cable). *Ceylon*—Colombo, £387 (including £58 telegraph apparatus). *China*—Shanghai, £278. *Colombia*—Santos, £310. *France*—Boulogne, £65. *Germany*—Hamburg, £440 (telegraph material). *Gibraltar*—£92. *Holland*—Amsterdam, £860. *Hong Kong*—£241. *India*—Bombay, £253 (including £29 telegraph wire); Calcutta, £146, *Japan*—Tokyo, £1,160; Yokohama, £292 (including £244 (telegraph material). *Malta*—£566 (telegraph material). *Norway*—Bergen, £10,675 (telegraph cable); Christiania, £68 (telegraph wire). *Russia*—St. Petersburg, £38 (telegraph material). *Straits Settlements*—Singapore, £77. *Sweden*—Gothenburg, £12 (telegraph wire); Stockholm, £143 (telegraph wire). Total, £71,320, against £11,838 in the corresponding week last year (Nov. 9 to 15).

MUNICIPAL, FOREIGN, AND GENERAL NOTES.

Aberdeen.—An experimental run was made on Monday over a portion of the George-street-Woodside electric tramway route.

Airdrie and Coatbridge Electric Tramway.—The Airdrie and Coatbridge Councils have decided to join in an application for a provisional order for the construction of an electric tramway between the two towns.

Asylum Lighting.—The Cork County Council recently decided to fit up the Youghal industrial school as a lunatic asylum, and to light the building electrically.

Barmouth.—The Council have retained Mr. F. J. Warden-Stevens in connection with their proposal to apply for electric lighting powers.

Bootle.—An inquiry was held here on Tuesday into the Corporation's application to borrow an additional £16,339 for electricity supply extensions. The town clerk (Mr. J. H. Farmer) appeared in support of the application, and said the undertaking was making good progress, and they were desirous of improving the public lighting and of increasing the capacity of the plant for private lighting. £3,426 was required for providing 92 arc and 202 incandescent lamps for lighting certain thoroughfares. The borough electrical engineer (Mr. W. R. Wright) gave technical details.

Caterham.—The Council do not propose to apply for a provisional order, but have offered to consider electric lighting proposals by Edmundson's Electricity Supply Corporation.

Clontarf (Dublin).—As the Dublin United Tramways Co. are giving up their power station at Dollymount, the Council are endeavouring to make arrangements with the company for the acquisition of the station, or to come to some arrangement for obtaining a supply of electric current for public and private lighting.

Darlington.—In future the electricity supply and gas undertakings of the Corporation will be under one committee.

Dewsbury.—Though the Council have decided to apply for a provisional order negotiations are proceeding with the British Electric Traction Co., and if terms can be arranged the application for an order will not be proceeded with.

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Dock Lighting.—Good progress has been made with the scheme for electric lighting at Aberdeen docks. The new system will greatly facilitate night traffic. In all 74 arcs of 2,000 c.p. each will be employed, and most of these have already been placed in position. Current will be supplied by the Corporation, and the lamps are arranged in two circuits, so that each alternate lamp can be switched out when desired. A feature of the lighting arrangements is the erection of beacon lights, which have, so far, proved most serviceable. These beacon lights are placed on steel latticed towers, and the centre of the lamp is 80ft. above the quay level. The beacon itself is composed of four independent arc lamps of 2,000 c.p. each. It is also proposed to erect four lamps at the pontoon dock, so that docking operations may be carried on by night. The whole of the public sheds are likewise to be illuminated electrically, and where discharging berths are opposite the sheds, arc lamps, suspended from swan standards, are to be provided.

Dumbarton.—The Glasgow District Tramways Co. are applying for powers to construct electric tramways in this district.

East Ham.—The Council have decided to let the work of constructing the permanent way of the proposed electric tramways to contract, and tenders are now being invited. A noisy meeting of ratepayers and others was held last week to protest against this course, and a resolution censuring the Council for their action was adopted.

Electric Swing Bridge.—The town bridge at Northwich, Cheshire, over the river Weaver, which was opened this week, is one of the few bridges in the country operated electrically.

Electric Traction in Holland.—A syndicate has been formed to construct an electric railway between Rotterdam, the Hague, and Scheveningen. The line will be double track throughout, and will be connected with the ordinary steam service at Rotterdam. A junction will be effected with the State railways at the Hague. The estimated cost is put at 7,000,000fl., and a mean speed of 50 kilometres (31 miles) per hour is proposed.

Farnham.—The Council have decided to obtain electric lighting powers.

Future of Municipal Electricity Supply.—On the invitation of the chairman of the Electric Lighting committee (Councillor Elvy Robb), Sir William Preece paid a visit last week to the Tunbridge Wells electricity works. The members of the Council were afterwards invited to meet him at luncheon, when Sir William delivered an interesting address on electricity supply. He said he remembered when he first came to Tunbridge Wells that the Council wanted a very small scheme, and what had been the result? The growth was so rapid that more than one enlargement was necessary, and in the short space of five years they had 30,000 lamps where only 1,500 were originally contemplated, and in another year the gross profit alone would repay the original outlay. That was progress which the town could be heartily congratulated upon. The electric light had come to be regarded, not as a luxury, but a necessity to health and comfort. And it did not really interfere with their gas friends, who found new openings for the use of gas. He really considered himself a gas man, because he had not a halfpenny invested in electric light, but was receiving a handsome return from the money he had invested in gas. The local electricity undertaking was one of the most remarkable examples of the growth of the electric light, and also of the excellent management of the works. If they looked at the tabulated statements which the technical journals published, they would find that Tunbridge Wells, although not a large town, occupied a position very near the top in the return the ratepayers were making on their capital. This was a thing on which Mr Robb and his committee hould be heartily congratulated. The fact that Tunbridge Wells occupied such an unique position was really due to the irrepressible energy and the admirable commercial spirit of their engineer (Mr. Horace Boot), who he was pleased to have had a little to do in recommending. Local authorities used to be content with making roads, but now they recognised that tramways were merely advanced forms of roads, and facilities for transit were appreciated everywhere. Electric tramways, the best means of transit, were being laid down in every direction. The problem of the housing of the working classes was being solved by carrying the population out of the crowded centres to the open country. All classes used tramways, and apart from that there was the indirect benefit that they made the electrical undertaking profit during the part of the day when their station was being run at a loss. At present all the profits of electricity supply had to be made in three or four hours, and the rest of the 24 hours was all loss; but a tramway, besides being a public convenience, reduced the number of hours of unprofitable working for the station. He urged that the local authority, and not a private company, should construct tramways, especially where they had been wise enough to own the electrical undertaking, because they effected the double object of providing rapid and easy locomotion and reduced the cost of producing electrical energy at the works. Street lighting was a second means of reducing the cost of electric current, and a third means was the provision of a refuse destructor. This was also desirable from the sanitary point of view, as they completely destroyed a danger to health, while providing fuel for the electric light works. The dust destructor had been brought to great perfection, and they could benefit by the experience of other towns. He was glad to hear that these questions were to have their serious consideration. He concluded by proposing continued success to the electrical undertaking. Mr. Ashby Wood and the borough electrical engineer (Mr. H. L. P. Boot) responded.

Glasgow.—The Tramways committee, on Wednesday, discussed with Mr. John Young, the general manager, the particulars of an accident which occurred on Saturday night. Two men were walking up Castle-street, when an overhead telephone wire broke and fell over the trolley tramway wire, causing current to pass along the telephone wire, which twisted round and encircled the two men. Both fell to the ground, and the strain on this telephone wire caused it to break, cutting the connection. Another man who saw the men fall ran forward to assist them, and, laying hold of the wire, received a slight shock. The three men were examined by Dr. Young, who found one suffering from shock due to electric current, and the other two from a slight stiffness of the arms. Mr. Young said due inquiries were made, but the tramway officials had been unable to discover any person who had been injured. 500 volts, at which current is distributed in Glasgow, would not injure any person. The only experience the department had had of any person other than one of their own employés receiving a shock was on an occasion when a telephone wire fell over the tramway wires, as in the case they were then discussing.

Guisbrough.—Negotiations are proceeding between the District Council and the Northern Electric Supply Co as to obtaining electric lighting powers.

Hampstead (London).—The accounts of the electricity undertaking for the Michaelmas quarter have been submitted. The total receipts amounted to £5,737. 14s. 1d., against £3,638. 4s. 1d. for the corresponding period last year, an increase of 58 per cent. The net profit last year was 6·65 per cent.

Hull.—The Corporation are seeking powers to construct three additional electric tramway lines.

Ingleton.—The Board of Trade having granted a licence for the electric lighting of this district, a contract has been placed with Messrs. Drake and Gorham. The turbines will be supplied by Messrs. Gilbert Gilkes and Co., of Kendal, the mains by the Callender Co., and the central station battery by the D.P. Battery Co.

Jamaica.—The report on the proposal to convert the Jamaica railway into an electric line was recently presented by the consulting engineers of the Jamaican Government (Messrs. W. Knight and M. A. Starret, of New York). The engineers consider that power obtained from the White river would be capable of generating sufficient electrical energy to work the railway from Kingston to Port Antonio, and that from the Black river for working the line from Spanish Town to Montego Bay. At each of the two stations three 750-H.P. units of plant would have to be installed, one unit being for reserve. The scheme provides for the generation of current at these stations at about 2,000 volts, using step-up transformation to probably 25,000 volts, the current at this higher voltage to be transmitted over bare wires carried on the poles which support the trolley wires to suitable transformer stations along the line, the voltage being reduced by step-down transformers to about 1,000 volts, this current being distributed along the line for use in the motors. The report says the transformers would require little attention, only an inspection once every two or three days being necessary. The rails would require to be thoroughly bonded, as they would serve as the third conductor in the three-phase system projected. Taking present traffic into consideration, and the increased number of trains necessary because of smaller train units, the road would require an equipment of 25 passenger cars and 25 freight cars, each equipped with two 75-H.P. motors. The cars should be eight wheeled cars, seating about 60 people each. In the calculations a speed of 30 miles per hour is assumed for passenger trains on grades up to 1 in 40, and 16 miles on grades of 1 in 40 or over. For goods trains a speed of 15 miles per hour on grades up to 1 in 40 and 12 miles on grades of 1 in 40 or over. On these assumptions the following estimates of cost of generating plant and rolling stock are based:—

25 passenger cars with motors	£25,773
25 freight cars with motors	18,040
190 miles overhead line	97,938
190 miles feeder construction	48,969
3,000 kw. in generators	15,464
6,000 kw. in transformers	11,136
4,000 h.p. hydraulic development	55,257

Total, £272,577. The saving in cost of fuel (due to the utilisation of water power) is put at £10,543 per annum, the saving in cost of maintenance of rolling stock at £2,341, and in the maintenance of permanent way £6,270; a total saving of £19,154 per annum by the change to electric power. The substitution of electricity for steam power on the Jamaica railways is stated to be perfectly feasible from an engineering standpoint.

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Kingston-on-Thames.—At a specially convened meeting of the Council last week, a formal resolution, empowering application for powers to construct and equip electric tramways was adopted.

Lambeth.—The County of London and Brush Provincial Co. has notified the Vestry of its intention to apply for a provisional order for the parish.

Lancaster.—Though the negotiations between the Corporation and the Tramways Co. for the purchase of the undertaking of the latter are not proceeding very smoothly, the Council propose to introduce a Bill next session for powers to construct, electrically equip and work an extensive system of tramways in the town. Ten routes are to be scheduled, and the estimated cost is put at £70,000.

Light Railways.—The Witney, Burford, and Andoversford Light Railway Syndicate (Limited) are applying for an order for the construction of a light railway from Witney to Andoversford.

The Light Railway Commissioners have submitted to the Board of Trade for confirmation the North Lindsey light railways and the North Lincolnshire light railway orders.

A further conference of local authorities interested in the North Surrey Light Railway scheme was held on Wednesday at Kingston-on-Thames. The Highways committee of the County Council recommended that it should be a county project, the expense of construction should be charged upon the county rate, but "reasonable compensation" should be given to the local authorities for the use of the roads. An amendment to postpone the matter until February, and in the meantime to obtain further expert advice, was carried.

The Sandgate and Hythe Electric Co. propose to apply for powers to construct an electric tramway from New Romney, through Dymchurch and Hythe, to Cheriton and Folkestone.

A scheme is being matured for the construction of a light railway from Hastings to Winchelsea, Rye, New Romney, Hythe, Sandgate, Folkestone, and Dover.

Liverpool.—An inquiry will be held this afternoon into the application of the Corporation to borrow £300,000 for electric lighting purposes.

London County Council.—At Tuesday's meeting the adjourned report of the Highways committee on the proposed Tramways Bill was discussed. Mr. Westacott said that the recommendation contained in the report was carried in committee when only three members were present—no notice having been given that such an important matter was to be considered. The committee had not yet asked the opinion of the local authority on the scheme, and if they objected they could not even introduce a Bill into Parliament. Mr. Benn explained that the matter had come before the committee as one of urgency, and that was the reason why only three members were present when it was discussed. If they did not go to Parliament next session for power to construct the tramways, the Council would be seriously hampered in the future. Fifty-six voted for the suspension of the standing orders and 28 against, and this not being a sufficient majority, the recommendation was lost.

The report of the committee dealing with the application of the London United Tramways Co. for power to equip certain portions of its lines electrically was further adjourned.

The consideration of a recommendation of the committee that the committee in their next Tramway Bill seek powers for the reconstruction for electric traction of that portion of the Council's tramways between (*a*) Westminster Bridge-road and Tooting, and (*b*) between Blackfriars Bridge and the tramway's junction near the Horns, Kennington, was adjourned.

Lyndhurst.—The Council were recently approached for consent to an electric lighting project by a company, but require further particulars.

Lynn.—The question of extensions to the electricity plant is already under consideration by the Council.

Manchester.—A Board of Trade inquiry was held here on Friday by Sir F. Marindin and Mr. A. P. Trotter into the application of the Corporation to borrow £860,000 for tramway purposes. The application, which was unopposed, was supported by the town clerk (Mr. W. H. Talbot). The chairman of the Tramways committee (Mr. D. Boyle) stated that the Corporation proposed to work all the tramway lines within the city, as well as those in the districts of Middleton, Failsworth, Droylsden, Higher Openshaw, Gorton, Denton, Levenshulme, Heaton Norris, and Stockport. Their Parliamentary powers also authorised them to enter into agreements with other local authorities, and the committee were in negotiation with the Councils of Stretford, Moss Side, and Withington. The scheme included the whole of the district now worked by the Manchester Carriage and Tramways Co., with the exception of Salford, Ashton, and Stalybridge. It comprised the reconstruction of the whole of the present track within the city, the electrical equipment of the whole of the track in the city and outside districts that the Corporation had already come to an agreement with, the provision of 600 cars considered necessary to operate the system, the estimated cost of constructing one car shed to accommodate 252 cars, and also the preliminary expenses chargeable to capital. After careful consideration the committee acting under the advice of their engineer, had come to the conclusion that £860,000 was the proper amount to be applied for to meet their present requirements. The sum would not cover the full capital outlay to be incurred in the tramway system, and at a future date it would be necessary to apply for further borrowing powers to cover the cost of providing additional car sheds and workshops, and also to defray the amount payable to the Manchester Carriage and Tramways Co., including the purchase of eleven miles of tramway within the city now opened by that company. Mr. W. H. Wainwright, deputy chairman of the committee, and the secretary of the Tramways Department (Mr. J. M. M'Elroy), also gave evidence. Mr. M'Elroy submitted plans, and said that it had been decided to adopt three types of car: (1) a double-decked car, to accommodate 43 passengers (18 inside and 25 out), to be used in constant services of two, three, four, five, or ten minutes throughout the day; (2) a double-deck car, to accommodate 67 passengers (28 inside and 39 outside), to be used for the inter-urban traffic between Manchester and neighbouring boroughs where there was a half-hour service, and also for the busy hours on other routes; and (3) a single-deck car, to accommodate 20 passengers, intended for running across the central parts of the city, and along those routes where the bridges were too low to admit of the double-deck cars. Replying to Mr. Trotter, he said the committee had no desire to use trailers, although they might have to do so under certain circumstances. Their preliminary expenses were £10,000, and this compared favourably with the £40,000 spent by the Glasgow Corporation. It was estimated that the amount required for electric tramcars to operate the city lines and the lines in districts outside the city to be leased to the Corporation was £360,000, equal to 600 cars at £600 each. The city electrical engineer (Mr. C. H. Wordingham) said that the overhead trolley system was that which, in his opinion, was best suited to the exigencies of Manchester traffic, with a single trolley wire and using the rails as a return. He regarded it as impracticable to construct an underground system without great inconvenience to the traffic of the city. In addition, the cost made it prohibitive. He regarded the span-wire construction, with the centre-running trolley, as the best mechanically, while what was called the Aigburth system, with side-running trolley, was the best in appearance. The committee had approved both systems. They might use in some streets one system and in other streets the second, but their choice would be determined partly by the width of the street and partly by the importance of a good appearance. The poles would be of the same strength in all cases, so that in case of need there would be no trouble in passing at slight expense from one system to the other. Various conditions with which they would have to contend would involve expense, so that a considerable margin must be left for contingencies. He assumed that the Aigburth system of construction would be used throughout, and therefore the cost of equipment of double track would be exactly double that of a single track, or approximately £1,300 a mile. That meant for an overhead equipment of 68 miles in the city an estimate of £88,400, with £22,100 for the outside districts. To this he added £16,575 for contingencies. For bonding the rails and further contingencies he put down £22,925, a total of £150,000. In regard to the stations and sub-stations, it was the proposal of the committee that no point of the track should be more than half-a-mile away from the source of supply. The permanent-way engineer (Mr. J. E. Scown) submitted estimates for reconstruction. The consulting engineer (Mr. J. Kincaid) also gave expert evidence as to the reconstruction of the lines, and Mr. John Gibbons submitted plans for the car shed. The town clerk requested that the repayment of the loan might extend over 30 years.

Morecambe.—The Electric Lighting committee recommend the Council to increase the salary of the electrical engineer (Mr. C. F. Parkinson) from £175 to £200 per annum.

Nelson.—An inquiry was held on Friday into the application of the Town Council to borrow £12,000 for electric lighting purposes. There was no opposition, and it was stated that the loan was required for making additions to the generating plant and extending the mains necessary owing to increased demand for current for private lighting.

Newcastle-on-Tyne.—The Tramways committee have received 53 applications for the position of resident electric tramway engineer, at a salary of £500 per annum.

Newington (London).—The following recommendation of the Electric Lighting committee was agreed to by the Vestry last week:—"That inasmuch as Messrs. Johnson and Phillips are installing approved resistance coils in the switch pillars, and, in addition, are providing in each arc column a substitution resistance, the contractors be allowed (without prejudice) until 20th inst. to render the running of the lamps entirely satisfactory."

Oldham.—The Electric Lighting committee propose to borrow £13,000 for extensions to electricity supply.

Perth.—On the recommendation of the electric lighting committee the Police Commissioners have decided to erect arc lamps, instead of the incandescents originally proposed, in a number of the streets.

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Provisional Order Notices.—The Kendal Corporation, the Cleethorpes and Thrunscoe, Elland, Exmouth, Gosport and Alverstoke and Sowerby Bridge District Councils, and the Witney Electric Supply Co. give notice of intention to apply for provisional orders for Kendal and Witney respectively.

Richmond (Surrey).—The Electric Lighting sub-committee has been authorised to enter into negotiation with the Richmond (Surrey) Electric Light and Power Co. for the acquisition of their undertaking, and, if necessary, to employ an expert to advise them.

Richmond (Yorks.).—The Urban Sanitary Authority have under consideration a proposal of the Cleveland and Saltburn Electric Light Co. for erecting electricity works for public and private lighting.

Rotherham.—At the last Council meeting tenders were received for the supply of electric lighting plant, particulars of which are given in another column, and the town clerk was instructed to apply for the necessary borrowing powers.

St. Pancras (London).—The Board of Trade has replied to the Vestry's application for a license under Section 3 of the Electric Lighting Act, 1882, to authorise the laying of mains in Brecknock-road and York-road, Islington. The Board of Trade are advised that that was not a purpose for which they were empowered to issue licenses under the section, which provides for licenses being granted authorising "the supply of electricity," and the application of the Vestry could not therefore be entertained. It will be remembered that in Nov. last the Board of Trade suggested that the matter was one for friendly negotiations between the vestries of St. Pancras and Islington, and it was now decided to approach the Islington Vestry with a request for their assent to the St. Pancras authorities laying mains in the two thoroughfares. This recommendation was adopted. Mr. Malcolm asked whether the Electricity and Public Lighting committee would consider the question of supplying electric current to artizans' dwellings at 8d. per week, as is being done by the Shoreditch Vestry? Dr. Smith, chairman of the committee, said the whole question of the charges for electric current was to be considered on an early date.

Salford.—In the Bill which is being promoted by the Corporation powers are being sought to enter into agreements with adjoining Councils for the supply of electric current, to supply and deal in electric motors and apparatus, and to establish a fire insurance fund.

Seaford.—The Council will support the application of the Newhaven and Seaford Electric Lighting Syndicate for a provisional order.

Southport.—A public meeting on Tuesday formally approved the proposed Corporation Bill for the construction of additional electric tramways and for powers to supply electricity for public and private lighting in Birkdale, &c.

South Shields.—At the Corporation meeting on Monday it was decided to promote a Bill to construct and electrically equip additional tramways in the borough.

Stamford.—Mr. F. J. Warden-Stevens has been retained by the Council as consulting engineer to advise on the proposal to establish electricity supply.

Stirling.—The British Electric Traction Co. have entered into an agreement with the Stirling and Bridge of Allan Tramways Co. for taking over the tramways from Bridge of Allan to St. Ninians.

Stockport.—An extensive tramway scheme is being promoted by the Corporation, who have unanimously decided to obtain Parliamentary powers.

Sydney (N.S.W.).—Electric has now superseded gas lighting at Government House. The installation comprises about 600 lights.

Telephone Municipalisation.—The Swindon and Pendlebury District Council have approved the application of the Mutual Telephone Co., Limited, for a licence to establish a telephone exchange.

The York City Council have decided to apply to the Postmaster-General for licence to establish a telephone exchange.

The Brighton Corporation have appointed a special committee to consider the advisability of establishing a municipal telephone exchange.

Telephone Trunk Extension.—Wallsend has been added to the towns connected up with the telephone trunk line system of the country.

Tiverton.—The period of the electric lighting order has been extended, in order to enable the Council to prepare an electric lighting scheme. Negotiations are being carried on with two companies for the transfer of the order. The order was obtained in 1890 and the whole question will be discussed at the next Council meeting.

Torquay.—The Electric Lighting committee reported last week that they were prepared to substitute and maintain incandescent electric for the existing gas lamps where the mains were laid, at an annual charge of £2. 10s. per lamp. The whole of the public lighting of the borough is to be placed under the control of the Electric Lighting committee. Mr. Ball said that, as the committee were charging less per lamp than the gas company (£2. 14s.), there could be no objection to the proposal.

Tottenham.—The electric lighting proposals of the Electric Power Distribution Co. have been referred to Messrs. Preece and Cardew for report.

Tramway Provisional Order Notice.—The Prestwich District Council give notice of intention to apply for a provisional order to authorise the construction of tramways and the use of electrical or other mechanical power.

Trowbridge.—The Lighting and Finance committee have been instructed by the Council to report upon the advisability of establishing electricity supply.

Tunbridge Wells.—A proposal was made at the last meeting of the Council that application should be made to the Light Railway Commissioners for authority to construct a system of electric tramways in the borough, but after discussion it was decided to refer the question to the Lighting committee, as they would have the advantage of the service of the borough electrical engineer (Mr. Horace Boot).

Tunstall.—Electric lighting powers for Tunstall and the parishes of Golden Hill and Chell are to be obtained by the Tunstall Council.

Village Lighting.—The village of Clydach, near Swansea, is now lighted electrically, an arrangement having been come to by the Pontardawe Council with Mr. John Player for supplying current. The work of supplying and erecting the generating plant and mains was carried out by Messrs. J. C. Howell and Co., of Llanelly; current is supplied by a Parker dynamo which is driven by a 40-H.P. Marshall steam engine; 54 16-c.p. incandescents are employed for street lighting.

Walsall.—An additional transformer is to be provided at a cost of £558. Powers for the construction of between 13 or 14 miles of tramway and for their electrical equipment, estimated to cost between £100,000 and £120,000, are being sought by the Corporation.

Walthamstow.—The Council have decided to obtain powers for the construction and electrical equipment of six new lines of tramway.

Withington.—Powers are being sought by the Council for the construction of electric tramways in the district.

Workhouse Lighting.—The Bristol Guardians have referred the question of the lighting of the Stapleton workhouse electrically to the House committee.

The Greenwich Guardians propose to light their new workhouse at Grove Park electrically.

Worksop.—The Council have adopted an electric lighting scheme prepared by their consulting engineer, (Mr. A. B. Mountain, of Huddersfield. The capital expenditure involved is put at £15,779.

York.—The City of York Tramways Co. recently offered to dispose of their undertaking for £20,000, but the Council are only willing to purchase in the same manner as if the separate sections were compulsorily purchased in 1900 and 1902 respectively.

The charge for electric current for places of worship has been fixed at 3½d. per unit. The extensions to the end of Burton-lane, including the laying of mains for arc lighting, are to be carried out, at an estimated cost of £3,000.

PATENT RECORD.

The following list of Applications for Patents and Specifications published has been compiled for this journal by Messrs. J. C. Chapman and Co., *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs, and Trade Marks may be obtained.*

APPLICATIONS FOR PATENTS.

Note.—*The undermentioned Applications are not open to public inspection until after the acceptance of the complete Specification. The names within parentheses are those of communicators of inventions. When complete specification accompanies application, an asterisk is affixed.*

October 9, 1899.

20,207. C. Adams-Randall. London. Improvements in electric telegraphs.

20,214. A. A. Vogelsang. London. Improvements in or connected with electrolytic bleaching of baled yarns.

20,227. A. M. Taylor. Improvements in electric tramways and in motor-cars therefor.

20,237. L. Bourdillon. Liverpool. Improved manufacture of articles plated with platinum, gold, and silver by electrolysis, and apparatus therefor.*

20,249. A. B. MacGregor. London. Improvements in apparatus for detecting and measuring or comparing the strength of electrically produced etheric waves, impulses, or vibrations commonly known as Hertzian waves.

20,261. E. S. Ellis. London. The improved electric incandescent lamp.

October 10, 1899.

20,277. A. Eckstein and H. J. Coates. Salford. An improved electrical selector switch.

20,290. I. Timar. Liverpool. Appliance for imparting electricity and heat to the body.*

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20,298. M. WADDELL. Manchester. Improvements in and connected with electrical indicating, measuring, and recording instruments.*
20,307. F. L. F. BOUDRY. Sheffield. Improvements in guides for trolley or collector pulleys on the overhead system of electrical tramways.
20,313. S. PERCY. London. An improved attachment to be applied to the new Scandinavian table telephones.
20,316. W. SYKES. London. Troughs for electric cables.
20,321. W. G. PYE. London. Improvements in the construction and arrangement of electrical resistance coils.
20,328. J. K. ROBISON. London. Improvements in or relating to dynamo-electric generators or transformers.*
20,336. W. L. VOELKER. London. Improvements in the manufacture of incandescing electric lamps.

October 11, 1899.

20,360. J. MARSHALL. Stourbridge. Improvements in chimneys for incandescent or other gas, oils, electric, or other lights.
20,383. C. A. SWAN. London. An improvement in incandescent electric lamp socket junction bodies.
20,389. L. CERBOTANI and C. MORADELLI. London. Improvements in transmitters for Morse alphabet and printing telegraphy.*
20,390. L. CERBOTANI. London. Improvements in apparatus for automatically connecting any two of a number of electric circuits branching from a central station.*
20,403. L. COEN and C. COHEN. London. An improved electric lamp.
20,412. R. LUNDELL. London. Improvements in electric railways working on the surface contact system.*

October 12, 1899.

20,438. J. BARKER. Manchester. Improvements in means for holding shades or globes for electric and other lights.
20,471. A. J. BOULT. London. Improvements in or relating to electric batteries. (P. Delafon, France.)*
20,480. C. CURWEN. London. Improvements in electric arc lamps.
20,486. A. JARAY. London. Improvements in electrical distribution switch and fuse boards.*
20,493. G. (*dit* ALFRED) BERRY. London. Improved electrical signalling system for railroads.
20,504. C. A. SAHLSTROM. London. Improvements in batteries or apparatus for producing ozone.
20,507. H. VON ARNSWALDT. London. Electric igniter for gas.*

October 13, 1899.

20,534. T. S. MCLAREN. Glasgow. High-voltage electric lighting ceiling rose.
20,544. R. BOWMAN. Cramlington, R.S.O. A waterproof compound action electric bell.
20,549. A. L. ADAMS. London. A portable electric incandescent coloured lamp or dark lantern for photographic purposes.
20,587. H. S. MAXIM. London. Improvements in and relating to electric railways working on the conduit system.

October 14, 1899.

20,605. J. K. STANLEY. Kidderminster. An apparatus for preventing sparking and making better contact with the conducting cable and trolley arm in electrically-propelled vehicles.
20,615. J. BUSH. London. An improved electric safety apparatus for lifts and elevators.
20,655. THE ALBION CLAY CO. (LIMITED) and R. LAWTON. London. Apparatus for use in forming joint ends on electric conduits, drain pipes, and the like.

October 16, 1899.

20,666. R. DOBSON. Salford. Improvements in regulating and starting switches for electric motors.
20,668. R. C. SAYER. Bristol. Improvements in obtaining heat and vaporising fluids by electricity.*
20,678. R. J. HOUGHTON. Hough Green. A short-circuit switch for electrical machines.
20,689. F. W. SMITH. London. A new or improved method of automatically extinguishing electric and gas lights at any required time, and apparatus for effecting same.
20,705. G. D. GRANGER. London. Improvements in and connected with electrically energised pendulum clocks.
20,720. V. I. FEENY. London. Improvements connected with electric lamps having illuminating bodies composed of second-class conductors. (Allgemeine Elektricitäts Gesellschaft, Germany.)*

October 17, 1899.

20,743. J. TOURTEL. London. Improvements in electricity meters. (Paul Rissler and H. Bauer, Germany.)*
20,751. E. ANDREAS. Manchester. An improved device for steering electrically driven motor-cars.
20,763. S. BIHELLER. London. Improvements in lanterns or globes, chiefly for incandescent gas lights, arc electric lights, and the like.*
20,767. B. J. B. MILLS. London. Improvements in phonographs. (T. A. Edison, United States.)*
20,790. A. C F. WEBB. Liverpool. An improvement in safety fuses for electric circuits.
20,793. J. RICHARDSON and F. S. HIGHTON. London. Improved means and apparatus for regulating the speed of gas and like engines driving dynamo electric machines.
20,803. THE BRITISH THOMSON-HOUSTON CO. (LIMITED). London. Improvements in electric meters. (E. Thomson, United States.)*
20,804. THE BRITISH THOMSON-HOUSTON CO. (LIMITED) and H. M. HOBART. London. Improvements in systems of electric conversion, comprising static and rotary transformers.

SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1898.

18,613. KINGSBURY (Western Electric Co.). Telephonic systems and apparatus.
20,208. PEGELOW. Electric signalling apparatus for railways.
22,115. BARESCH, BARESCH, TOSLER and VON LABERN. Galvanic batteries.
23,411. HARTVIGSON. Manufacture of electrical cables for submarine telegraph purposes.
23,750. BROWN. Electro-dynamic relays for use on telephone and telegraph lines.
24,379. MUIRHEAD. Telephonic apparatus.
24,418. LANGDON-DAVIES. Alternating-current motors.
25,038. THOMPSON. Electric surface-contact tramways.

1899.

5,139. HOLLAND and LAURIE. Electrolytic decomposing apparatus.
7,321. W. A. GENT and S. JEVONS. Secondary battery plates, grids, and the like.
8,913. HALL. Cut-outs, fuse boxes, and analogous electrical fittings and connections for such fittings and other electrical purposes.
9,631. GENERAL ELECTROLYTIC PARENT CO. (LIMITED). (Hargreaves and Stubbs.) Electrical conductors and anodes for electrolytic and similar purposes.
9,791. DUCRETET. Apparatus for receiving "Hertz" electric insulations or waves.
12,113. SPERRY AND JAMES. Machine for covering electric wires or cables with strips of fibre.
15,369. MATHIESON. Arc lamps having two arcs in series.
15,438. FRENOT. Electrolytic process and apparatus for the production of chemically pure cupric sulphate and copper.
15,486. TIEFENTHAL, MEYER AND NEBLING. Method of and apparatus for stamping electrode plates.
16,247. SMITH. Material adapted for electrical insulation, and also for many purposes for which ebonite, wood, and such like materials are used.
16,308. SCHUCHHARDT. Operating device for electric bells and house telegraph signals.
16,373. BURNS. Vibrating switches or contact breakers for induction coils, bells, and the like.
16,553. LAKE (Dickinson). Phonographs, graphophones, and like machines.
16,878. SIEMENS BROS. AND CO. (LIMITED) (Siemens and Halske Aktien Gesellschaft.) Telephonic apparatus for transmitting and receiving messages simultaneously to and from several distant stations.
17,203. EARLE. Pole-pieces for dynamos.
17,256. JONES. Electric log recorder.
17,474. BERNDT. Electric massage apparatus.

COMPANIES' MEETINGS AND REPORTS.

West India and Panama Telegraph Co. (Limited).

The forty-fifth ordinary general meeting was held on Wednesday, under the presidency of Mr. WILLIAM ANDREWS.

The MANAGER and SECRETARY (Mr. R. T. Brown) read the notice calling the meeting, and the report of the Directors was taken as read.

The CHAIRMAN then said: Gentlemen, there is very little to put before you to-day, and I only wish that it were of a more cheerful character. We usually take the receipts first, and there is, as we led you to expect that there would be at the last meeting, a considerable falling off in the receipts, which compare with the period of the Spanish-American war. At our last meeting I drew your attention to the then state of affairs, and to the then revenue, and I said: "Unfortunately, the whole of this large increase was earned owing to the Spanish-American war, and it is impossible to forecast what the future traffic will be now that that war is happily passed." I went on to say: "It is, however, discouraging, notwithstanding the large reductions made in the tariffs more than twelve months ago, that there should not only be no increase in the number of words exchanged with the British islands, but an actual decrease. I can understand a decrease in money, but a decrease in the number of words exchanged in face of the large reductions made in the tariff is another thing." Well, of course, that points to stagnant commercial relations. I also said at our last meeting: "Our revenue has been improved owing to interruptions of other lines, but the entire position is so fluctuating and so obscure that no reliable calculation can be made." Well, gentlemen, you will have seen by our report that, unfortunately, events have not belied these anticipations. We have not alone got down to the commercial foundation, but that foundation has itself sunk down a little. Reminding you that we can expect no progress until the commercial state of the West Indies improves, I will come to the actual figures. I need not, of course, again remind you that we are comparing with a war period. The total receipts of the past half-year to June 30th last amounted to £30,928, against £39,612 for the corresponding period of 1898, showing a decrease, therefore, of £8,683. In this there is included a sum of £500 owing to the Jamaica subsidy not having quite ceased in the half-year we are comparing with, and which therefore still appeared to show a further reduction, and certain rebates allowed to this Company were also lower in the half-year. Turning to the expenses, there is a small decrease of £212, notwithstanding the sum which you were good enough to vote to the Directors, which came to be paid in the half-year under review. The expenses of ships and cables were rather less. A pretty extensive renewal in the St. Lucia-St. Vincent section was charged to reserve. The result of all this is that we are able

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to recommend the usual dividends on the first and second Preference shares, and 6d. per share on the Ordinary shares, carrying forward £379. We all wish, as you do, that this result were more favourable, but under the difficult and discouraging circumstances we have had to contend with it has been the utmost that we could accomplish. It became necessary, for important reasons in connection with the altered relation of things in the West Indies, to reduce the international tariff to and from Porto Rico on February 15th last. Fortunately, this reduction has resulted in an increase—a turn of the tide—in the number of words sent last half-year; but this has been mainly confined to Porto Rico, which the reduction affected, and which is now, as you are aware, working under American rule. Although the earnings have not yet made good the loss of revenue by the reduction in the tariff, there is an increase in the number of words exchanged with that island, and this we deem decidedly an encouraging feature. Not only that, but according to our last returns there is taking place, what was not taking place some time back, an increase in the number of words exchanged. The revenue, however, is still lower than it was, on account of the reduction of the tariff; but the increase in the number of words does point to an improvement in the business, which is, after all, what we have to depend on. I am sorry to say that the ill-fortune of the West Indies, which seems to have been so persistent, has pursued them in the period under review, because the islands were again visited by a disastrous hurricane, which mainly affected Montserrat and the Leeward Islands, the Danish island of St. Croix, and also Porto Rico. The Company subscribed in all £120 for the relief of the consequent distress—a proceeding which we hope the shareholders will approve, because, as you will readily apprehend, it is right and politic, even quite apart from our own personal feelings, that we should show our sympathy with the West Indies in their distress, although, unfortunately, that sympathy has to be of such a very restricted character in its manifestation, owing to our poverty and therefore to our inability to do as much as we should wish. You are all aware that Sir Cuthbert Quilter and Sir Nevile Lubbock visited the West Indies and made certain recommendations to the Governments. The West India Committee, too, have also shown themselves to be alive to the West Indian crisis; and the Colonial Bank has drawn attention to the fact that recent reciprocity arrangements between certain islands and the United States, with the object of benefiting the trade of the colonies concerned, should tend to very considerable improvement. Of course, this is really the crux of the position. We cannot expect our revenues to improve until the trade and commerce of the islands shall, as we hope they may, become more active. It is from that field that we gain our revenue, and unless the field is active we shall not make money. I am afraid that we must make up our minds to that. The Cuba Co.'s action against this Company has not yet come on for hearing, and it is not likely to do so for a considerable period. I wish I had had a more cheerful story to tell you, but what we feel is that we must endeavour not to lose ground if we can help it, but to keep "pegging away" and doing the best we can for you under the circumstances. The circumstances are not what I could wish them to be, but they may improve. If the reciprocity arrangements between the islands and America, and American management—commercial and otherwise—in Porto Rico begin to tell, there will be some hope for us; and there is certainly more life in the foreign islands—by "foreign islands" I mean as distinct from the British islands in the West Indies. I do not know whether we may, if necessary, get a little assistance elsewhere, but that is a card which we have not yet played, because the opportunity has not arisen, though we hope it may. I now move the adoption of the report and accounts, with the payment of the dividends set out therein.

Mr. HENRY HOLMES seconded the motion.

A discussion ensued, in which the speakers were Mr. Blackley, Mr. S. P. Moore, Mr. John Newton, and Mr. Rylands. The Chairman having replied, the resolution was passed, and a vote of thanks to the Chairman and Directors terminated the proceedings.

Brazilian Submarine Telegraph Co. (Limited).

An extraordinary general meeting of this Company was held on the 10th inst., under the presidency of Mr. W. S. ANDREWS, to confirm the resolutions passed at the extraordinary general meeting held on 25th ult., as set out in *The Electrician* of Oct. 27. A proposal to this effect was made by the CHAIRMAN and seconded by Mr. J. DENISON-PENDER.

Mr. THOMAS BETTS inquired how the Directors would be able in future to continue paying a dividend of 7 per cent., seeing that to pay it on the extra 120,000 shares an additional £84,000 net would be required.

The CHAIRMAN replied that against the new shares which had been created the Company had absorbed some thousands of miles of telegraphs, and in addition had taken from the other company the whole of their receipts. The effect of this was shown by the fact that the Directors had already paid the dividend upon the increased capital, although the half-year had been rather unfavourable. He therefore did not think that Mr. Betts need entertain the slightest fear. The creation of shares meant nothing, as they remained in the company's hands; and if the directors eventually issued some more of the shares that had been created, it would only be in connection with the creation and development of works which would be undertaken for the purpose of increasing the Company's revenue. He thought he might say that in the matter before the meeting the Directors had acted with that prudence which he thought had hitherto distinguished the board in managing the Company's affairs. If Mr. Betts would call at the offices, any of the officials would readily explain any figures that might puzzle him.

In reply to a question from Mr. Woodd, the Chairman said there was no question of issuing any shares at the present time.

The resolutions were carried unanimously.

A vote of thanks to the Chairman and Directors terminated the proceedings.

Western and Brazilian Telegraph Co. (Limited).

At an extraordinary general meeting of this Company on the 10th inst., Mr. W. S. ANDREWS in the chair, resolutions confirming as special resolutions the resolutions adopted at the extraordinary meeting on the 24th ult. (and set out in *The Electrician* for Oct. 27) were duly approved, on the motion of the CHAIRMAN, seconded by Mr. D. H. GOODSALL.

ALLGEMEINE ELEKTRICITATS GESELLSCHAFT.—The report of the directors for the year ended June 30 has just been issued, and will be presented at the meeting on 30th inst. The various departments have been very busy, resulting in a largely increased volume of business. In addition to putting aside the usual sum for reserve, depreciation, &c., a dividend of 15 per cent. on a capital of 47,000,000 marks is recommended to be paid, against a similar dividend on 30,000,000 marks last year. In May last it was decided to increase the capital to 60,000,000 marks, to provide for extensions of the business and to take over the electro-chemical works of Bitterfeld and Rheinfelden. The demand for poly-phase plant shows a satisfactory expansion. The company's cable department has been extended, and the output has considerably increased. Owing to the increase in the price of copper experiments are being made with aluminium wire and cables, and these give promise of good results. In the incandescent lamp factory 925 hands were engaged, against 725 in the previous year. Works for the manufacture of the Nernst lamp are being erected. The installation, sale, and electric railway departments also show advances on the previous year. At the end of last year there were 65 railways in operation with plant supplied by the company, representing 1,300 kilometres of track and 2,300 motor cars, and the company are busy in carrying out extensions to existing and constructing several new lines. In addition to its numerous undertakings in Germany, the company are also constructing electric tramways in Jassy (Roumania), Santiago (Chili), Barcelona, Seville, Genoa, Lodz, &c. The electric lighting department has also been kept busy, and at present contracts are in hand for plant equivalent to about 80,000 H.P. During the year the power transmission works at Rheinfelden were put in operation, and extensions have already become necessary. Amongst the contracts outside Germany which the company have in hand are those at Baku (Russia), Neuberg-a-Donau, Imatra (Finland), and Matrei (Tyrol). Carbide works have been erected at Sarpsborg (Norway). Financial particulars of the various subsidiary companies are given in the report. The company now own 57 German and 150 foreign patents, while application has been made for 154 more. There was a net profit on the year of 9,939,251·53 marks.

COMMERCIAL CABLE CO.—A special meeting of the shareholders of this company will be held in New York, on Dec. 4, for the purpose of authorising an increase in the common stock from $10,000,000 to $15,000,000, in order to provide for new cables.

NEW COMPANIES, STATUTORY RETURNS, &c.

HARVEY AND WILLIAMS (LIMITED).—This company was registered on Nov. 6, with a capital of £90,000 in £1 shares, to acquire the business of a company of the same name, and to carry on the business of ironfounders, electrical and general engineers, &c. The first directors are R. Harvey, A. F. Williams, F. B. Thackray, S. F. Leney, and B. D. Beever.

LOUGHBOROUGH AND DISTRICT ELECTRIC TRACTION SYNDICATE (LIMITED).—This company was registered on Nov. 9, with a capital of £1,000 in £10 shares, to construct, equip, and work by electricity or other power any tramways and light railways at Loughborough, Leicestershire, and elsewhere. The subscribers are R. P. Sellon (electrical engineer), B. Broadhurst, N. S. Russell (civil engineer), R. A. Dawbarn (engineer), E. H. Tyler (engineer), W. E. Lane, and J. Maclachlan.

MONOBLOC ACCUMULATOR SYNDICATE (LTD.).—This company was registered on Nov. 10, with a capital of £20,000, in £1 shares, to acquire from M. Gustave Leve certain inventions, to construct and maintain accumulators, cables, and electrical apparatus and machinery, and to carry on the business of an electric traction and light company generally. The subscribers are C. Wanklyn, J. M. Gorham (engineer), J. F. Albright (civil engineer), B. M. Drake (engineer), G. Leve, F. Belcher, and A. Eaney. The first directors are C. Wanklyn, B. M. Drake, J. M. Gorham, and J. F. Albright.

THANET CONSTRUCTIONAL CO. (LTD.).—This company was registered on Nov. 3, with a capital of £300,000, in £10 shares to adopt an agreement with the Isle of Thanet Electric Tramways and Lighting Co. (Ltd.) and with Mr. W. M. Murphy, and to carry on in the Isle of Thanet, Kent, the business of tramway and light or other railway proprietors, suppliers of electric light and power, electricians, engineers, motor manufacturers, &c. The subscribers are W. M. Murphy (11,997 shares), H. R. Pecton (6,000 shares), British Thomson-Houston Co. (Ltd.) (4,000 shares), V. A. Waldron (6,000 shares), E. A. Lazarus (2,000 shares), and J. J. O'Conner, J. F. Murphy, and W. H. Briggs (with one share each).

TRAMWAY TRACTION CO. OF SOUTH AMERICA (LTD.).—This company was registered on Nov. 4, with a capital of £60,007, in 240 £250 shares and seven £1 shares, to adopt an agreement with A. W. Rosz, A. Falcao, and C. Georgi, and to carry on the business of electrical and general engineers, tramway and railway contractors, suppliers of electricity, &c. The subscribers are P. B. Poter, A. C. Downing, P. J. Hellis, W. H. Thompson, E. Punchard, E. Cadett, and F. Durant.

WATTS, RUMFORD AND CO. (LIMITED).—This company was registered on Nov. 8, with a capital of £5,000 in £1 shares, to carry on the business of electrical engineers, ironmongers, smiths, and suppliers of electricity for light, heat, or motive power, &c. The subscribers are J. Morales, jun., J. Robertson, G. W. Rumford (engineer), R. Rumford (electrical engineer), R. W. Graham, E. B. Biglan, and C. Watts (electrical engineer).

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CHLORIDE ELECTRICAL STORAGE SYNDICATE (LIMITED).—The annual return to Sept. 12 has been filed. The nominal capital is £262,500, in 80,000 "A," 30,000 "B," 140,000 "C," and 12,500 "Founders" shares of £1 each. 80,000 "A," 30,000 "B," 100,000 "C," and 12,500 "Founders" shares have been taken up. 15,000 "A," 30,000 "B," 100,000 "C," and 12,500 "Founders" shares are considered as fully paid, and £65,000 has been paid on £65,000 "A."

CITY NOTES.

MEMORANDA.—Bank rate 5 per cent. (since Oct. 5, 1899). Price of silver 27d. per oz. (Nov. 16). Consols (2¾ per cent.) 103⅝—103⅞ for money, 103¾—104 for account; 2½ per cent. 100½–101½ (Nov. 16). Stock Exchange Settling Days: Consols, Dec. 1; Stocks and Shares Continuation Days, Nov. 28 and Dec. 12; Ticket Days, Nov. 29 and Dec. 13; Pay Days, Nov. 30 and Dec. 14; Mining Share Carry-over Days, Nov. 27 and Dec. 11.

ARON ELECTRICITY METER (LTD.)—The transfer books of the Ordinary and Preference shares of this Company will be closed from 20th inst. to Dec. 7th, inclusive, for the preparation of dividend warrants.

CASTNER-KELLNER ALKALI CO. (LTD.).—Subscriptions are invited to an issue of £150,000 Four and a Half per cent. first mortgage Debenture stock of this company, issued at £102 per cent., secured by a first mortgage on the whole of the freehold land, works, and buildings of the company, and as a first floating charge on all property and assets present and future. The company has the right to issue a further £50,000 to rank with this issue under certain conditions. This Debenture stock is redeemable at £107 per cent. at six months' notice after 1st Jan., 1915. Interest is payable half-yearly in February and August. The funds provided by this issue are required to pay off debenture loans raised at a higher rate of interest, and for meeting other liabilities incurred on the completion of the works at Runcorn, Cheshire. The power plant here installed is capable of developing 7,000 I.H.P. The amount expended within the last three years upon buildings and plant has exceeded £290,000, and other assets included in the last issued balance-sheet stand at £162,000. The profit for the year ended March 31, 1899, before the works were completed or the whole plant working, was £24,554, and for the six months to Sept. 30, 1899, the profits are certified at £16,525, after allowing £5,000 for depreciation for the half-year.

EASTERN AND SOUTH AFRICAN TELEGRAPH CO. (LTD.)—The list will be found set out on another page of the drawing of 458 5 per cent. mortgage debentures in this company, for payment at par on January 1st next by Messrs. Barclay and Co. This completes the drawings for these debentures.

RICHARD HORNSBY AND SONS (LTD.).—A dividend of 8s. on the Ordinary shares for the year ended Sept. 30 (5 per cent. on the amount called up) has been declared. £25,000 has been placed to reserve, and £7,000 carried forward.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee have ordered £150,000 Five per Cent. Preference stock (1891), £200,000 Five per Cent. Preference stock (1896), and a further issue of £225,000 Consolidated Ordinary stock of the *City and South London Railway Co.* to be quoted in the official list, in lieu of the Preference and Ordinary shares now quoted. The committee has also been asked to allow the further issue of £6,000 Four and a Half per Cent. Cumulative Preference £5 fully-paid shares of *W. T. Henley's Telegraph Works Co. (Limited)* to be quoted in the official list.

TELEGRAPH MANUFACTURING CO. (LTD.).—Notice is given of an interim dividend on the Ordinary shares of this company at the rate of 6 per cent. per annum, free of tax, for the half-year to Sept. 30, payable Dec. 1. The Ordinary share transfer books will be closed from 16th to 30th inst. inclusive.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount	Aggregate. Inc. or Dec.
	1899	£	£		£	£
*Birmingham Tramways.	Nov. 11	4,415	+ 374	19	79,455	+ 8,420
Blackpool Corporation...	„ 9	163	+ 10	32	19,732	+ 4,316
Blackpool and Fleetwood	„ 11	182	– 47	19	19,243	+ 5,878
Bradford Corporation ...	„ 12	357	+ 111	65	21,620	...
Brisbane Trams	Sept. 27	1,467	+ 555	52	67,823	+ 20,223
*Bristol Trams & Carriage	Nov. 10	2,998	+ 390	19	59,204	+ 5,823
*Buenos Ayres & Belgrano	Oct. 15	2,035	+ 687	41	87,948	+ 40,551
City & South London Ry.	Nov. 12	1,082	+ 26	20	19,406	+ 47
Dover Corporation	„ 11	171	+ 10	32	7,144	...
Dublin United	„ 10	2,732	+ 2,380	...	...	...
Dublin Southern Dist...	„ 10	711	– 80	...	...	...
*Glasgow Corporation ...	„ 11	8,855	+ 625	...	...	...
*Liverpool Corporation...	„ 4	7,146	+ 1,184	44	302,893	+ 35,205
Liverpool Overhead Rly.	„ 12	1,684	+ 248	20	72,823	+ 1,143
*Sheffield Tramways	„ 12	1,857	+ 716	45	63,995	+ 18,428
*South Staffs. Trams....	„ 10	740	+ 79	45	30,095	+ 1,548

* Partly electrical.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Nov. 8.		Price Wednesday, Nov. 15.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Nov. 15. Highest	Lowest
			TELEGRAPHS.					£ s. d.			
£110,900	100	4%	*African Direct Telegraph 4% Mort. Deb. (red.)	100	104	100	104	3 16 11	January and July	...	...
25,000	10	...	Amazon Telegraph	3	4	3	4	...	June and December	...	...
£125,000	100	5%	Do. 5 per Cent. Debentures	85	90	85	90	5 11 1		...	...
£875,520	Stock	15/0	Anglo-American	65	68	66	69	5 0 5	Feb., May, Aug., Nov.	68	66½
£3,062,240	Stock	30/0	Do. Preferred	116½	117½	117	118	5 1 11	„ „	118	116½
£3,062,240	Stock	18/0	Do. Deferred	17	17½	17½	18	5 0 0	...	18	17 1/16
205,993	10	5/0	Brazilian Submarine	15	15½	15	15½	4 10 4	Mar., June, Oct., Dec.	15⅝	15⅛
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1900)	107	111	107	111	4 11 6	June and December	...	...
$10,000,000	$100	$1½	Commercial Cable Capital Stock	189	190	190	200	4 0 7	Jan., Apr., July, Oct.	195	...
£1,132,823	Stock	4%	* Do. 4 per Cent. Debenture Stock	103	105	103	105	3 16 6	„ „	104½	...
16,000	10	8/0	Cuba Submarine Ordinary	9	10	9	10	8 0 0	February and August	9¼	9⅛
6,000	10	10,0	Do. Preference 10 per Cent.	19	20	19	20	5 0 0	„ „	...	...
12,931	5	2/0	Direct Spanish Ordinary	4	5	4	5	4 0 0	April and October	...	...
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference	9	10	9	10	5 0 0	„ „	...	...
£30,000	50	4½%	Do. 4½ per Cent. Debentures	103⅞	107⅞	103⅞	107⅞	4 4 1	January and July	...	...
60,710	20	3 0	Direct United States Cable	12	12½	12	12½	5 12 0	Jan., Apr., July, Oct.	12¼	12⅛
£120,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red.)	101	104	101	104	4 7 10	June and December	...	...
£4,000,000	Stock	5%	Eastern Ordinary	157	162	157	162	4 6 8	Jan., Apr., July, Oct	160	159
£1,795,000	Stock	3½%	Do. 3½ per Cent. Preference Stock	99	103	99	102	3 8 8	„ „	99½	...
£1,432,268	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.)	117	122	117	122	3 5 7	May and November	118½	...
250,000	10	2/6	Eastern Extension	15½	16	15½	16	4 7 6	Jan., Apr., July, Oct	15⅝	15½
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	118	123	118	123	3 5 7	February and August	...	...
£16,200	100	5%	* Do. 5% (Austln. Gov. Sub.) Deb., 1900 (reg.)	99	103	99	103	4 17 4	January and July	...	...
£64,400	100	5%	Do. (Bearer)	100	103	100	103	4 17 1	„ „	...	...
£17,400	100	5%	*Eastern and S. African 5% Mort. Deb., 1900 (reg.)	99	103	99	103	4 17 1	„ „	...	...
£21,500	100	5%	Do. (Bearer)	100	103	100	103	4 17 1	„ „	...	...
£300,000	100	4%	* Do. 4 per Cent. Mortgage Debentures, 1909	101	104	101	104	3 16 11	February and August	...	...
£200,000	25	4%	Do. 4 per Cent. Mauritius Sub. Debs. (red.)	101⅞	104⅞	101⅞	104⅞	3 16 10	May and November	...	...
180,227	10	1/9	Globe Telegraph and Trust	11½	11¾	11½	11¾	4 9 4	Jan., Apr., July, Oct.	11½	11½
180,042	10	3 0	Do. 6 per Cent. Preference	15½	16	15½	16	3 15 0	„ „	15 1/16	15 1/16
150,000	10	5/0	Great Northern of Copenhagen	30	31	30	32	3 18 2	January and July	30¼	...
£89,500	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb. (red.)	100	103	100	103	4 7 5	...	...	...
17,000	25	12/6	Indo-European	48	52	48	52	4 16 2	May and November	51	...
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904	106	109	106	109	5 10 1	March and September	...	...
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.)	103	106	103	106	3 15 6	June and December	...	...
11,859	8	4/0	Reuter's	7	8	7	8	5 0 0	April and October	...	...
3,381	£100 Cert.	6%	Submarine Cables Trust	129	134	129	134	4 9 11	„ „	...	...
15,609	10	...	West African Telegraph	2½	3½	2¾	3½	4 9 3	December and July	...	...
£200,000	100	5%	* Do. 5 per Cent. Debentures (red.)	99	102	99	102	4 18 0	March and September	100¼	100
30,008	2½	...	West Coast of America	½	1	½	1	...	...	...	...
£150,000	100	4%	* Do. 4 per Cent. Debentures	102	105	102	105	3 16 8	January and July	...	...
89,821	10	2/6	West India and Panama	1⅜	1½	1⅛	1⅜	...	May and November	1⅛	...
34,563	10	6/0	Do. 6 per Cent. 1st Preference	10½	10¾	10½	10¾	5 11 6	„ „	...	...
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	9	10	9	10	6 0 0	„ „	...	...
£80,000	100	5%	* Do. 5 per Cent. Debentures	103	108	105	109	4 13 11	January and July	...	...
£33,731	Stock	4%	Western & Brazilian 4 per Cent. Debenture Stock	104	107	104	107	3 15 0	June and December	...	...
£158,100	100	6%	*Western Union 6 per Cent. Sterling Bonds (red.)	98	103	98	103	5 16 6	March and September	...	...

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Nov. 8.	Price Wednesday, Nov. 15.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Nov. 15. Highest	Lowest
			TELEPHONES.			£ s. d.			
44,000	£5	3/0	Chili Telephone (fully paid)	2 3	2 3	6 13 4	August	...	...
224,850	10s.	0/1½	Consolidated Telephone Const. & Manufacturing	¼ ¼	¼ ¼	4 15 3	July	...	...
71,000	1	0/6	Monte Video Telephone Ordinary	⅜ ⅜	⅜ ⅜	5 0 0	October	...	...
81,000	1	1 0	Do. 5 per Cent. Preference	¾ 1	¾ 1	5 0 0		...	...
400,000	5	3/0	National	5 5¼	5 5¼	5 14 3	February and August	5¼	5⅛
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Preference	14 15	14 15	4 0 0	" "	...	...
15,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference	14 15	14 15	4 0 0	" "	...	...
250,000	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref.	5¼ 5½	5¼ 5¼	4 10 11	" "	5 7/16	5 5/8
1,329,471	Stock	3½%	* Do. Debenture Stock 3½ per Cent. (red.)	100 102	100 102	3 8 8	June and December	101¼	...
171,504	1	0/4	Oriental	¾ 1	¾ 1	5 0 0	April and October	...	...
58,000	5	6/0	United River Plate	4⅜ 5¼	4⅜ 5¼	5 14 3	July	...	...
18,633	5	...	Do. 5 per Cent. Cumulative Preference	... ...	3½ 3¾	...		...	...
£179,917	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	105 108	105 108	4 13 9	June and Decc mber	...	...
			ELECTRICITY SUPPLY COMPANIES.						
100,000	1	...	Bl'ckh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.)	¾ 1	¾ 1	...		...	...
6,000	10	7/9½	Bournemouth and Poole Electricity Supply Ord.	13 13½	12½ 13½	2 18 10		...	...
6,000	10	4/6	Do. 4½ per Cent. Cumulative Preference	10 11	10 11	4 1 10		...	...
19,661	5	2/6	Brompton & Kensington Electricity Supply Ord.	7½ 8½	7½ 8	3 15 0		8 1/16	...
12,000	5	3/6	Do. 7 per Cent. Preference	9 10	9 10	3 10 0	March and September	...	...
20,000	5	...	Calcutta Elec. Supply Ordinary (£4 paid)	5½ 6	5½ 6	...		...	...
30,000	5	4/0	Charing Cross & Strand Electricity Supply Corp.	9⅛ 10⅛	10 11	4 1 10	February & August	10½	...
20,000	5	...	Do. (Nos. 3,001 to 50,000)	9½ 10½	9½ 10½	...		...	...
20,000	5	2/3	Do. 4½ per Cent. Preference	6 6½	6½ 6½	3 12 0	" "	6 1/16	5 13/16
34,000	5	2/6	Chelsea Electricity Supply Ordinary	8 9	8 9	3 6 8	March	...	...
£100,000	Stock	4½%	* Do. 4½ per Cent. Debenture Stock (red)	111 113	111 113	4 0 9	June and December	113	...
$1,200,000	$1,000	5%	Chicago Edison 1st Mort. 5% 30 year Gold Bonds (red.)	100 110	100 110	4 10 11	April and October	...	...
60,000	10	7/0	City of London Electric Lighting Ordinary	11½ 12½	11½ 12	5 0 0	February and August	11⅞	11⅝
40,000	10	6/	Do. 6 per Cent. Cumulative Preference	13 14	13 14	4 5 9	January and July	13½	...
£400,000	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	125 130	125 130	3 17 5	June and December	...	...
40,000	10	...	County of London and Brush Prov. Ordinary	10 11	10½ 11	...		11	10⅝
20,000	10	6/0	Do. 6 per Cent. Cumulative Preference	13 14	13 14	4 5 9	March and September	...	...
£200,000	Stock	7/8	Do. 4½% Deb. Stock Certs. (all pd.) (red.)	111 114	111 114	...		112½	...
15,000	5	10%	Kensington and Knightsbridge Ordinary	12½ 13½	12½ 13½	4 1 5		...	...
10,000	5	6%	Do. 6 per Cent. 1st Preference	7½ 7¾	7½ 7¾	3 17 5	January and July	...	...
110,000	3	...	London Electric Supply Ordinary	3⅜ 4	3½ 3⅝	...		...	...
48,050	5	3/0	Do. 6 per Cent. Preference	6½ 6¾	6½ 6¾	4 8 11		...	...
£100,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures	104 106	104 103	3 16 4	Mar., June, Sept., Dec.	105½	...
62,500	10	5/0	Metropolitan Elec. Supply Ord. (Nos. 1 to 62,500)	15 16	15 16	3 2 6	April and October	12⅝	15 9/16
22,500	10	3/7½	Do. (Nos. 62,501 to 85,000)	14 15	14 15	3 5 10		...	...
£220,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage	117 119	117 119	3 15 7	June and December	...	...
6,452	10	6/0	Notting Hill Electric Ordinary	15½ 16½	15⅝ 16⅝	3 13 0	March	...	...
10,000	5	5/0	Oxford Electric Ordinary	6⅞ 7⅛	6⅞ 7⅛	3 9 0	"	...	...
300,000	1	8%	Rand Electric	⅞ ⅞	⅞ ⅞	10 13 4	...	...	...
£130,070	Stock	5%	River Plate El. Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb.	80 90	80 90	5 11 1	...	...	...
150,000	$100	$2	Royal Electric Company of Montreal Shares	160 180	160 180	4 8 11	...	...	...
£123,200	100	4½%	* Do. 4½ per Cent. 1st Mortgage Debentures	103 105	103 105	4 5 9	April and October	...	...
31,980	5	5/0	St. James's and Pall Mall Electric Ordinary	15½ 16½	15⅝ 16⅝	4 7 11	February and August	16⅜	16 1/16
20,000	5	3/6	Do. 7 per Cent. Preference	9 9½	9 9⅜	3 13 8	" "	...	...
65,000	5	...	South London Electric Supply Ordinary (£4 paid)	3⅜ 4	3⅜ 4	...		3 1/16	3 1/16
79,900	5	5/0	Westminster Electric Supply Ordinary	14½ 15½	14⅝ 15⅝	3 17 5	March and September	15⅛	14⅞
			ELECTRIC MANUFACTURING, &c., COMPANIES.						
125,000	1	...	Aron Electricity Meter 6 per Cent. Cum. Pref.	7/16 1/8	13/16 1/8	...		...	...
40,000	5	5/0	British Insulated Wire Ordinary	11 12	11 12	4 3 4		...	...
27,500	5	3/0	Do. Preference	6½ 6¾	6½ 6¾	4 8 11		...	...
90,000	2	2/0	Brush Electrical Engineering	1⅜ 2⅛	1⅜ 2⅛	4 14 1	September	...	...
90,000	2	1/2½	Do. 6 per Cent. Pref. Non-Cumulative	2¼ 2½	2¼ 2½	4 16 0	"	2 1/16	2 1/16
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Deb. Stock	110 115	110 115	3 18 5	February and August	...	...
£50,000	Stock	4½%	* Do. 2nd Debenture Stock (red.)	104 107	104 107	4 4 11	June and December	...	...
20,000	5	5/0	Callender's Cable Construction Ordinary	13 14	13 14	5 7 2	" "	13½	...
20,000	5	...	Do. 5 per Cent. Cumulative Preference	5½ 6	5½ 6	...		...	...
£90,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb. (red.)	113 116	113 116	3 19 7	November and May	...	...
300,000	1	0/9½	Castner-Kellner Alkali Co. (fully paid)	1⅛ 1⅜	1⅛ 1⅜	5 16 5		1 1/16	...
60,000	1	0/7½	Chadburn's Ship Telegraph Ordinary	1 1½	1 1½	...		...	...
60,000	1	0/7½	Do. 6 per Cent. Cumulative Preference	1 1½	1 1½	4 16 0		...	...
32,098	3	2/1½	Crompton and Co. (Nos. 1 to 32,098)	3½ 4	3½ 4	4 10 9	January and July	...	...
£100,000	100	5%	* Do. 5 per Cent. First Mortgage Deb. (red.)	100 103	100 103	4 17 10	" "	...	...
60,000	1	0/3	Davis and Timmins 6 per Cent. Cum. Pref.	¾ 1	¾ 1	...		...	...
99,261	5	1/9½	Edison and Swan United ("A" Shares) (£3 paid)	2 2½	2 2½	7 4 0	February and August	...	...
17,139	5	2/9⅜	Do. (£5 paid)	4 5	4 5	6 0 0	" "	...	...
£350,000	Stock	4%	Do. 4 per Cent. Mortgage Deb. Stock (red.)	95 97	95 97	4 2 6	June and December	...	...
26,100	5	5/11½	Edmundson's Electric Corporation Ord. (fully pd.)	5 5½	5 5½	5 9 1	Half-yearly	...	...
112,100	2	1/2⅝	Electric Construction Co. (Limited)	2 2¼	2 2¼	5 2 3	January and July	...	...
25,000	2	2/9⅜	Do. 7 per Cent. Cumulative Preference	3 3½	3 3½	4 0 0	July	...	...
192,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	104 107	104 107	3 15 8	January and July	...	...
91,195	1	...	Elmore's Patent Copper Depositing	½ ½	½ ½	...		...	...
15,900	10	8/0	Henley's Telegraph Works Ordinary	... ...	... ...	...	February and August	...	...
3,000	10	9/4	Do. 7 per Cent. Preference	... ...	... ...	...	" "	...	...
£50,000	Stock	4½%	Do. 4½ per Cent. Mortgage Deb. Stock (red.)	111 114	111 114	3 19 6	" "	...	...
50,000	10	5/0	India Rubber, Gutta Percha, &c., Works	21 22	21 22	4 8 11	" "	21½	21½
£300,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	100 104	100 104	3 16 11	March and September	102½	101½
37,350	12	12/0	Telegraph Construction and Maintenance	37 41	37 41	4 8 3	March and July	37½	37
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909	103 106	103 106	3 15 6		...	...
20,000	5	4/5⅜	Do. Manufacturing Ordinary	9½ 9⅝	9½ 9⅝	4 2 1		...	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5½ 6	5½ 6	4 3 4		...	...
30,000	5	5/0	Willans and Robinson Ordinary	10½ 11	10½ 11	4 1 10	April and October	...	...
30,000	5	2/0	Do. 6 per Cent. Cumulative Preference	7 7½	7 7½	4 0 0	" "	7⅛	...
£100,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Debentures	103 103	108 108	3 18 8	May and November	...	...
			ELECTRIC RAILWAYS, TRAMWAYS, &c.						
12,000	10	6/0	Blackpool and Fleetwood Tramways	19 21	18 20	4 0 0		...	...
£167,900	100	5%	Brisbane Tramway 5 per Cent. Debentures	104 106	104 106	4 14 4		...	...
50,000	10	7%	Bristol Tramways and Carriage Ordinary	23 24	23 24	2 17 2	February and August	...	...
25,000	10	...	Do. Cumulative Preference (£4 paid)	4⅜ 4⅝	4⅜ 4⅝	...		...	...
£100,000	Stock	4%	Do. 4 per Cent. Debentures	118 119	118 119	3 7 3		...	...
30,000	10	9/0	British Electric Traction Ordinary	16½ 17½	16½ 17½	6 0 0		17	...
30,000	10	6/0	Do. 6% Cum. Pref. (Nos. 30,001 to 60,000)	13½ 14	13½ 14	4 5 9		14	13⅜
£200,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures	126 129	126 129	3 17 10		12 7/8	...
40,000	5	1/9	Buenos Ayres & Belgrano 6% "A" Cum. Pref.	5½ 5¾	5½ 6½	5 9 1		5½	...
27,500	5	...	Do. "B"	5⅜ 5⅝	5 5½	...		...	...
265,585	Stock	5%	Do. 5 per Cent. Debentures	108 111	108 111	4 10 1		...	...
35,250	10	3/0	Central London Ordinary	10½ 10⅝	10½ 10⅝	2 15 10	June and December	10⅜	...
178,303	10	2/4 1/10	Do.	... ...	... ...	...	" "	...	...
£365,000	Stock	2½%	City and South London Railway Con. Ordinary	63 66	63 66	3 4 6	January and July	64	...
37,000	10	...	Do. (Nos. 22,501 to 60,000) (£4. 10s. paid)	3⅜ 4⅛	3⅜ 4⅛	...		...	...
£150,000	Stock	5%	Do. 5 per Cent. Perpetual Preference (1891)	14 15	14⅜ 14⅝	3 8 0	January and July	...	...
£200,000	Stock	5%	Do. (1896)	13½ 14½	13⅝ 14⅛	3 11 11		...	...
£187,701	Stock	4%	Do. 4 per Cent. Perpetual Debenture	132 134	132 134	2 19 9	May and November	...	...
20,000	10	7½%	Imperial Tramways Ordinary	23 24	23 24	...	March and September	...	...
10,000	10	6%	† Do. 6 per Cent. Preference	15½ 16¼	15½ 15¾	3 13 10	" "	...	...
£200,000	Stock	4½%	† Do. 4½ per Cent. Debenture	114 115	115 116	3 17 4	January and July	116	114½
37,500	10	2½%	Liverpool Overhead Railway Ordinary	9½ 9¾	9 9⅛	3 10 3	February and August	...	...
10,000	10	5%	Do. 5 per Cent. Preference	13½ 13¾	13½ 13⅞	3 12 9	" "	...	...
125,000	Stock	4%	Do. 4 per Cent. Debenture	104 105	104 105	3 16 5	January and July	...	...
24,000	5	...	New General Traction Ordinary	3¾ 4¼	3¾ 4¼	...		4 1/16	...
30,000	5	6/0	Do. 6 per Cent. Cumulative Preference	5 5½	5½ 5⅝	5 4 4	May	4⅛	...
13,334	10	...	Potteries Electric Traction Ordinary	13 14	14 14	...		...	...
20,000	10	5/10	Do. 5 per Cent. Cumulative Preference	10½ 11	10⅝ 11	4 10 11		...	...
£340,000	Stock	3%	Waterloo and City Ordinary	101 101½	101 101½	2 18 0	June and December	...	...

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

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THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED. First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,123. [No. 5. Vol. XLIV.] FRIDAY, NOVEMBER 24, 1899. PRICE SIXPENCE (by post, 6½d.), Abroad, 8d., or 16 cents. or 80fr.. or 70nf.

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NOTES.

IF further proof were needed of the inexorable nature of the purchase clause in the Tramways Act of 1870, it has been furnished by the result of the case heard in the Appeal Court last Friday, and reported in another column. Not contented with the decision of the House of Lords in the famous case of the London Tramways Co. *v.* the London County Council, the Southampton Tramways Co. appealed against a judgment of Mr. Justice BRUCE and Mr. Justice RIDLEY which practically decided that the Southampton tramways should be sold to the Southampton Corporation at a price representing the value of the plant, and not the value of the plant *plus* the value of the "goodwill." The company contended that the Southampton Corporation Tramways Act of 1897, authorising the Corporation to buy the tramways from the company, altered the circumstances of the case. The decision of the Court of Appeal is quite clear on this point, however. A tramway company's undertaking is owned subject to the conditions imposed by the Tramways Act of 1870, and there was nothing in the Southampton Act of 1897 to free the undertaking from these fetters. It is doubtful whether any private Act whatever could remove them.

PROF. S. P. THOMPSON, in his presidential address to the Institution of Electrical Engineers, departed from the custom usually followed on such occasions, and not only touched several most controversial topics, but actually stated his own personal opinions about them. The suggestion made by him in 1893, and by OLIVER HEAVISIDE some time previously, to employ inductive leaks to accelerate signalling on submarine cables, was renewed. No mention was made, however, of Mr. HEAVISIDE's alternative suggestion of a means he himself considered more effective—viz., to distribute inductance not as a leak but in the conductor itself. Prof. THOMPSON's reference to telephony was unduly short. He referred gracefully to Prof. HUGHES' invention, but said nothing as to recent progress.

REFERRING to house wiring, Prof. THOMPSON advocated a system with uninsulated or "semi-insulated" return. Such a system is not only objected to by station engineers and fire inspectors, but by a still greater authority—the Board of Trade. We should be glad to hear the matter of earthing fully discussed at the Institution of Electrical Engineers, for there is much to be said on both sides.

NOR do we think his remarks as to the position that should be taken by alternating current will be received without comment by advocates of continuous-current systems. It has not been the absence of the motor load that has caused single-phase alternating-current stations to be less successful than continuous-current ones, but rather the higher capital expenditure necessary and the waste during the hours of light load. The latter drawbacks apply equally to two- and three-phase systems. Here again, therefore, there is much to be said on both sides; but even if the introduction of one or two more phases into the question should lead to a new alternating *v.* continuous current controversy as vigorous as that which took place a few years ago, we expect that the same conclusion will be arrived at as before: viz., that both systems are needed, and that the choice cannot be fixed by any hard and fast rule, but must be governed by the particular circumstances of each case.

IN spite of the persistence of the American interviewer, Mr. MARCONI has returned to this country without having given any clue to the method of preventing interference or cross signalling which has been so much spoken of. In a note in our last issue an account was given of the tests made by officers of the United States Navy, in which "interference signals" were found to render messages unintelligible. The apparatus for preventing such interference had not, it appears, been included in the equipments brought to America, and in

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a final letter to the Naval Board who had charge of the experiments Mr. MARCONI says: "Having consulted with my partners, I regret to be unable to give a demonstration of the devices I use for preventing interference, and of the means I use for tuning or syntonising the instruments," adding that the devices have not yet been completely protected by patents. The letter also asks that the results of the naval experiments should not be regarded as a test of the system, as the instruments used were of an early type intended only for short-distance work. Whether it be meant as praise or blame, the *Electrical World* of New York, after giving the substance of this letter, adds: "If the visit of MARCONI has resulted in no additions to our knowledge of wireless telegraphy, on the other hand, his managers have shown that they have nothing to learn from Yankeedom as to the art of commercial exploitation of an inventor and his inventions."

THE annual report of the Post and Telegraph Department of Queensland for the year 1898, just to hand, is taken up largely with discussing the merits of the Pacific cable scheme from the Queensland point of view. That this is not the Australasian Colonial view as a whole we know from the exhaustive report recently published on the subject by the POSTMASTER-GENERAL of South Australia. In respect of the Tasmanian and New Zealand cables, the arrangements entered into by the Queensland Government promise to prove satisfactory, notwithstanding considerable reduction in the tariff rates. A similar experiment with the inter-colonial lines between Queensland and New South Wales has not yet proved successful, the traffic being greatly increased but the revenue substantially diminished. Between the Colony and Victoria the rate was also reduced from 3s. to 2s. for 10 words in January last, but no information is given as to the effect of this change. For the inland telegraph service the year was a prosperous one, the receipts showing an increase much larger than, with one exception, any during the past 15 years. Unfortunately, the land lines are showing serious signs of deterioration in several important areas, and a large sum of money will be needed to put them in a good state of repair.

A School for Wireless Telegraphy.—A school for wireless telegraphy is being established on one of the Government hulks in Portsmouth harbour.

Erratum.—In the last note of the first column of page 104 of our last issue, the fourth line from the bottom, read $2\frac{3}{4}$ per cent. instead of $3\frac{3}{4}$ per cent.

Cable Interruptions.

Latakia—Cyprus	June 21, 1899
Cayenne—Pinhieros	Oct. 11, 1899
Zanzibar—Mombassa	Oct. 27, 1899

Wireless Telegraphy in America.—A Laffan telegram dispatched from New York yesterday reports that the Marconi Wireless Telegraph Co., with a capital of $10,000,000, has been incorporated to introduce and work Mr. Marconi's patents in America.

Christmas Lectures at the Royal Institution.—The annual course of Christmas lectures, specially adapted for young people, at the Royal Institution, will this year be delivered by Mr. Charles Vernon Boys, F.R.S. The subject will be "Fluids in Motion and at Rest." The lectures (which will be six in number) will commence on Thursday, December 28th, at three o'clock. The remaining lectures will be delivered on December 30th, and on January 2nd, 4th, 6th, and 9th, 1900.

The County of London and Brush Provincial and its Affiliated Companies.—With regard to the editorial note on these companies in our last issue, it is interesting to record that, at a meeting of the Bournemouth and Poole Electricity Supply Co., on Thursday, the provisional agreement between this company and the County of London and Brush Provincial Electric Lighting Co. for the purchase of the latter company's interests in the Richmond (Surrey) Electric Light and Power Co. was duly approved.

Royal Society.—The council of the Royal Society has awarded the Copley Medal for the current year to Lord Rayleigh for his contributions to physical science, and a Royal Medal to Prof. G. F. Fitzgerald for his contributions to the advancement of physical science, especially in the domains of optics and electricity.

Among the Papers down for reading yesterday were two by Sir J. Norman Lockyer: (1) "Note on the Spectrum of Silicium"; (2) "Preliminary Table of Wave-Lengths of Enhanced Lines."

The Telegraph Censorship.—We noted in our last issue that the Mozambique–Lourenço Marquez cable had been restored, thus reopening communication in South Africa by the east coast route. On Saturday the Postmaster-General announced that it had been found necessary to suspend at Aden, as well as at the Cape of Good Hope, the transmission of all telegrams in code or cipher, whether of foreign Governments or private persons, to and from Zanibar, Seychelles, Mauritius, Madagascar, British East Africa, German East Africa, Mozambique, Delagoa Bay, Rhodesia, British Central Africa, Orange Free State, Transvaal, Cape Colony, and Natal. Telegrams in plain language will be subject to censorship, and be sent at the sender's risk.

The Institution of Electrical Engineers.—The first ordinary general meeting of the session of the Institution of Electrical Engineers took place on the 16th inst. The first business was the distribution of the premiums for Papers read during last session, a list of which will be found in *The Electrician*, Vol. XLIII., p. 181. Sir Henry Mance then proposed, and Mr. Alexander Siemens seconded, a vote of thanks to the retiring President, Mr. J. W. Swan, for the admirable manner in which he had filled the position of President during his seventeen months of office; and the chair was then taken by the new President, Dr. Silvanus P. Thompson. After the conclusion of the new President's address (a portion of which will be found in another part of this issue) Mr. R. K. Gray proposed a vote of thanks to Dr. Thompson for his Paper. The motion was seconded by Mr. W. M. Mordey, and carried by acclamation.

Russian Electrical Congress.—The first congress of Russian electricians, under the auspices of the Société Impériale Technique de Russie, and convoked with the authority of the Ministries of the Interior and Finance, will be held at St. Petersburg on December 27, 1899, O.S. (January 8, 1900). The objects of the congress are the promotion of friendly intercourse between Russian electricians, the exhibition of the most recent inventions in electricity and its industrial applications, the discussion of instruction in technical electricity, and similar subjects. New apparatus and machinery, plant, models, and drawings, sent by electricians of any nationality, will be exhibited in the rooms of the Imperial Technical Society, Panteleimonskaja 2, St. Petersburg, to which address all communications should be forwarded. Objects intended for the exhibition will be admitted into Russia free of duty, under the condition that they are removed from the country within a month of the close of the exhibition.

Telephony in Warfare.—To judge by the full account of the battle of Elands Laagte mailed by the *Daily News* war correspondent, the success of this engagement was largely due to the employment of the telephone to effect an elastic means of communication between General French's reconnoitring column and headquarters. During the whole of the engagement General French was in communication with the chief of the staff in Ladysmith by means of an apparatus worked

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by telegraphists of the Natal Government Post Office. On board the armoured train accompanying the column were operators carrying phonopores and other appliances, which could be attached to the railway telegraph wire at any point, so that the officer in charge was able to talk with the head-quarters at Ladysmith. It was owing to this arrangement that reinforcements were sent in such numbers that, instead of remaining on the defensive, as had almost been decided upon, General French continued his advance with success.

The Proposed Sale of the Marylebone Section of the Metropolitan Company's Undertaking.— The *Financial Times* of Wednesday gives the following particulars of the basis of negotiations between the Marylebone Vestry and the Metropolitan Electric Supply Co., which it will be seen, are identical with those published in *The Electrician*, Sept. 29, 1899, p. 821 :—

The basis of the negotiations is that the Vestry shall agree to pay to the company (1) a sum equivalent to the capital expenditure on the Marylebone section; (2) the value of the goodwill attributable to the Marylebone section, having regard to the earnings of that section in relation to the general undertaking; (3) the capital value of the loss which will result in the cost of administration alone from the separation of the Marylebone section; (4) a sum fairly representing the addition to the direct cost of working the remainder and the damage to the company consequent upon excessive provision of power which will result from the separation, and (5) reasonable compensation for the displacement of the company from this important area, which under the circumstances should be somewhat more than 10 per cent. allowed in cases of purchase under compulsory powers. As to the question of valuation, the company's accountants agree with those of the Vestry that this should be put at £319,735, but the former's estimate of goodwill amounts to £613,476, as against £305,283 by the latter, together with £4,222 for the loss sustained by reason of the debentures not being redeemable until 1916. No. 3 is calculated for the Vestry at £11,875, and No. 4 at £2,465, whilst no amounts for these two items have been suggested on behalf of the company. The totals in the two cases are £643,580 for the Vestry and £933,211 for the company.

The negotiations between the parties are still proceeding.

Prof. Rowland before the American Physical Society.—The newly-organised American Physical Society met at Columbia University on October 28th, and there was a good attendance. The proceedings were opened by an address from the President of the Society (Prof. H. A. Rowland, of Johns Hopkins University). Prof. Rowland thought there was in America still too much concentration upon so-called practical science. He referred to the fact that while $100,000,000 were readily forthcoming for the purposes of human slaughter, 1 per cent. of the amount was grudged for the endowment of science and of its teachers. Where, he asked, even now could the discoverer in pure science earn more than the wages of a day labourer or a cook? Nevertheless, they must press forward with confidence, holding their heads high, with pure consciences, hopeful for the next century, and trusting that their society would do its share to unravel these great problems of the laws and constitution of the universe. During the day Prof. Rowland presented three or four notes detailing some interesting experiments, with negative results, as to relative motion of the matter and the ether, &c. Prof. A. S. Webster read a Paper on "The Induction of the Equation of Electromagnetic Waves," and Dr. M. I. Pupin presented a Paper on "An Electrolytic Rectifier of Alternating Currents."

Electric Motors and Printing Machinery.—During the course of his presidential address to the Newcastle Association of the Students of the Institution of Civil Engineers, on Thursday last week, Mr. J. H. Holmes gave some interesting notes on the application of electric driving in printing works. He had been assured by one firm of letterpress and general printers and lithographers, who had adopted the system of driving independent machines by separate electric motors, and who had 74 such motors at work, that the output from their works had increased at least 20 per cent. since the introduction of electric driving. Mr. Holmes attributes this increase of output to six different causes: (1) The readiness of an electric motor, as compared with other prime movers, to respond to any demand made upon it for power above its normal load. (2) Its uniformity of speed ensures more perfect register of the printed matter, and wastes are few and far between. (3) The absence of spoilt sheets caused by drops of oil from the overhead shafting and bearings or by dirt carried round by the belting. (4) The more accurate adjustment of speed which is possible with a motor (by means of a regulating switch) than with the usual three or four step cone pulley for belt driving. (5) Electric driving of machines is so much steadier that they can be run at higher speeds without excessive vibration. (6) The main engine, which is usually a slow-running one, invariably decreases its speed somewhat when there is a sudden increase of load caused by more machines being started or by the running machines happening to get into step and synchronising. In such cases also, he says the main-driving belt is sure to slip.

Promise of Telephone Opposition in the United States.—Our New York Correspondent refers to the announcement that a large company is being organised by a syndicate of well-known capitalists to engage in the telephone business on a large scale. If the reports may be depended upon, he says the magnitude of the enterprise will surpass any effort in this direction that has been attempted outside of the Bell telephone organisation. The name of the new company is the Continental Telephone, Telegraph, and Cable Co., and among its promoters are Messrs. Maloney, Widener, Elkins, and Whitney, all prominently identified with various electrical enterprises in this country. It is stated that the company will be capitalised at $50,000,000, and that Mr. George Gould is in line and the Western Union Telegraph Co. looks on with friendly feeling, the underlying motive being a desire to recoup the losses that have been inflicted on the telegraph by the growth of the telephone and by the cessation of the 20 per cent. royalty once received from the American Bell Telephone Co. The plans of the company have not yet been fully or clearly formulated. One plan that is well authenticated is that of building a long-distance line from Boston to New York, and thence to leading southern and western points. Around this nucleus the 2,000 or 3,000 independent companies are expected to group, and several of the larger ones are understood to be already in line. A number of points of interest arise in connection with this formidable movement. One of them relates to patents. The Bell system of to-day, while it has lost by lapse of time its fundamental Bell patents and put forth the Berliner transmitter patent as a substitute, has behind these a vast collection of other patents relating to an endless variety of details of operation and construction. What the value of these is may now be demonstrated. Some of them of real value, such as the Carty bridging bell, have already been sustained by the courts, and there are others of scarcely inferior significance. On the other hand, a host of manufacturing companies has lately sprung up, and most of them are turning out large quantities of apparatus. Another point of interest lies in the *personnel*. It will be impossible to organise an independent opposition of the proposed magnitude without securing some of the talent and experience that have been developed within the Bell service, and it will certainly be interesting to see how far the *esprit de corps* or good salaries will keep the ranks intact.

MEETINGS OF SCIENTIFIC AND ENGINEERING SOCIETIES, &c.

TO-DAY (FRIDAY), November 24th.

INSTITUTION OF MECHANICAL ENGINEERS.

8 p.m. Ordinary General Meeting. Paper to be read: "Openings for Mechanical Engineers in China." By the Right Hon. Rear-Admiral Lord Charles Beresford.

PHYSICAL SOCIETY.

5 p.m. Meeting in the Rooms of the Chemical Society, Burlington House. Papers to be read: (1) "On the Conductivities of Certain Heterogeneous Media for a Steady Flux having a Potential," by Dr. C. H. Lees; (2) "On the Thermal Conductivities of Mixtures and of their Constituents," by Dr. C. H. Lees.

TUESDAY, November 28th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Messrs. H. H. Dalrymple-Hay and B. M. Jenkin's Papers will be further discussed, and, time permitting, the following Paper will be read: "Combined Refuse Destructors and Power Plants," by C. Newton Russell.

THURSDAY, November 30th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Students' Meeting, at which the President (Sir Douglas Fox) will give a short address to the students. A Paper will afterwards be read on "Bridges for Light Railways," by L. H. Rugg.

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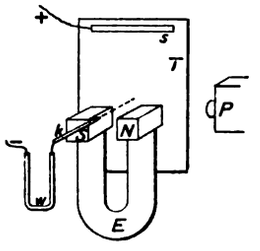
CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

Secondary Radio-Activity.—M. and Mme. Curie have discovered an important new property of radio-active substances. The rays emitted by radium and polonium are capable of communicating a temporary radio-activity to otherwise inactive substances such as zinc, platinum, bismuth, paper, barium carbonate, and bismuth sulphide. The property may be exhibited by mounting a plate of the neutral substance over a powdered radium compound, and removing it from time to time to test it by the air-conductivity apparatus. The acquired radio-activity increases with the exposure and diminishes after exposure, rapidly at first and then more and more slowly. Operating with radio-active substances possessing from 5,000 to 50,000 times the radio-activity of uranium, the secondary activities amounted to from one to fifty times that of uranium. After two or three hours the activity was reduced to one-tenth of its original amount. In favourable circumstances the induced radio-activity may be several hundred times that of barium. The authors have proved that it is not due to traces of radio active substances in the neutral plate, nor to vapours of the radio-active substance. The phenomenon is allied to phosphorescence rather than to the production of secondary Röntgen rays, as the latter are extinguished immediately on cessation of the original rays.

[P. Curie and Mme. Curie, *Comptes Rendus*, Nov. 6, 1899.]

Spark Discharge in a Magnetic Field.—M. Toepler, who was the first to describe the stratification of the open-air discharge, has found that the stratification of the brush discharge is considerably modified by a magnetic field. The arrangement adopted is shown in the diagram, where *k* is the cathode,



attached to a high water resistance *w*, T is the anode, consisting of a slate to which a strip of tinfoil *s* is attached. SEN is the electromagnet, and the discharge is observed or photographed at P. The magnetic field has the effect of crowding the stratifications together, and also of displacing them laterally with respect to each other. An unstable brush discharge is converted into a spark discharge by the magnetic field.

[M. Toepler, *Wied. Ann.* No. 11, 1899.]

Spectrum of Radium.—E. Demarçay has studied the spectrum of radium in specimens supplied by Curie containing increasing proportions of the radio-active substance. He found that certain lines increased in prominence in successive samples, and as these lines were hitherto unknown, he is safe in ascribing them to radium. They are 15 in number, the brightest being at $\lambda = 3814{\cdot}7$, $4683{\cdot}0$, $4340{\cdot}6$, $3649{\cdot}6$, and $4826{\cdot}3$. The line $4627{\cdot}4$ is the centre of a peculiar nebulous band. The other lines are sharp, like those of barium, which are all present and strongly marked. The author has not finished the study of the less refrangible portion.

[E. Demarçay, *Comptes Rendus*, Nov. 6, 1899.]

Wehnelt's Interrupter.—E. Rothe has observed that if the resistance is gradually diminished in the circuit of a Wehnelt interrupter, the electrolytic stage persists to much smaller values than when a lower resistance is suddenly inserted. The true limiting resistance of the electrolytic stage can only be ascertained by a gradual change of the resistance, and every E.M.F. has its own limiting resistance. Incandescent lamps light up when the electrolytic stage is past, or in the electrolytic stage when an inductance is introduced.

[E. Rothe, *Comptes Rendus*, Oct. 30, 1899.]

Electric Waves through Water.—The firing of submarine mines by means of electric waves from a distance can only be accomplished if water is transparent to the waves used. The fact that a sheet of tinfoil is capable of completely intercepting electric waves would render the opacity of water, and more especially of salt water, very probable. E. Branly has tested various liquids and solutions experimentally, and has found that a layer of tap water 20cm. thick suffices to reduce the signalling distance to one-fifth of its value in open air. The same thickness of salt water intercepts the waves completely. Mineral oil exercises no more absorption than air itself. Sea salt is particularly absorptive, more so indeed than the sulphates of zinc, sodium, or copper. The result is therefore so far fatal to the use of electric waves across intervening water. It is just possible that the wave-length used may make some difference. Waves from a 2cm. coil are completely intercepted, while those from a 20cm. Righi spark are transmitted to the extent of about $\frac{1}{2}$ per cent. by sea water 20cm. thick. It should be remembered that sea water is largely transparent to electric waves of the length of light waves, and it is just possible that there are other regions of non-absorption in the electric spectrum.

[E. Branly, *Comptes Rendus*, Oct. 30, 1899.]

Electrical Savart Figures.—P. de Heen describes a curious phenomenon, and furnishes for it a still more curious explanation. Lichtenberg's figures are obtained in the usual way by electrifying a plate of resin and sprinkling it with powdered sulphur. If now a number of "centres of ether disturbance," such as flames or electric brush discharges, are placed symmetrically about the plate, the sulphur arranges itself into symmetrical figures. When there are only two centres, the figure is a straight line normal to the line joining them. Three centres give three lines meeting in a point. The geometrical figure obtained may be defined by saying that the locus is formed by points equi-distant from two centres, the common distance being less than the distance of any other centre. The simplest demonstration is made by means of small gas jets. X-rays may be made to serve the same purpose, but their intensity requires much reducing. The author bases his explanation upon a supposed "ether blast," which is to justify to some extent Newton's emission theory of light. It would be interesting to determine whether sources of Becquerel rays similarly disposed produce the same result.

[P. de Heen, *Comptes Rendus*, Nov. 6, 1899.]

Influence of Becquerel Rays upon Spark-Gaps.—That ultra-violet light and electric waves have a pronounced influence upon the form of discharge in a spark-gap has been known since Hertz's fundamental experiments in this field. A number of workers, and chief among them J. Elster and E. Geitel, have elucidated the part played by the ionisation of air in this phenomenon. The same authors have lately studied the effect of the double ionisation known to be due to Becquerel rays. A spark-gap 1cm. wide, between a positive knob and a negative disc, was exposed to a radium preparation. The sparks or brushes of the discharge were immediately converted into a glow discharge, a violet glow surrounding the knob. The former discharge form was re-established on intercepting the Becquerel rays by means of a plate of lead. When the disc was made of semi-conducting cardboard instead of metal, the gap became so sensitive that the radium preparation affected the discharge at a distance of over a metre. Unlike the case of short-wave light, it is indifferent whether the electrodes be polished or amalgamated or not, but in both cases it is found that negative brushes cannot be extinguished. Röntgen rays, like intermittent ultra-violet light, produce no effect, probably owing to their intermittence.

[Elster and Geitel, *Wied. Ann.* No. 11, 1899.]

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THE ELECTRIC DRAINAGE OF NEW ORLEANS.*

BY LYMAN C. REED.

For many years the city of New Orleans has been awake to the necessity of having an efficient drainage system. To secure its effective accomplishment Major B. M. Harrod and Henry B. Richardson, of New Orleans, and Rudolph Herring, of New York, were appointed to draw up specifications and plans to solve the difficult and unique problems involved. The civil engineering problems were of a more difficult nature than those of determining and designing the machinery and nature of power to be used.

An important factor was the severity of some of the storms in this climate which a drainage system has to handle, imposing tremendous temporary demands on canals and pumping stations at such times. The highest portion of the city lies adjacent to the river, and the lowest portion some 9,000ft. away, parallel to it, and forming a basin between the river and Metairie Ridge, which runs parallel to the lake and forms a natural dividing line between the city and the swamp beyond. The gradual slope, from an average of 33ft. at the river and 25ft. at Metairie Ridge to 20ft. at the basin at Broad street, formed a natural plan for draining the included

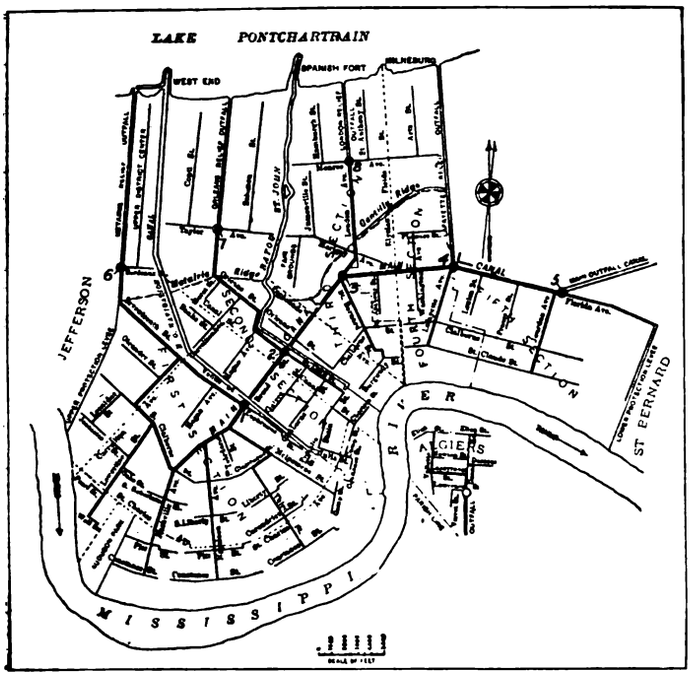

FIG. 1.—MAP SHOWING MAIN CANAL, BRANCHES, AND POSITIONS OF PUMPING STATIONS.

Pumping Stations shown, •8.

areas, which was utilised by feeding branch canals and pumping stations at such times. Fig. 1 shows a plan of this main canal and branches, giving a very clear idea of the system as a whole.

The water flows through the branch canals into the main canal by gravity, but as the main canal lies in a flat basin, it has no natural flow, and therefore an artificial slope had to be given it. This artificial slope was divided into five sections, and pumping stations 1, 2, 3, 4, and 5 are placed at the end of each section respectively, at which points the water is lifted by centrifugal pumps and discharged into the sections beyond. Each pumping station is designed to handle the water of its section, and whatever surplus is received from the preceding section. The shortest and easiest route for disposing of the drainage water lies in emptying it directly into Lake Pontchatrain. The first washings from the street, however, being very foul, it was feared that the lake would become polluted, so a longer route was chosen viâ Bayou Bienvenue to Lake Borgne, distant some 30 miles from the city. But after the first run-off takes place and the water becomes comparatively clean, it is planned to empty, by means of branch relief canals and pumping stations 6, 7, and 8, the main body of the water into Lake Pontchatrain, and thus avoid the accumulated volumes which would otherwise appear at stations, 3, 4, and 5. These branch relief canals are so constructed as to act as drains into the main canal at times of ordinary flow, furnishing also a large storage capacity in the event of a sudden rainstorm, thereby giving the necessary element of time in which to allow for the starting of the pumps at 6, 7, and 8.

Bids were received for both steam and electric operation of pumps, and all conditions of economy and efficiency of operation and cleanliness being considered, electrically operated pumps fed from one central power plant were finally decided upon as being preferable to individual steam pumping stations. This plan, furthermore, enables the entire system to be run as a unit controlled from one point, and under the management of one experienced head, instead of running independently each pumping station, while the power for light loads has the advantage of being economically generated at one point instead of being inefficiently generated at many points. As is seen from the foregoing description, the constant duty demand is very small compared with the maximum. To meet this condition, the generating plant and the pumping stations on the main canal may be considered, as will be shown later,

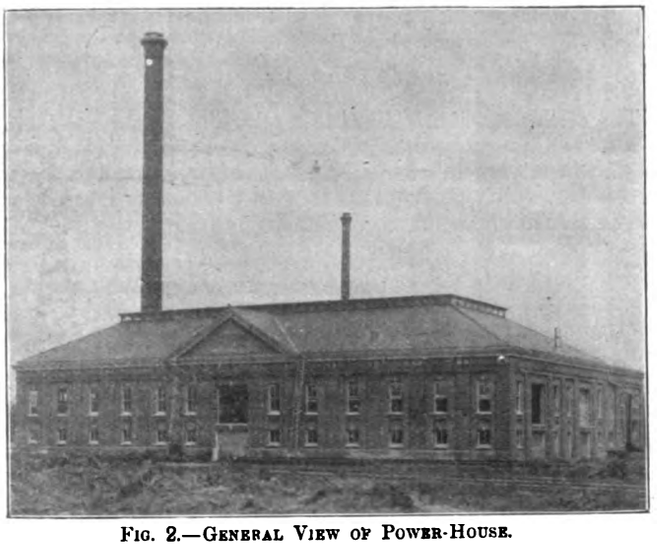

FIG. 2.—GENERAL VIEW OF POWER-HOUSE.

as divided into two parts, one for light and the other for heavy duty; auxiliary stations Nos. 6, 7, and 8 may be classed as for heavy duty only.

The central power plant is located in close proximity to pumping station No. 4, and while this is not the geographical centre of distribution, it is practically the mean centre of electrical distribution. Three-phase alternating currents generated at 3,800 volts and 25 cycles are used for operating the system. The pump motors are run synchronously without reduction in voltage, and the system is always maintained in balance by having all the motors fed from one common 'bus at the central plant. The present contract includes the completion of stations Nos. 2, 6, and 7, with No. 2 only partially operated, together with the necessary central station equipment. The power-house building is complete, together with the present equipment; engine foundations are also built for the full complement of power for the completed system.

The power ultimately required in pump or water horse-power for the various sub-stations is as follows:—

Station No. 1	471 H.P.
Station No. 2	534 H.P.
Station No. 3	370 H.P.
Station No. 4	587 H.P.
Station No. 5	1,364 H.P.
Station No. 6	796 H.P.
Station No. 7	796 H.P.
Total	4,918 H.P.

* Abstract from the *Electrical World* of New York.

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The present requirements are as follows :—

Station No. 2	193 H.P.
Station No. 6	796 H.P.
Station No. 7	796 H.P.
Total	1,785 H.P.

west; the tall steel stack, 175ft. high by 9ft. 6in. at base, is shown at the left, and the small stack, 100ft. high, in the centre of the building. The large stack furnishes the draft for six boiler units, the small stack for two units. The object of this division will be dwelt upon later.

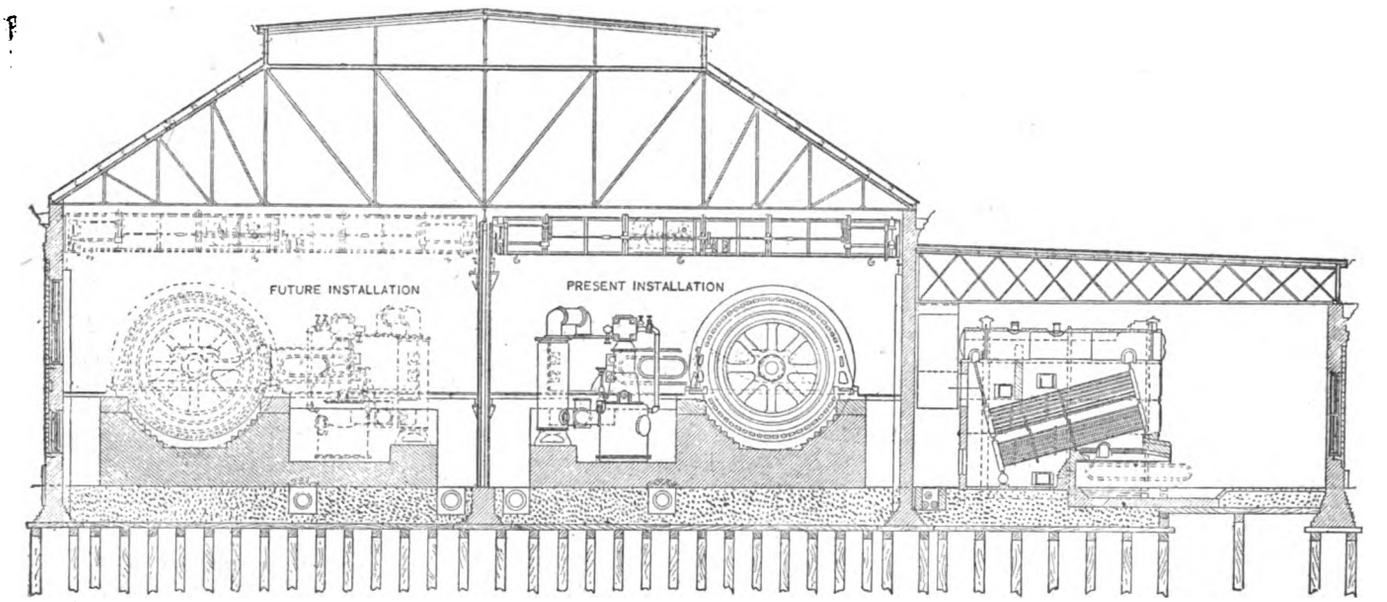

FIG. 3.—SECTION OF ENGINE AND BOILER ROOMS AT POWER-HOUSE.

The central station is situated at the junction of two railroads, and is conveniently located with reference to two important factors in economical operation—cheap coal and free water. The plant presents a very pleasing appearance, and is in striking contrast to the surrounding swamp. The ground is soft and marshy, and the foundation is laid on piles, driven 40ft. deep and spaced 4ft. by 3ft. between centres under weights, and 4ft. by 4ft. between centres under the walls and central columns. The plan of capping and decking is shown in the cross-section of engine and boiler room (Fig. 3). Fig. 2 is a view of the exterior of the central station looking north-

Fig. 4 is a plan of the central station, showing the arrangement of boilers and engines for the present and future equipment; likewise, the arrangement of the condenser and exhaust piping. The switchboard is mounted on a gallery overlooking the engine room. The engine room is practically

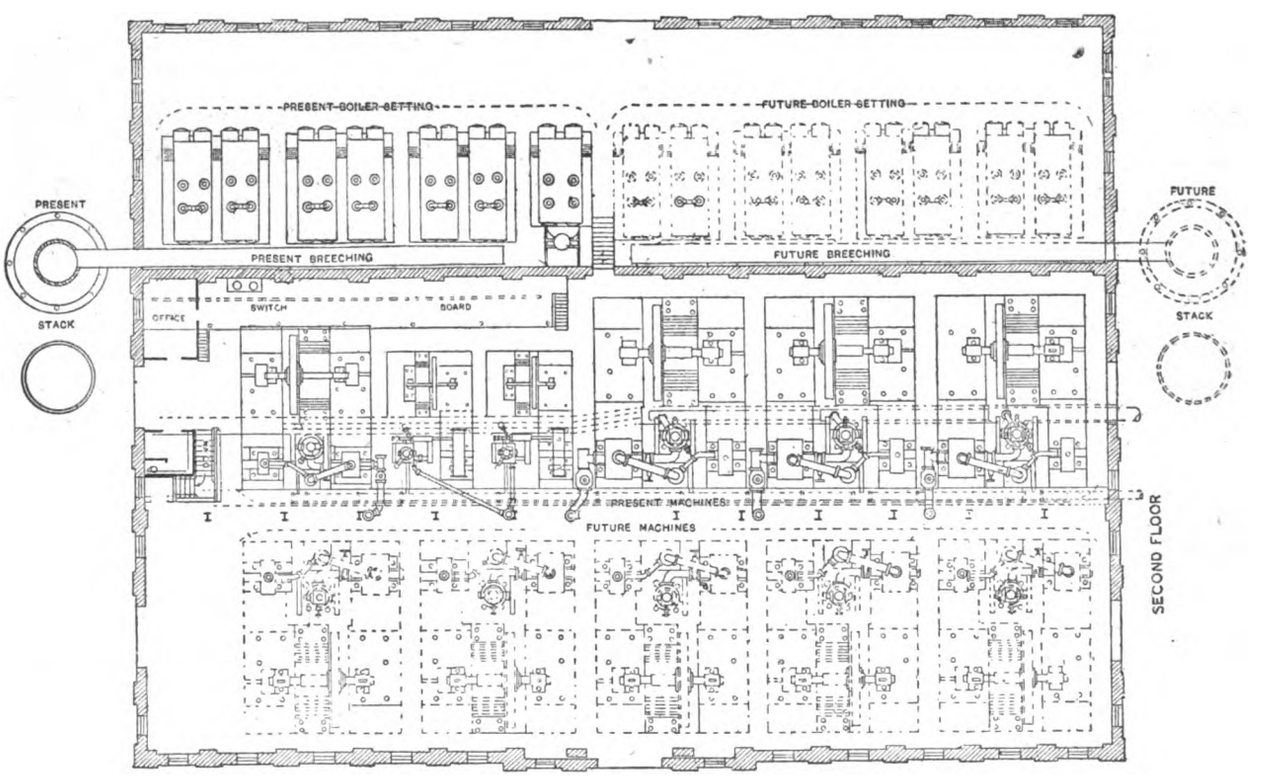

FIG. 4.—PLAN OF POWER-HOUSE.

divided into two divisions by a central row of columns. Two travelling cranes of 10 tons capacity will be used, as shown in the sectional view, only one, however, being placed for the present equipment. The dimensions of engine room are, length, 178ft.; breadth, 90ft.; boiler room, 178ft. by 45ft.; with a fireproof wall separating the two rooms. The plan of

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steam piping is such as to allow each boiler unit to be separately connected to the main header.

The present installation of engines in the power station consists of six units, aggregating 3,750 H.P., divided as follows: Three 1,000 H.P. horizontal cross-compound Allis-Corliss engines, having each a 750-kilowatt three-phase alternator hung directly on the engine shaft, revolving at 94 revolutions per minute; one 500 H.P. horizontal cross-compound Allis-Corliss engine, with a 375-kilowatt three-phase alternator mounted in like manner, running at 107 revolutions per minute; two 125 H.P. horizontal tandem-compound Allis-Coriss engines, directly connected to 75-kilowatt three-phase

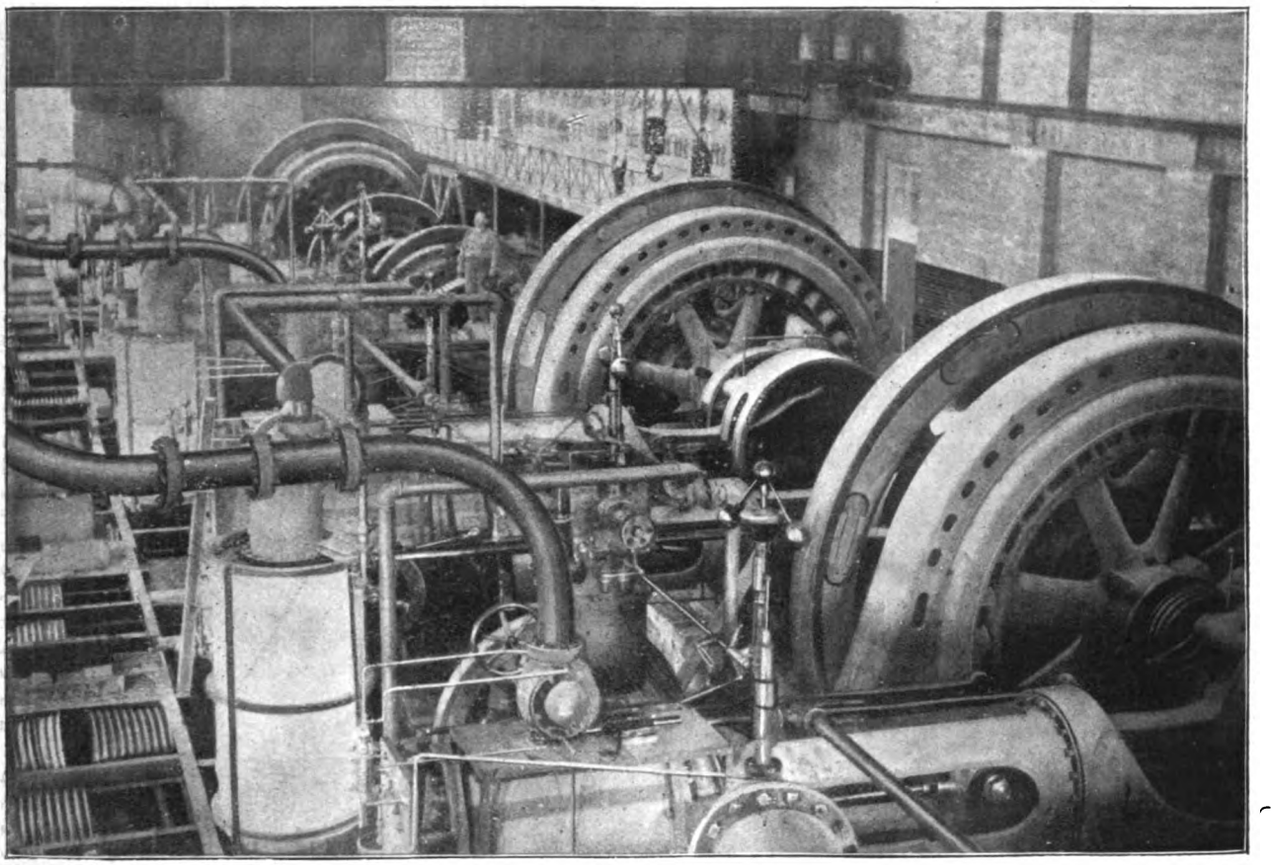

FIG. 5.—VIEW OF ENGINE ROOM, LOOKING NORTH-WEST

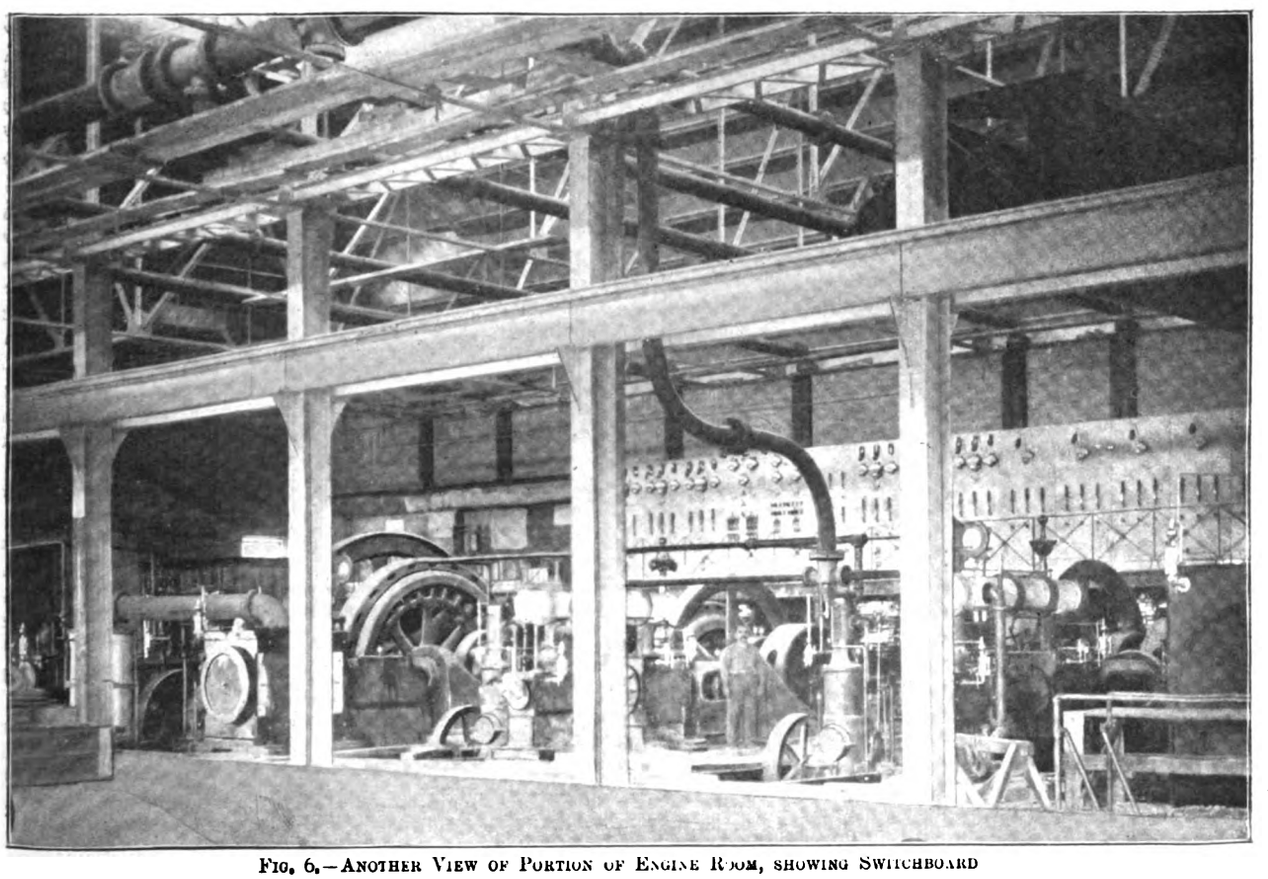

FIG. 6.—ANOTHER VIEW OF PORTION OF ENGINE ROOM, SHOWING SWITCHBOARD

alternators. Fig. 5 is a view showing a portion of the large units in the foreground and smaller units in the rear, taken during construction.

The reheater coils and standard Allis condensers are placed in between the high and low-pressure cylinders of the large units, the arrangement being shown in the plan view of the engine room. The condensed steam is passed through a set of coils, not shown in the plan, over which the low pressure exhaust passes, raising the temperature of the condensed steam on its way to the common boiler feed header. The discharged circulating water of the condensers flows through a pipe running in an arch of the engine foundations, and discharges into an open circulating canal, which makes a long *détour* of possibly a half-mile, whereby the water is cooled ready for further use by the condensers. The engines receive steam from a header, traversing the entire length of the building, supported by tie rods from the roof trusses. There are no valves in the entire length of the heading, but one valve is placed on the steam lead pipe of the small battery of boilers, just before entering the header, cutting it off therefrom; and one boiler valve is also placed on each steam lead of the other boilers. Whenever a heavier demand is made on the system than can be met by the constant-duty engines fed by the small battery of boilers, the whole header, 160ft. in length, is filled with live steam to the engine throttles. The two small constant-duty engines, generators, and their feeding

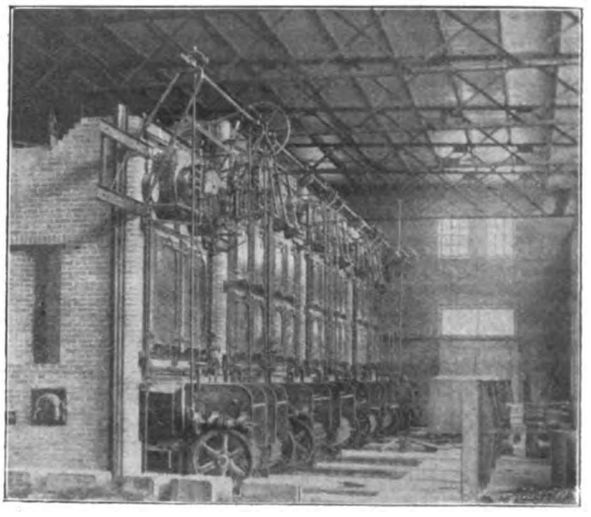

Fig 7.—Boiler Room.

battery of boilers are installed to permit of economical fuel consumption on light load, thus obtaining a greater efficiency than would be possible with the large units lightly loaded.

The engine-room floor is some 8ft. above the ground, and in the basement thus formed, and directly under the live steam header, is carried the atmospheric exhaust header, which runs the entire length of the building, and receives the exhaust of all the engines. The boiler feed pumps are two in number, and are located in the basement of the engine-room, near the boiler-room wall. The pumps are operated by steam, and are furnished with valves to enable them to feed cold or hot water, or both, as the need may be. Four direct-connected marine type exciter sets complete the engine-room equipment.

The boiler room is large enough to accommodate the entire complement of boilers needed for the complete system, but for the present needs only eight batteries are installed, aggregating 2,330 boiler horse-power, divided into six 355 H.P. units and two 100 H.P. units. As stated above, the two 100 H.P. units are for constant duty, and are provided with a separate stack. All the boilers are Babcock and Wilcox, double deck, and fitted with their automatic chain strokers driven by a small single-acting vertical engine placed on top of the boilers. Fig. 7 gives a fair idea of the boiler installation; the arrangement is shown in the plan and sectional views. The small upright posts at the right are supports for the coal bins, and the coal is dumped from cars through the windows into the bins, whence it is hand-fed to the boilers. The coal cars are side-tracked on a switch from the adjacent railroads. The boilers are provided with front feed only, the blow-off pipes being carried in a pipeway under the floor at the rear of the boilers. Each boiler is equipped with a separate steam lead to the main header in the engine room, the pipes passing through the engine room wall above the switchboard, traversing half the width of the engine room before reaching the header.

All the generators are of the General Electric revolving field type, and furnish three-phase currents at 3,300 volts and 25 cycles. The cycles were chosen thus low for the reason that the current is primarily for power purposes. The generators are operated in parallel, and feed a common 'bus at the switchboard. The board is provided with two sets of high-tension 'busses, so that in case of accident the operation of the system will not be interfered with; the two sets of low-tension exciter 'busses are also in duplicate for reasons of safety. The leads from the generators to the board are run open under the engine room floor, and are supported on triple-petticoat glass insulators placed on wooden supports. The switchboard is of handsome grey marble, and is of the standard General Electric three-phase type. The panels are divided into two sections, the upper portion carrying the high tension, and the lower portion the excitation current. A view of the board in Fig. 6 shows at the left the three generator panels for the small units, each panel containing fuse blocks, one ammeter for alternating current, one for exciter direct current, and an indicting wattmeter for the generator. Spring break single-pole switches are used on the high tension current, and the usual type of knife switch for the exciter current. The next two panels are for exciter control, and are fitted with the usual ammeters, voltmeters, &c. Following these is the transformer panel, which controls the transformers used for lowering the voltage for two rotary converters, which furnish direct current at 125 volts for the station lighting, crane hoist and other motors. Panels for the 750-kilowatt generators follow, fitted in like manner to the panels for the smaller high-tension units. Five feeder panels complete the present board, each panel containing one ammeter and three controlling switches. On the rear of each of these panels are located Wirt lighting arresters on the feeder wires. Since the system is always in balance, only one ammeter is used to indicate the current on each feeder.

The pole line is constructed of best heart yellow pine poles, 14in. by 14in. at butt and 10in. by 10in. at the top, and 35ft. high. The insulators are triple-petticoat glass, tested for 10,000 volts. Wherever firm ground is obtainable the poles are set in concrete, but for a considerable distance along the railroad the pole line traverses swamp land, and here square piles, 40ft. long, were driven 30ft. deep, and the poles bolted thereto. Conductors are insulated wherever contact is possible with foreign wires; all other portions are bare. The feeders to station No. 6 are two sets of No. 000 B & S copper, running a total distance of five miles. The feeder to No. 7 is 3½ miles long, with two circuits of 00 B & S copper. Feeder No. 2 is three miles long, with one circuit of No. 3 B & S copper. The line losses on the above for full load are for No. 6, 9 per cent.; No. 7, 11 per cent.; and No. 2, 9 per cent. The constant duty loss on feeder to No. 2 is only 3 per cent. It will be noticed here that the operation of the system alters the final plan of operation, in that station No. 2 will, for the time being, carry the constant-duty load instead of station No. 5.

As the general features of all the pumping stations are the same, a description of No. 2 will suffice, it being entirely complete. The building is similar in construction to the central power plant. A travelling crane of five tons' capacity traverses the entire length of the building. The three centrifugal pumps are driven by direct-connected three-phase synchronous motors. The horizontal revolving fields of these motors are keyed to the vertical shafts of the pumps, and their armatures are supported on I-beams placed across the top of the wheel pits, the bottom of the armature castings being

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flush with the floor. One 40 H.P. motor, running 214 revolutions, operates the constant-duty pump, lifting 40 cubic ft. of water per second 5ft. Two 125-H.P. units, running at 167 revolutions per minute, lift 500 cubic ft. per second through 3ft. to the discharge. The remaining apparatus consists of one compound cylinder pump directly geared to an 800-G.E. railway motor, operated by 125-volt direct current. This pump is for the purpose of emptying the pits of seepage water before starting the pumps, as the motors have not sufficient torque to start readily under this dead weight of water. Five direct-current 10 H.P. motors, of 125 volts, are directly geared to mechanism for operating the gates, the positions of which are shown by indicators on the wall. The plan of operating the valves shown in section is not followed. The feeder wires are brought to a receiving panel on the switchboard, which is similar in construction and finish to the one in the central station. The entire current consumed in this pumping station is registered by a recording wattmeter placed on this receiving panel, and three spring break switches connect the feeders to the high-tension 'bus running the length of the board. Three motor panels, one exciter panel, and one transformer panel complete the board. The two exciters are rotatory converters receiving current from two distinct sets of delta connected transformers, which lower the high tension currents to 80 volts, from which it is transformed to 125 volts direct current for exciting the synchronous motor fields, operating the other motors, and furnishing lights for the building.

The calculated efficiency of the entire system may be roughly stated as lying between 50 and 60 per cent. of the power generated at the central station. It remains, however, for the elaborate tests which are to be made to determine the actual efficiency.

Mr. L. W. Brown, to whom I am indebted for the plans of the central station, and the engineer for the National Contracting Co., which has carried this undertaking to a successful completion, has met and solved every arising difficulty. The drainage system is now on the eve of being placed in operation, and is entirely controlled by a drainage commission, which has selected Mr. Alfred Raymond, of this city, as general manager, whose able management will insure to the citizens of New Orleans the successful handling of the drainage system.

THE ZEROGRAPH.

About two years ago* we described an office type-printing telegraph devised by Mr. Leo Kamm. Since then this instrument has been greatly improved and simplified, and we append a description of its latest form. The chief improvement is that the number of electromagnets required to operate it has been diminished. In addition, the weight which formerly propelled the "synchronising arm" has been replaced by a spring; and this and minor improvements in detail have increased the speed at which the instrument can be worked to 15 or 20 words per minute with but little practice.

A flat spring moves over a lever which presses against a pin on the synchronising arm itself and forces it forward as soon as the arm is released by the depression of a key. The travel of this lever can be altered by adjusting a screw. Originally the depression of a key energised a starting magnet which released the synchronising arm, but this is now done away with, and the disengagement of the arm is effected mechanically, as is also the contact sending a current to line. As formerly, when the arm reaches a position corresponding to the key depressed, a second contact is made. Formerly this closed the circuit of a "second-contact magnet," whose function was to send a second current to line. Now also a second current impulse is sent to line, but the "second-contact" magnet is replaced by a light armature added to the printing magnet.

The action will best be understood by reference to the illustrations. Fig. 1 is a general view of the instrument, Fig. 2 is a diagrammatic view of the working parts, and Fig. 3 is a part elevation, showing the detail of the synchronising arm, the attachment of the type quadrant, the printing hammer, and the upper end of one of the contact pins. The figures apply equally well to the instrument at either end of the line, as the same instrument is employed for transmitting and receiving; in fact, the message transmitted is recorded on the tape of the sending instrument. If any key K is pressed, it raises a corresponding pin P in front of the synchronising arm or balance S, and also causes the stud 7 on the rocking lever beneath the key to leave the receiving contact 1, permitting the contacts 2 and 8 to come together; at the same time contact is effected at 3, and a current is sent to line from the battery G. If no relay is being used, plugs are inserted at *a* and *a*, and the current received passes through the releasing magnet A, which attracts this armature and pulls back the little catch *k* on the synchronising arm, allowing it to swing forward synchronously with the arm at the transmitting end. The two arms continue their rotatory motion until the arm at the transmitting end is stopped by the pin P, and closes the local circuit passing through the printing magnet B to the battery G. The light armature already mentioned on the printing magnet is attracted, and sends a second impulse to line, which is in its turn received by the magnet A on the receiving apparatus. This magnet again pulls the cord of the balance, and a small plunger *p* is made to protrude against the nearest pin, closing the local circuit of the printing magnet in precisely the same way as in the transmitting instrument. A condenser is bridged across the printing magnet, to diminish sparking. The armature 4 of the printing magnet moves a hammer which presses the paper against the type. Directly this armature moves, a rocking lever 5 is tilted over, breaking the circuit of the printing magnet and closing the circuit of another magnet C. This is also a strong magnet, termed the zero magnet, and it returns the synchronising arm back to its initial or "zero" position.

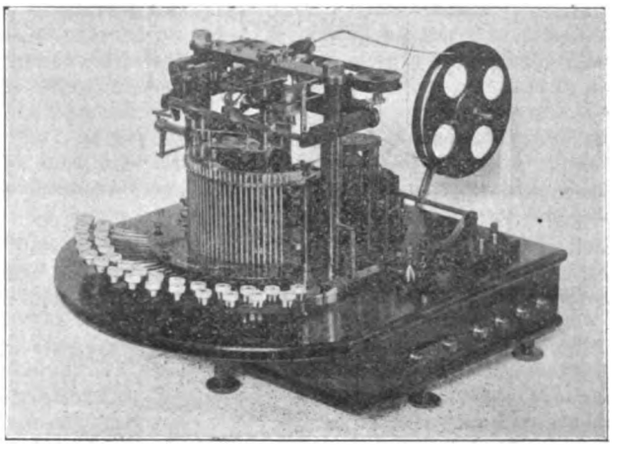

FIG. 1.—General View of the Zerograph.

If worked over long distances, a relay is used by inserting the plugs of the plug switch at *b* instead of at *a*, when a secondary battery of 12 to 16 volts suffices to work both the local and line circuits.

To have the maximum number of signs with the minimum number of keys, there are two types on each type spring; and there is a special key, as on some typewriters, to change from upper to lower case. The quadrant on which are the type springs is moved up or down when this key is pressed or released by a very simple but effective arrangement. This is best seen by reference to Fig. 3. On each type spring are two types T_1 and T_2, one above the other. Attached to the printing hammer H is a metal piece $U U_1$, one-sixteenth of an inch thick, the two ends of which are grooved as indicated by the dotted line. Each time the printing magnet is energised, the end *h* of the hammer comes forward and strikes one of the types against the tape and ink ribbon on the wheel W. In the position shown in the figure it will be the type T_1 that is printed. When, however, the shifting key is depressed, a pin is raised which stops the synchronising arm when the flat

* *The Electrician*, Vol. XL., p. 114.

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wheel Y is in the position Y_1—*i.e.*, in the same plane as the end V of the piece U U_1. As the latter travels forward it lifts the wheel Y and the whole carriage R, on

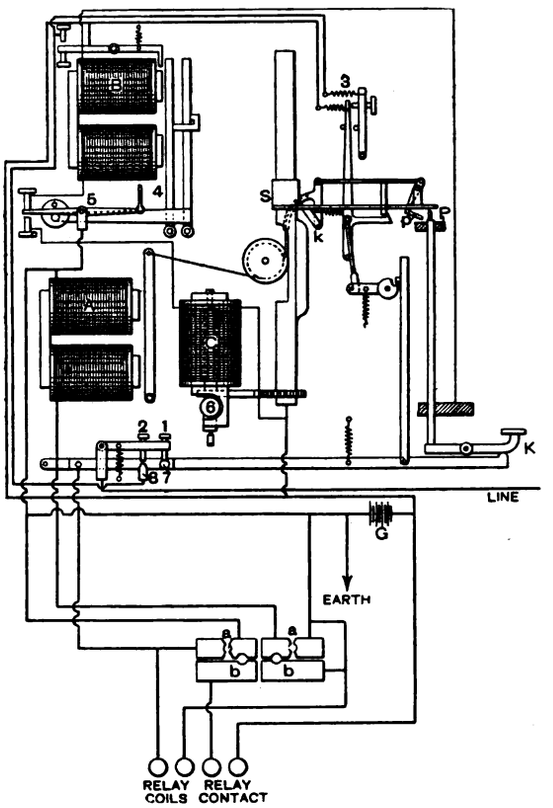

FIG. 2.—Diagrammatic View of the Working Parts of the Instrument.

which is the type quadrant Q. This rises by exactly the difference in height between the two types T_1 and T_2, and the type T_2 comes into action. The type carrier is held in its

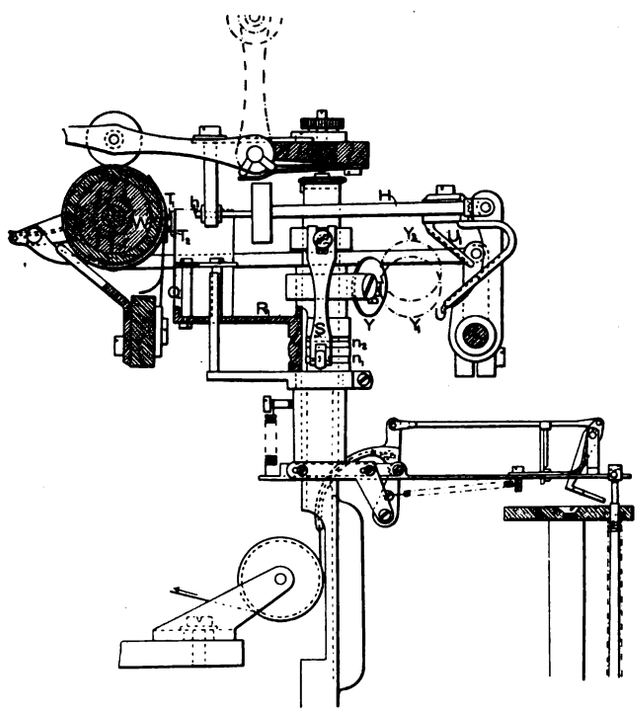

FIG. 3.—Part Elevation, showing detail of the Synchronising Arm, attachment of the Type Quadrant, Printing Hammer, and upper end of a Contact Pin. Scale: One-half.

upper or lower position by a light spring S resting in one of the grooves n_1 or n_2. When the other shifting key is depressed, the synchronising arm is stopped in a position in which the wheel Y is at Y_2—*i.e.*, in the same plane as the end U_1 of the piece U U_1, this end being bent round by the angle equal to that between the two contact pins. Then on the backward stroke of the printing hammer the part U_1 presses against the upper part of the wheel Y and pushes down the type carriage. It should be added that the position of the type quadrant corresponding to these two keys is just beyond the paper, so that nothing is printed when those keys are depressed.

It is claimed by the maker of this instrument that the effect of capacity resistance and inductance on a long line is minimised by the fact that the duration of each current impulse is extremely short—viz., less than that of a Morse dot from a Wheatstone automatic. Successful trials, we are informed, have been made on an iron telegraph wire between Berlin and Frankfort-on-the-Oder, and subsequently some machines were ordered by the Berlin telegraph authorities. The machines have also worked successfully on a metallic circuit line from Brussels to Antwerp and Ostend and between Paris and Rouen. The latter line consisted of 100 miles of phosphor bronze, 100 miles of iron wire, and the remainder underground. Mr. Kamm informs us also that two machines at present on trial at the General Post Office in London have been worked on the new underground cable from London to Leamington. Perhaps the most successful trial, however, was made between Paris and Brussels during a lecture given by Prof. Gérard.

ELECTRICAL EYES.

BY G. H. ROBERTSON, F.C.S.

Many readers of *The Electrician* may have noticed articles under the above heading, or a similar one, which appeared in various newspapers some two or three months ago, and possibly they may have felt curious to know a little more about Mr. Stiens' work. It is not the first time that an attempt has been made to give sight to the blind, or to find a substitute for the human eye; and it will be remembered that two or three years ago Mr. Edison proposed to utilise the X-rays for this purpose, although it is a little difficult to understand how rays, which are useless for purposes of vision to those whose sight is perfect, could possibly be of use to those who have lost their sight. Further, the physiological action of the rays is known to set up inflammation under certain conditions, and it seems that there would be some danger of causing inflammation of the optic nerve if it were exposed to the action of these rays when not protected by the lens of the eye, as it is in the case of a normally healthy person. Mr. Edison did not hope to be able to do more than show the shadows of objects to the blind, but Mr. Stiens is more ambitious in his ideas, for, according to a representative of the *Daily News* who interviewed him, Mr. Stiens has succeeded in constructing an electrical apparatus which forms an efficient substitute for the eye itself. But here it will be best to quote from this newspaper's report, because the results recorded are rather surprising.

Mr. Stiens is described as a Russian scientist and a Doctor of Philosophy, but the university at which he obtained his degrees is not given; and then we are told that, in response to the question, "You say you will make the blind to see?" Mr. Stiens replied, "Absolutely. . . . I give artificial sight, and it makes no difference whether the person was born without eyes, whether the eyes have been wholly or partially destroyed since birth, or how the sight has gone. . . . My apparatus will, as in the camera, focus the rays of light from the object to the brain, and sight is given, the objects being clearly seen, not inverted, but in their proper form. My apparatus constitutes a substitute for the lens. . . . So long as the receiving part—the brain—is there, my apparatus will do the rest. The rays of light strike my apparatus instead of the eyes, and pass thence to the brain, the real camera. And the apparatus will be effective carried anywhere, so long as it is connected with the body, the nearer the brain the better." The interviewer was then asked by Mr. Stiens whether he would like to test the apparatus, and eagerly replied in the affirmative, whereon he was taken into a small room and "effectually" blindfolded. "I could see abso-

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lutely nothing. Matches and candles were lighted before me, but I could not see them. Then I was connected with his apparatus. I felt a slight sensation of an electric current passing through my body. Then quickly the darkness passed away, a dull grey took its place, and was succeeded by a bright light. I saw fingers held up before me, and a disc that looked like a coin. And when I was disconnected from the apparatus I found I was standing just where I was when the eyes were bandaged. Mr. Stiens had been by my side all the time, and there was no one else present." The inventor would not permit any examination of the apparatus, as the patents for it have not yet been applied for, nor would he explain the precise character of his invention, or the means employed to achieve such results, but he claimed that the apparatus performed all the functions of the eye, and was a substitute for it.

Now, as I myself have been blind some six years, I was naturally interested by this account of Mr. Stiens' achievement, and as a first step towards putting myself in communication with him, I wrote to the editor of *The Electrician* to ask for the address of Mr. Stiens, who was described in the interview just quoted as an electrical engineer who had been working for some years in this country. The editor did not know the address, however, and suggested that I might obtain it from the editor of the *Daily News*, and that I should then arrange for an interview on behalf of *The Electrician*. At the same time he offered that one of his staff should accompany me. On applying to the editor of the *Daily News*, he kindly favoured me with the following reply: "October 12th. The manager of the *Daily News* writes to inform Mr. Robertson that he has no knowledge of Mr. Stiens, save that his address is Marion Villa, Padua-road, Penge."

I wrote requesting an interview, but as over a week elapsed without my receiving any reply, I called on Mr. Stiens at Penge on Friday, October 20th, accompanied by a member of the staff of *The Electrician*. Mr. Stiens excused himself for not having replied to my letter by stating that he was overburdened with correspondence since the publication of his discovery, and he regretted very much that he could show us no experiments then, as his apparatus was not at Penge, but in a laboratory which had been placed at his disposal. He said the report in the *Daily News* gave an accurate account of what had occurred at the interview which he had with its representative. He was an experimentalist who experimented on "zee blinds," and he would be most happy to give us a demonstration of the results he had obtained. But it must be on some other occasion, as he had had no sleep for two nights owing to his having been engrossed with his experiments; and as he scarcely knew what his engagements were then, he said he would make an appointment by letter. After some further conversation, in the course of which he alluded to some marvellous results he had obtained by a new method of wireless telephony, we took our leave, Mr. Stiens courteously escorting us part of our way to the station.

Days went by, and the promised appointment was never made, so on Saturday, November 4th, having announced our intention some days beforehand, we called on Mr. Stiens at the laboratory in which he stated he had been working. He regretted that he was again unable to give us any demonstration, as he had, he said, removed his apparatus to his house at Penge on the previous day. However, he told us that he had been successful in making a young lady, who had been blind five years, see the light of a lamp which he showed us, and that since then she had had some sense of light. The lamp in question was an ordinary continuous-current open arc lamp, and as the room was very small, it is not surprising that she did receive some sense of light from the lamp. I myself had a similar experience, more especially when a red glass was held in front of the lamp; but I put this down to the penetrative power of the red rays, and the subsequent flashes in the eye I attribute to the irritation caused in the optic nerve by the intense light. Mr. Stiens appeared perfectly satisfied with the result of the lamp experiment, and again promised to show us what could be done with his apparatus; but, as before, he failed to make any appointment, although we expressed our willingness to meet him when and where he liked. Accordingly, on Monday, November 13th, I wrote to inform him that, unless the long-promised interview was afforded me on or before November 18th, I should be obliged, as I am doing now, to publish the record of my attempts to obtain a demonstration of the powers of his apparatus. Mr. Stiens has subsequently stated to a representative of *The Electrician* that since the date of our first visit to him he has, within a week, had no less than 70 blind people at the laboratory, and that in each case the person was able to see him before he left his laboratory. He further stated that he was to be visited by Dr. Campbell (of the Royal Normal College for the Blind) and some of his pupils on Tuesday, November 21st. I wrote to Dr. Campbell asking for confirmation of this statement, and received the following reply: "November 19th. I do not know anything about the tests to which you refer. I certainly have not promised to have any meeting with the gentleman referred to." In face of this reply, and of Mr. Stiens' failure to afford any experimental proof in substantiation of the very remarkable claims which he allowed to be put forward on his behalf in the columns of the *Daily News*, I think the only conclusion to be drawn is that these claims are as groundless as his statement that Dr. Campbell had made an appointment with him.

It may be thought that I have taken unnecessary trouble to prove what ought to be a self-evident fact—namely, that a substitute for the human eye has not been constructed at the present time; and even were it constructed, the connection between it and the sight centre in the brain could not be established, because it could not be connected to the optic nerve, which is a highly specialised structure, and there is no recorded instance of any other nerve having ever taken up its function, although blindness frequently arises from injury to this nerve, the eye itself and the receiving centre in the brain being healthy. It is impossible to cause any union to take place between the living tissues of the body and any foreign substance; and unless such union could be effected, the impressions received by any artificial eye, electrical or otherwise, could not be transmitted to the brain by the optic or any other nerve. This fact alone ought to have been sufficient to prevent credence being given to Mr. Stiens' reputed discovery. However, so much weight is attached to statements which appear in the columns of the leading daily papers, that I have heard of at least one blind person whom the report in the *Daily News* has led to believe that an artificial substitute for the eye was an accomplished fact, and that the requisite apparatus, if not actually already on the market, would at any rate be obtainable soon. Moreover, different friends have called my attention to Mr. Stiens' reputed invention in the hope that it might be of benefit to me, and so I determined to try to find out what foundation there was in fact, if any, for the statements which had appeared in the Press. The publication of unfounded reports that cures or remedies have been found for blindness or deafness causes a great deal of unnecessary pain to the relatives and friends of the deaf or blind; for although I doubt if the persons themselves ever believe that the lost sense can be restored, their friends always hope against hope that something may be done. It is therefore most important that any claim of this nature should be thoroughly sifted before it is given to the world. There is also the danger that reports which have appeared in influential papers may be utilised by quacks for their own purposes, and these two reasons must be my excuse for treating Mr. Stiens' pretensions at such length.

BOOKS RECEIVED.

(Copies of any of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price.)

"Leçons sur L'Electricité." By Eric Gerard. Vol. II. Sixth edition. (Paris: Gauthier-Villars.) 12fr.

"Le Phénomène de Zeeman." By A. Cotton. (Paris: Carré and C. Naud.) 2fr.

"Designing and Drawing for Beginners." By C. G. Leland. (London: Dawbarn and Ward.) 6d.

"The Official Gazette of the United States Patent Office." No. 6. Vol. LXXXIX. Published by authority of Congress. (Washington: Government Printing Office.)

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PROF. SILVANUS P. THOMPSON'S PRESIDENTIAL ADDRESS TO THE INSTITUTION OF ELECTRICAL ENGINEERS.

The Institution of Electrical Engineers represents not only a great and growing industry, but also an important scientific profession. Any man, therefore, who finds himself placed by the will of his fellow members in the position of president of such an Institution may well ask himself, on entering upon his term of office as head of the profession, what are the interests of the Institution, what are the most pressing needs for its development, and how he can best serve those interests or aid in that development. In these days the advancement of science depends largely upon the mutual co operation of scientific workers and of the societies founded for the diffusion and co-ordination of knowledge. The progress of electrical engineering, both in its industrial and its professional aspects, depends likewise in no small degree upon the combination of electrical engineers of all classes in active union. Rightly conducted, the influence of such an Institution as ours, both within and without its borders, is very great. If we speak in the name of the united profession, with the weight of the whole industry to emphasise our views, we command the respect not only of all other professional bodies, not only of other industries akin to ours, but of public bodies, central as well as local. We can influence even the administrative departments of the Government itself when considering any regulation or proposed legislation touching electrical questions.

Further, our discussions in this room have a most direct influence not only on the development of electrical practice, but on that of electrical science. To find an instance I need hardly go farther than the presidential address of Prof. Hughes in 1886, which set the electrical world discussing the effects of self-induction. The number of scientific Papers read before this and other bodies during the succeeding two or three years upon the measurement of self and mutual induction is directly attributable to the effect of that remarkable address. In the electrical world, however, there are many other influences at work. Great as may be the influence of scientific societies, of the open discussion of scientific and technical problems, there are others equally potent. The prices of the materials used in our industry—iron, steel, copper, gutta-percha, india-rubber, mica—the cost of coal, the cost of water power, the cost of transport by land and sea, the cost of labour, the technical skill and training of our designers and manufacturers relatively to those of our foreign competitors—all have the most direct influence in determining the development of the industry in one direction or another. At a time of disquietude in international politics many of these factors in the problem may far outweigh the direct influence of our Institution. All of them will have an influence, direct or indirect, on us. For we flourish in proportion as the electrical industry flourishes; and as the Empire flourishes so will our Institution share in the general weal. Yet amid this complicated state of the conditions which determine the future of the electrical industry our Institution can render real and lasting service, if by directing attention to the things which make for progress, if only by pointing out the path along which technical advances are being made or are to be made, it can assist the manufacturer, the designer, the contractor, the consulting engineer, and the capitalist, and ultimately the authorities of local and central government. There is no question but that at the present time money is being spent in this country, in many directions not to the best advantage, on electrical schemes which are ill-advised, or antiquated, or too petty; that machinery is being constructed on wrong lines, to be discarded a few years hence long before its natural term of life is reached; that electrical appliances, because not made to the standards recommended by experience, are made in smaller quantities at a time, and therefore at greater expense than need be. Our Institution, by the recommendations of its standardising committee, has tried to prevent at least some of this waste; and it might do much more without imposing any harmful restrictions upon the freedom of a single individual. If it can point out the trend of opinion the ameliorations resulting from experience in all parts of the world; if it can help to diffuse amongst its membership generally a knowledge of these things and of the latest discoveries and inventions, the benefit it will confer not only on its members but on the industry at large, will be no small one.

I therefore propose to direct your attention to some of the tendencies which manifest themselves at present in the electrical world; some of them doubless transitory, but others indicating changes of a permanent kind.

In telegraphy, the oldest branch of our profession, there is not much room to chronicle change. Nevertheless, there is an obvious tendency to increased use of automatic methods of sending. Slowly but surely the use of the automatic transmitter is extending in cable service, whilst on the Continent and in America the advantages of the Wheatstone automatic are being gradually recognised, as the increase of matter to be transmitted over existing land lines causes a demand for accelerated methods. It may be here recalled that the very first Paper read before this Institution on March 13, 1872, when it commenced operations as the Society of Telegraph Engineers, was on the topic of automatic transmission. The use of alternating currents of a fairly high frequency is also receiving attention. Prof. Rowland has invented a multiplex typewriter working with alternate currents. The substitution of delicate optical receivers working by photography, for the purpose of enabling more rapid signals to be received, for the relays and recorders previously used, opens out a further field. Just as the limit at which the hand can send is surpassed by the automatic sender, so the speed at which the eye can read the visible motion is surpassed by that of the photographic receiver. In this connection the recent suggestions on the one hand of Squier and Crehore, and on the other of Pollak and Virág, demand careful attention. The experiments of the latter between Buda-Pesth and Berlin appear to have come as a surprise to many Continental electricians not previously conversant with the Wheatstone automatic transmitter; while the success that they have obtained in sending words at the rate of 1,300 to 1,500 words per minute over a land line 475 miles long once more raises the familiar question whether a mile or two of subterranean cable inserted in the line would not have effectually barred the transmission and reduced it to ordinary rates. We need not believe all the nonsense telegraphed by special correspondents to the daily press from Vienna, that home of scientific canards. But Pollak and Virág's results are of more substance than the imaginary achievements of Jan Szczczepanik. It is interesting to note that in their experiments success was largely due to the use at each end of the line of an inductive shunt—a device advocated so strongly for cables by our late past President, Mr. Willoughby Smith.

When we turn to the question whether such rapid methods of signalling will prove of any use on subterranean or submarine cables, we are still confronted by the old difficulty that no improvements whatever in apparatus at the ends of the cable will get rid of the sluggishness inherent in the cable itself, if constructed upon the traditional patterns. The suggestion which I advocated in 1893, of accelerating the speed of signalling by attacking the problem in the middle instead of tinkering at the ends, has not yet borne fruit. My suggestion to construct cables with a series of self-inductive artificial leaks of high resistance distributed all along its length to combat its distributive capacity appears to be too radical to be acceptable to the cable authorities. But it is self-evident that, whatever good an inductive shunt (or artificial "leak") at the end of a cable will do in getting rid of the static charges, an inductive shunt (or artificial inductive "leak") at the middle will do just twice as much. Why, then, should the suggestion to utilise this known property at one or more points along the length of the cable not be put to an experimental trial?

Of the tendencies in the telephonic world I forbear to speak. Great Britain has little to be proud of her record—past and present—in that line. She allowed the microphone, freely given to the world by its too generous inventor, to be exploited as a monopoly by others.

The competition of electricity with gas as a means of illumination has been rendered very severe by the improvements introduced during recent years in incandescent gas lighting. The discovery of the properties of the rare earths in giving an augmented illumination—the result of a purely scientific research—was the foundation of the invention of the Welsbach mantle. It is singular that the very same properties were not turned to account in electric illumination before the invention by Nernst of the lamp which bears his name—a lamp for the commercial introduction of which electrical engineers are still waiting expectantly. Meantime a far more important factor in the economic struggle remains in a possible reduction of the high prime cost of electric wiring of buildings. Could electric house wiring be carried out as simply and as cheaply as the putting in of gas pipes, an enormous advance might be confidently expected. But so long as our station engineers and our fire insurance inspectors insist on having both wires fully insulated, and do not allow an uninsulated or a semi-insulated return conductor, so long will this advance be delayed. With the introduction of armoured conduits for interior wiring, surely the prejudice which requires a double insulation will disappear.

In the public distribution of electric energy for lighting and power the necessities of economic working are effecting a slow but sure revolution. The methods that were in vogue at the date when the Electric Lighting Act of 1888 made electric distribution in this country commercially possible are being superseded. Larger generating units are being used in our stations. Larger areas of supply and fewer generating centres in an area are a necessity of the time. From the row of little bipolar dynamos, each with its own small high-speed engine—a sight so familiar in the older lighting stations of this country—we are gradually passing to the use of large multipolar machines coupled to larger and more economical steam engines. Ten years ago a distribution at six miles from the generating station was looked upon askance by many electrical engineers. To-day it is recognised that the secret of economical work is to generate on the large scale—"in bulk" as the phrase goes—and to distribute

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over large areas at an appropriately high voltage. Whether the prime source of power be hydraulic or thermal, the problems of economic distribution are essentially identical. Two of the most recent examples—both of water power stations—must suffice. At the Kanderwerke at Spiez a pressure of 4,000 volts suffices for the distribution of current for lighting and power within a radius of six miles; but for the 30 mile distribution from the same station, to supply the city of Berne and the Burgdorf-Thun railway, a 16,000-volt pressure is adopted. The city of Milan, which is lit by power from the hydraulic station at Paderno, 24 miles distant, receives its currents at 13,500 volts. When electric energy is thus generated and distributed on the larger scale the time-honoured methods suitable for parochial areas must give way to newer ones of greater economy. Continuous current generators and motors are unsuitable for operation in such wise at economic voltages. The great superiority of alternating currents asserts itself here uncontested. And with the greater economy of copper that is afforded—in the transmission at a given superior limit of voltage—by the use of three-phase currents, commercial considerations of the most elementary order decree that the fittest shall survive. It was doubtless in its time a great advance when the late Dr. Hopkinson in this country, and independently Mr. Edison in America, introduced the "three-wire" system, in which, by the employment of a central or neutral wire, three copper conductors were made to suffice where four conductors had previously been needed. The obvious economy of using *one* neutral wire instead of *two* separate return conductors was sufficient to secure its rapid adoption. But with the introduction of three-phase distribution we may now have three wires doing the work of six, each wire, when the circuits are equally loaded, serving as a return for the currents of the other two. In cases where, as in three-phase lighting, the three lines are not equally loaded, we may, by adopting a Y-grouping with a neutral wire leading back to the common junction have *one* neutral wire serving in the place of *three* separate return conductors; thus carrying forward Dr. Hopkinson's idea to its logical extension. Experience in Heilbronn, in Strassburg, in Lyon, and a score of other places proves that the fear formerly expressed as to difficulties in balancing the circuits is unfounded. In the light of such experience it is not premature to say that the use of the three-wire system with continuous currents is obsolete. Obsolete it is not, however, in the sense of being disused. Obsolete it is in the sense that a better and more economical method is known and is already largely in use. Of all the new lighting stations now under construction in middle Europe quite two-thirds are designed for three-phase work. Even in Berlin, where the admirably engineered group of lighting stations on the continuous-current plan has been eminently successful, financially and technically, all extensions are being made on the three-phase plan; and in a few years the whole will probably have been converted to alternating currents.

While the continuous current is, of course, the only species admissible for electrolytic work with all its rapidly-growing applications in the chemical industries, the superiority of alternating currents for motive power and for all long-distance work is every day becoming apparent. Only a very short time ago it was the fashion to decry alternating currents on the alleged ground that alternating current motors were not self-starting. That reflection might have had some weight 10 years ago. But the simple truth is that continuous currents will not work motors at all except toys of the old Barlow wheel type. Let him who doubts this statement ask himself what is the purpose of that costly organ, the commutator, which is an integral part of every so-called continuous-current motor. The sole function of a commutator is to commute a continuous-current into an alternating one, or *vice versâ*. If a continuous current will drive a motor, why go to the expense of putting into any motor a commutator to commute that current into an alternating one inside the machine? Moreover, the unnecessary commutator—for it is unnecessary if the currents are supplied to begin with as alternating currents—introduces the risks attendant upon the use of "brushes"—risks which have led the insurance companies to prescribe that all motors with commutators should be put in fire-proof enclosures. Let it be once realised that the commutator is an unnecessary excrescence due to the supply of a particular kind of current which won't work a motor until commuted, and that, with the supply of the proper kind of current, no commutator is needed, and before long we shall see these restrictions withdrawn. A common grindstone is a thousand times more likely than a well-constructed modern commutatorless motor to cause an outbreak of fire. Yet no one prescribes fire-proof enclosures around grindstones in any ordinary factory.

Another tendency of the times is the simplification of the switchboard, its construction of fire-proof materials throughout, and with more room both before and behind for the good arrangement of gear and connections, and the avoidance of an unnecessary multiplication of fuses. The avoidance of step-up transformers by direct generation at high voltage is in itself an obvious step toward simplification.

In the working of alternate-current generating stations, where parallel running of a number of generators is a necessity, the station engineer has always had before him the fear of a serious breakdown should anything happen to one of the generators. If the field magnet of any one generator loses its magnetism through any failure of the exciting current, then all the other generators instantly pour an immense current through its armature, with dire disaster not only to it but to the station as a whole. All manner of devices have been designed to combat this dread eventuality. Fuses and safety-devices of every description, including automatic disconnecting gear warranted only to operate for currents in opposition of phase, are found not always to do their duty. Much discussion has arisen as to whether the excitation of alternators in parallel ought to be an excitation in parallel, or whether each alternator ought to be provided with a separate exciter on its own shaft. Even excitation in duplicate from two independent sources has been tried. It is satisfactory to note that a means has been discovered which will entirely remove this source of anxiety, and render such accidents impossible in the future. Let me here narrate a test described in a recent number of the *Bulletin de la Société Internationale des Electriciens* (December, 1898, p. 498) upon two alternators of 250 kilowatts each, direct-driven at 67 revolutions per minute by two horizontal compound engines, the alternators being constructed by the well-known house of Farcot. Both alternators were separately excited, and were synchronised together and put in parallel in the usual manner. While thus running, the excitation was suddenly cut off from the field-magnets of one alternator, and then the steam was cut off from the engine of the other alternator, which remained excited. Both machines continued to turn, the unexcited alternator continuing the supply, furnishing current for the lighting circuit, and also supplying enough current to continue to drive at nearly normal speed the other machine and its engine. This extraordinary test, repeated many times, took place in the lighting station of the town of St. Ouen. The explanation lies in the construction of the alternators. Their revolving field-magnets are furnished, on the plan suggested by M. Leblanc, with the device termed by him an *amortisseur*, which is nothing else than a simple and substantial squirrel cage of copper embedded in the pole pieces of the field-magnets, each pole being perforated with six slots to receive six stout copper rods, the whole of which are short-circuited together by two external rings of copper. We are all familiar with the device of the embedded squirrel-cage construction introduced by Dobrowolsky and Brown nearly ten years ago into the so-called *rotors* of polyphase motors. In these motors the squirrel-cage structure revolves at a slightly lower speed than that of the revolving magnetic field; and it has long been known that if the same structure is mechanically caused to revolve at a speed slightly above synchronism the machine becomes a generator, taking power to drive it. In brief, the induced eddy-currents in the copper structure, when revolved above or below synchronism, magnetise it and make it act as a field-magnet. Leblanc, adapting this device to the actual field-magnets of alternators, has not only simplified the operation of synchronising, but has given to the alternator the new and remarkable property that, on the failure of the excitation from the ordinary source, the automatic action of the eddy-currents comes into play, and thereby entirely prevents the disastrous reactions which have been so much dreaded by station engineers. I regard this invention as one of the most important of recent years. It has been applied also to the 600-kilowatt alternators in the sector of the Champs Elysées in Paris.

Passing from the generation of current to its utilisation for electric traction, the most notable evolution now in progress is that of the application of electric power to heavy railways. The application to street railroads—in other words, the mere tramways—has been an accomplished fact for ten years on the other side of the Atlantic, where there are now thousands of miles of electric tramways, mostly operated from overhead lines from which the current is taken by a contact trolley-wheel. If in this country the development of electric tramways has been slower, we have at least the advantage that our cities are not disfigured by networks of overhead trolley lines. No such objections hold good for rural districts, and slowly but surely both the industrial and agricultural districts of England are being furnished with electric intercommunication with its many attendant advantages. It may come as a surprise to many who think England behindhand in this respect, when they learn that while the total subscribed capital invested in this country in 1899 for public electric supply is about £17,800,000, no less than £20,800,000 is already invested in electric traction. Of the effect of the introduction of electric traction as a social and economic factor I have spoken elsewhere. There can be no question of the immense social benefit, particularly to the artisan population, afforded by this means. But the electrical engineer is now engaged on the still greater problem of operating heavy railways, and the development in this branch is being watched with keen interest. The two deep-level railways in London, the City and South London Railway and the Waterloo and City Railway, both of which have amply justified their promoters, are shortly to be supplemented by the Central Electric Railway, an undertaking of much greater magnitude, while several other similar schemes are either under construction or authorised. In the City and South London Railway the rolling stock is designed for separate

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electric locomotives., each drawing three passenger cars. The gauge is 4ft. 8½in. On the Waterloo and City line the trains consist each of four cars, of which the two end ones are fitted with motors, four motors on each terminal car, so that the train can be driven by either set of four motors. Each train can carry 204 passengers. The gauge is 4ft. 8½in., but owing to the size of the tunnel ordinary railway rolling stock could not be used. In the Central London line the gauge is also 4ft. 8½in. The locomotives, each with four gearless motors, weigh 35 tons each. Each will draw a train of seven cars, with a seating capacity of 336 persons per train. The total length, including sidings and cross-over lines, exceeds eight miles of double track.

In all three of these railways the current is taken from a third rail on the surface, and the return circuit is through the ordinary rails, which for this purpose are bonded with copper bonds. All these lines are operated by continuous currents at 400 to 500 volts. In the case of the Central London line part of the feeding is effected through rotatory converters, which receive three-phase currents from step-down transformers.

In sharp contrast to these three London undertakings is the Burgdorf-Thun railway in Switzerland, which was opened in July last. It is in every sense of the word a full-gauge railway. Not only is its rolling stock full gauge (the full gauge of Switzerland is 4ft. 8½in.), but the railway admits of use by ordinary steam locomotives drawing ordinary trains. The electric rolling stock is of two kinds—automobile cars carrying 66 passengers each, for use singly or in pairs, and locomotives of 300 H.P. each, for drawing trains of ordinary carriages or goods wagons. This railway is worked by alternating currents supplied in three phases, at 750 volts, the feeding being effected through stationary transformers at 16,000 volts. The currents are taken from two overhead conducting wires, the rails serving as the third conductor. The length of line thus electrically equipped is 40 kilometres, or 26 miles. The arrangements were designed, and the electrical equipment constructed, by Messrs. Brown, Boveri and Co., of Baden, who were the first to apply three-phase currents to traction. In the Lugano tramways as a commencement, then in the steep mountain light railways of Engelberg, of the Gornergrat, and lastly of the Jungfrau, they gained experience in this method, which now stands triumphantly demonstrated in its adaptability to the service of heavy lines.

(*To be concluded.*)

ELECTRICITY WORKS ACCOUNTS.

Bolton Municipal Electric Supply Works.

As may be learnt from the following subsidiary table, the municipal electric supply undertaking at Bolton has from the commencement made excellent progress; and considering the magnitude of the concern, the results obtained in the working during the last completed year, as set forth in our first analysis this week, indicate that an excellent general position has been attained.

Year.	No. of consumers.	Lamp connections 8-c.p. equiv.	Max. supply demanded. KW.	Plant capacity. KW.	Total output.	Cap. expend. Total.	Rev. from supply per unit sold.	Total costs per unit sold.	W'rk'g pr'fit Total.	W'rk'g pr'fit % to mean cap.
5 m'ths to Mar. 25, 96	65	5,100	...	...	35,128	£24,460	...	...	£945	...
To Mar. 31 1896	117	9,525	144	400	94,914	34,910	5·25d.	4·19d.	794	2·67%
To Mar. 31 1897	237	19,477	266	550	186,957	46,901	4·80d.	2·81d.	2,296	5·52%
To Mar. 31 1898	390	32,000	380	750	341,888	57,038	4·02d.	2·05d.	3,771	7·26%
To Mar. 31 1899	559	43,740	481	1,000	416,635	67 253	4·02d	1·95d.	4,536	7·3%

It will be noticed that during the year ended at March 31st last the number of consumers has been increased by the addition of 169, while the equivalent lamp connections show the gratifying increase of 86·7 per cent. The year's output at 416,635 units sold was an advance of nearly 22 per cent. on the output of 1897-8, and was productive of a revenue of £6,973 at the average rate of 4·02d. per unit. Other minor sources of revenue brought the total up to 4·57d. per unit.

It is exceedingly gratifying to find that the costs are still undergoing reduction. Both the works costs and the management charges contribute to a reduction in the total costs of from 2·05d. to 1·95d. per unit. This latter figure, and also works costs at 1·42d., are excellent results at the output of little more than 400,000 units. It is in the items of fuel and repairs and maintenance that the chief sources of economy are apparent, the remaining two items of generating costs being somewhat higher than the average at the output.

In conjunction with such a comparatively moderate average price as 4·02d. per unit, the working profit of £4,536 is a most satisfactory result, representing, as it does, 7·3 per cent. on the mean capital expenditure. £1,782 was placed aside for the redemption of debt, while £1,599 was the net interest charge, thus leaving a net profit for the year of £1,205.

Dewsbury Municipal Electric Supply Works.

The second table presented this week deals with the accounts of the working, during the year ended at March 31st last, of the Dewsbury municipal electric supply undertaking. A cursory glance at the salient values in the table shows rather disappointing results, but, on the other hand, we must hasten to add that there is much to discount the apparent retrogression.

Although, as may be noticed, there is a rise in the costs of about 0·26d. per unit, the works costs are alone responsible for this and more, since the management and property charges have dropped. The chief source of the increased expenditure is the repairs and maintenance item; but we are informed that some of the expenses under this head last year were exceptional.

Among these exceptional items may be mentioned the following:—£180 for replating the greater portion of the battery, which, we are told, had got into a very bad state; £80 for new furnace fronts and grate bars, and some smaller sums in connection with alterations in the arrangement of the mains and feeding boxes of the distributing system.

Unfortunately, there is a material rise in the fuel item—viz., from 0·55d. to 0·63d. per unit. This is attributed to the poorer quality of coal obtainable as compared with the preceding year.

Thanks to an increase in the revenue, the working profit has been kept up, and amounted to £1,006, representing 3·87 per cent. of the mean capital expended. The interest charges absorbed £719 of this, while £765 represents the charge for the repayment of loans, thus resulting in a deficit for the year of £477, to be met by the rates.

We give a short table indicative of the history of the growth of the undertaking since 1895:—

Year.	No. of consumers.	Equiv. lamp connections.	Max. supply demanded. KW.	Plant capacity. KW.	Output. Units sold.	Total rev. per unit.	Total costs per unit.	Working profit. Total.
1895	60	4,200	121	250	58,000	...	..	...
15 months ending March 31, 1897... ..	67	6,317	125	250	150,875	5·94d.	3·37d.	£1,614
Year to Mar. 31, 1898	101	8,056	150	275	145,474	4·65d.	3·11d.	935
1899	111	10,500	190	280	161,154	4·87d.	3·37d.	1,006

The following is the table, omitted from our last issue, showing the growth of the Edinburgh electricity supply system:—

Year ended May 15.	No. of consumers.	Equivalent lamp connections.	Output. Units sold. Total.	Output. Units sold. Public lighting.	Plant capacity. Kilowatts.	Maximum supply demanded. Kilowatts.	Load factor.	Total costs per unit.	Total revenue per unit.	Working profit. Total.	Working profit. Per cent. to mean capital.
1896	452	57,690	888,335	...	1,160	1,016	9·98%	...	...	...	...
1897	900	99,970	1,721,557	621,260	2,700	1,621	12·1 %	1·40d.	3·74d.	£16,815	8·97%
1898	1,630	158,900	2,894,437	834,660	3,300	2,388	13·8 %	1·44d.	3·16d.	20,648	7·97%
1899	2,514	226,737	4,174,541	1,044,733	4,705	3,116	15·3 %	1·41d.	2·77d.	23,730	6·95%

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	BOLTON.		DEWSBURY.	
Undertaking Worked by	Bolton Corporation.		Dewsbury Corporation.	
Date of Commencement of Supply	October 31, 1894.	[transformers.	December, 1894.	
System of Supply	Alt.-current trans. sub-stations, also house		Three-wire continuous current.	
Chief Engineer	Arthur Ellis.		O. M. Jonas.	
YEAR ENDED	MAR. 31, **1898.**	MAR. 31, **1899.**	MAR. 31, **1898.**	MAR. 31, **1899.**
QUANTITIES—				
Units generated	486,836	560,375	152,805	172,097
,, SOLD (TOTAL)	341,888	416,635	145,474	161,154
,, sold to consumers	331,382	406,306	141,527	144,957
,, sold for public lighting, &c.	10,506	10,329	3,947	16,197
,, used on works	13,034	11,240	1,109	1,750
UNITS SOLD PER 8 C.P. LAMP CAPACITY	14·6	13·3	16·9	18·4
Maximum supply demanded	380 kilowatts	481 kilowatts	150 kilowatts	190 kilowatts
Number of public lamps	5 arc	5 arc, 5 (32-c.p.) glow	14 arc, 16 glow [a]	16 arc, 22 (16-c.p.) glow
Number of consumers	390	559	101	111
Connections to mains in 8-c.p. lamps	32,000	43,740	8,056	10,500 approx.
CAPACITY OF PLANT IN 8-C.P. LAMPS	23,400	31,300	8,600	8,750
CAPACITY OF PLANT IN KILOWATTS	750	1,000	275	220
CAPITAL—	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.
AUTHORISED (TOTAL)	— —	— —	£25,000 £91·0	£25,000 £89·3
Share	— —	— —	— —	— —
Loan (including Debenture charges)	— —	— —	25,000 91·0	25,000 89·3
RECEIVED (TOTAL)	£60,000 £80	£68,222 £68·2	24,881 90·4	— —
Share	— —	— —	— —	— —
Loan (including Debenture charges)	60,000 80	68,222 68·2	24,881 90·4	— —
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	— —	— —	119 0·43	— —
Share (unissued)	— —	— —	— —	— —
Share (uncalled)	— —	— —	— —	— —
Loan (including Debentures)	— —	— —	119 0·43	— —
REPAID (TOTAL)	3,929 5·24	5,660 5·66	600 2·18	—[f] —
RESERVE OR SINKING FUND	— —	— —	1,723 6·26	—[f] —
DEPRECIATION FUND	— —	— —	— —	— —
EXPENDED (TOTAL)	57,038 76·1	67,253 67·3	25,303 92·0	26,691 95·3
Lands and buildings	40,034 53·5	45,358 45·4	4,933 17·9	4,943 17·6
Plant			11,823 43·0	12,060 43·0
Mains	16,943[a] 22·6	21,891 21·9	6,791 24·7	7,767 27·7
Miscellaneous	— —	— —	1,756 6·38	1,922 6·86
BALANCE OF CAPITAL ACCOUNT	+2,962 +3·95	+969 0·97	−422[b] −1·53	— —
REVENUE—	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.
TOTAL	£6,694 4·695d.	£7,928 4·568d.	£2,820 4·653d.	£3,269 4·870d.
Revenue from supply	5,720 4·015d.	6,975 4·016d.	2,702 4·460d.	3,124 4·655d.
,, meters, &c.	157 0·110d.	219 0·126d.	84 0·139d.	95 0·143d.
,, public lighting	— —	— —	—[c] —	—[c] —
,, sale of lamps, &c.	816 0·573d.	735 0·424d.	— —	26 0·039d.
,, miscellaneous sources	— —	— —	34 0·056d.	23 0·034d.
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	£2,922 2·050d.	£3,393 1·954d.	£1,885 3·110d.	£2,263 3·371d.
WORKS COSTS	2,110 1·481d.	2,461 1·418d.	1,002 1·653d.	1,436 2·139d.
Generation of electricity	*2,087 1·465d.*	*2,390 1·377d.*	*952 1·570d.*	*1,336 1·990d.*
Fuel (including cartage, &c.)	691 0·485d.	838 0·483d.	332 0·548d.	424 0·632d.
Oil, waste, water, stores	330 0·232d.	348 0·201d.	126 0·208d.	159 0·237d.
Wages at station	995 0·698d.	1,086 0·626d.	362 0·597d.	353 0·526d.	
Repairs and maintenance at station	71 0·050d.	118 0·068d.	131 0·216d.	401 0·598d.
Distribution of electricity	*23 0·016d.*	*71 0·041d.*		*21[g] 0·031d.*
Wages, &c.	4 0·003d.	nil —		47 0·070d.
Repairs, renewals of mains, &c.	19 0·013d.	71 0·041d.		50 0·075d.
Public lighting	— —	— —	50 0·083d.	*79 0·118d.*
Attendance	— —	— —		70 0·104d.
Renewals	— —	— —		9 0·013d.
MANAGEMENT AND PROPERTY CHARGES	813 0·571d.	932 0·537d.	883 1·456d.	827 1·232d.
Royalties	— —	— —	— —	— —
Rent, rates, taxes	*224 0·157d.*	*249 0·143d.*	*93 0·153d.*	*114 0·170d.*
Management	*589 0·413d.*	*682 0·393d.*	*790 1·304d.*	*713 1·062d.*
Salaries	371 0·260d.	400 0·230d.	275 0·454d.	309 0·460d.
Stationery, &c.	57 0·040d.	83 0·048d.	41 0·068d.	31 0·046d.
Establishment charges	65 0·046d.	119 0·069d.	52 0·086d.	43 0·064d.
Law charges, &c.	96[b] 0·057d.	80[d] 0·045d.	422[d] 0·696d.	330[h] 0·492d.
FINANCIAL RESULTS—	Total / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded
WORKING PROFIT FOR YEAR	£3,771 7·26%	£4,536 7·3%	£935 3·78%	£1,006 3·87%
Sum carried to Depreciation Fund	— —	— —	— —	— —
Sum carried to Reserve or Sinking Fund	2,021 3·90%	1,732 2·79%	682 2·75%	765 2·94%
Net interest on loans (incl. Debenture charges)	1,443 2·78%	1,599 2·57%	732 2·96%	719 2·77%
BALANCE FROM LAST ACCOUNT	— —	307 0·494%	- 146 - 0·59%	— —
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	307 0·59%	1,512 2·43%	— —	— —
Deficit	— —	— —	*625[i] 2·52%*	*477 1·83%*
ORDINARY DIVIDEND PAID	— —	— —	— —	— —
PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE	43·85%	42·8%	66·9%	69·2%
Expenditure per kilowatt capacity	£3. 17s. 11d.	£3. 7s. 10d.	£6. 17s. 1d.	£8. 1s. 7d.
REVENUE PER KILOWATT CAPACITY	£8. 18s. 6d.	£7. 18s. 7d.	£10. 5s. 2d.	£11. 13s. 6d.
Expenditure per 8-c. lamp capacity	2s. 6d.	2s. 2d.	4s. 4½d.	5s. 2d.
REVENUE PER 8-C.P. LAMP CAPACITY	5s. 8½d.	5s. 0½d.	6s. 6½d.	7s. 5¾d.
REVENUE PER 8-C.P. LAMP CONNECTED	4s. 2½d.	3s. 7½d.	7s. 0d.	6s. 2¾d.
Price charged for lighting, per unit	6d. to 3d.[e]	6d. to 3d.[e]	6d. to 3½d.[e]	6d. to 3½d.[e]
Price charged for power, per unit			3d.	3d. to 1½d.[f]
Price charged for public lighting			6d. to 3½d.[e]	6d. to 3½d.[e]

BOLTON.—REMARKS—*a* Inclusive of an amount (not stated) for transformers. *b* Includes insurance £23, and "collection of accounts" £56. *c* By maximum demand system, 6d. for first hour, 3d. after, less 10 per cent. discount. *d* Includes

DEWSBURY.—REMARKS—*a* Glow lamps of 16 c.p. *b* Over-expended. *c* Included in figure for "revenue from supply." *d* Includes Town Hall charges £306, Diamond Jubilee illuminations £80, and insurance £19. *e* By maximum demand system, 6d. for first 1½ hours, 3½d. after. *f* Owing to their absence in the accounts supplied, we are unable to give these figures. *g* After deducting £76 refunded. *h* Includes £261 "joint expenditure,"

The Electrician.

The Oldest Electrical Journal (established as a weekly Journal 1861—1878)

Published every Friday, Price Sixpence; Post Free, Sixpence-Halfpenny
Editorial, Publishing and Printing Offices,
1, 2 & 3, SALISBURY COURT, FLEET ST., LONDON,
Telephone: 949 Holborn. *Telegrams:* "ELECTRICIAN NEWSPAPER LONDON."

All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher "THE ELECTRICIAN," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN" *Printing and Publishing Company, Limited, and be crossed "Coutts and Co."*

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"THE ELECTRICIAN" *is published every Friday morning, in time for the morning mails. It is on sale at the railway bookstalls throughout the Kingdom on Friday morning, and can be obtained of all Booksellers and Newsvendors; or direct from the Publishing Offices, as above*

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DR. STIENS.

In no direction is electricity likely to be more serviceable in the hands of skilled men, and in none has it been more abused in the hands of the unskilled than when applied to the art of healing. Long before medical men had properly studied the effects of the electric current and electrical discharges upon the human organism, electricity was being applied by ignorant persons and quacks for the cure of almost every complaint. In some cases such applications have done harm, more often they have been innocuous, while frequently the mere name of electricity has, through the medium of perfectly useless nostrums, effected the psychical phenomenon known as a "faith cure." In spite of the advance in medical science, and in spite of the intimate knowledge possessed by electricians of the science they have made their special study, the outside public still regards electricity as an agent whose laws are enveloped in mystery and are far beyond the comprehension of mortals. The days of miracles being past, the place of the supernatural is taken by electricity. Recent advances in electrical science have not tended to render this popular superstition less prevalent. Although millions of words may be telegraphed daily with absolute precision, millions of lamps lighted by means of the electric current, and millions of passengers transported from place to place in electrically-driven vehicles, the least hitch gives rise to the widespread expression of opinion that so long as the question "What is electricity?" remains unsolved, no engineer can expect to control the vagaries of this mysterious power. This is no doubt because the electrical and its allied sciences are constantly being developed in a sensational way. The applications of Röntgen rays and of Hertz waves have filled the world with wonderment, and the public is ever ready for a new miracle. This state of affairs results in the appearance from time to time of bogus inventions. At one time a man with a smattering of science, or one whose head has been turned with too much study, will delude himself into believing that he has made an epoch-making discovery or that he has found a means to set the laws of Nature at defiance. Quite as often the public are alone the dupes, and the so-called discovery is merely an effort by its perpetrator to obtain monetary gain or a passing notoriety. Probably in the majority of cases such incidents do little harm, except

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occasionally to the pockets of the "inventor" or of his victims. When however, electricity is applied by ignorant persons with the avowed object of curing a disease or relieving an infirmity, much harm, both physical and mental, can be done to the over-credulous patient.

In another column we print an article from the pen of Mr. G. H. Robertson, giving an account of a cruel imposition upon those suffering from one of the greatest afflictions—blindness. A short time ago articles and paragraphs appeared in some of the most widely circulated daily newspapers to the effect that a certain Dr. Stiens, a Russian scientist, had invented an electrical apparatus through whose medium the blind could see. The inventor is reported to have said to an interviewer: ". . . I give artificial sight, and it makes no difference whether the person was born without eyes, whether the eyes have been wholly or partially destroyed since birth, or how the sight has gone. . . So long as the receiving part—the brain—is there, my apparatus will do the rest." This statement, rendered more plausible by the account of an experiment which may have appeared conclusive to many, must have aroused hope in the minds of hundreds if not thousands of blind people and their friends. The announcement was made in such a manner that these poor afflicted ones must have thought that in a short time the power of sight would be restored to them. Mr. Robertson has patiently endeavoured, but to no purpose, to obtain a repetition of the experiment upon himself. He has twice visited Mr. Stiens, and each time has received a promise that the properties of the apparatus referred to should be shown to him, but this promise has been disregarded. He is therefore quite justified in concluding that the loudly-trumpeted assurance that the blind should see is no more likely to be fulfilled than Mr. Stiens' verbal promises. What greater refinement of cruelty can be conceived than to revive the dying hopes and longings of poor suffering people, only to dash them to the ground or wear them out again with fruitless waiting? Of Mr. Stiens' numerous other claims to notoriety we have no need to speak on this occasion. Let him put on one side his other ambitions as an inventor, and show us that he has progressed a single step towards discovering a means by which sight can be restored, and we shall be among the first to respect him. But if he can accomplish no more than the delusion of a newspaper correspondent and the narration of pseudo-scientific fairy tales, he should be forced to confine his operations to directions in which he can inflict no pain.

THE HIGH-VOLTAGE LAMP.

(*Concluded from page 119.*)

Coming now to the question of efficiency, life, and candle-power, generally the average standard of efficiency worked to in high-voltage lamps is about 4 watts per candle-power, but this varies considerably during the life of the lamps. Some makers employ a much better efficiency at starting than the above. Fig. 13 gives a typical efficiency curve, taken by a leading English lamp manufacturer on a circuit occasionally exceeding the normal voltage by 4 per cent. Another firm sends us the curves shown in Figs. 14 and 15 as the results of a 500-hour test on a new make of lamp. It is reasonable to assume that these tests are "selected" ones, and that they have been made with an ideally constant voltage.

Figs. 16 and 17 are good average light and efficiency curves of 8 and 16 c.p. 200-volt lamps of another make. These lamps have "unflashed filaments," and are nominally 4½ watts and 4 watts per candle-power respectively. Although plotted from tests made by the manufacturer, each is the mean of the tests on six lamps taken indiscriminately from "stock." These tests were commenced on January 16th of this year. An approximation to a fluctuating public supply pressure was obtained in this case by making use of the factory circuit, which is also connected to the pump tables, where large currents are constantly being switched on or off suddenly. The dotted lines show percentages of the nominal candle-power of the lamp, the full lines efficiencies in watts per candle.

As might be expected, we have had difficulty in obtaining from all manufacturers particulars with regard to the "flashing" or "treating" question. Mr. Stearn, of the Zurich

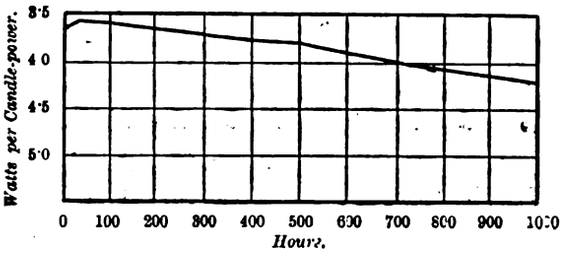

Fig. 13.—Efficiency Curve of High-voltage Lamp by a leading English Manufacturer.

Incandescence Lamp Co., which we may mention *en passant* now manufactures a large proportion of its lamps in this country, is as much the champion of the untreated filament as ever. He informs us that practically no change has been made in his lamps during the last two years, and that no change was needed. The standard efficiency of his 16-c.p. lamps he fixes at from 3·5 to 3·7 watts per candle, of his 8-c.p. lamps 3·5 or 3·7 to 4 watts per candle, and in his 5-c.p.

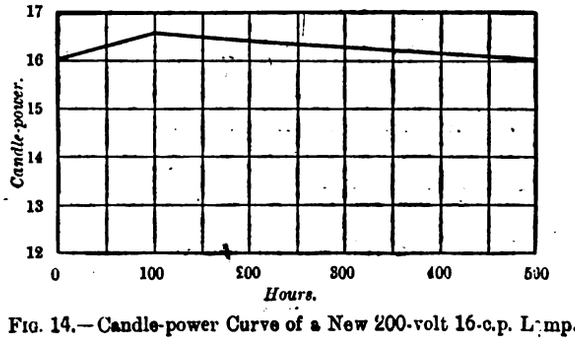

Fig. 14.—Candle-power Curve of a New 200-volt 16-c.p. Lamp.

and 6-c.p. lamps allows a margin up to 4·2 watts per candle. As the smaller the candle-power of the lamp the finer the filament, an inaccuracy in the size of the filament makes a greater variation in the lamp's smaller candle-power, and hence a larger margin for efficiency must be left. Most makers agree that the lower the candle-power of a lamp the poorer its efficiency, other things being equal; but nearly all state that they have no difficulty in supplying 5 and 6-c.p. lamps at 4 to 4½ watts

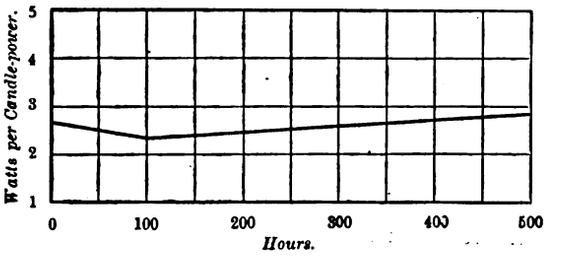

Fig. 15.—Efficiency Curve of a New 200-volt 16-c.p. Lamp.

per candle, these giving satisfaction to the buyers and bringing in repeat orders. Mr. Robertson continues to employ untreated filaments and, he informs us, has recently been most successful with the fine ones required for lamps of smaller candle-power. The Berrenberg Co., on the other hand, have made no progress with untreated filaments; and Messrs. Goossens, Pope and Co. consider an untreated filament to be less efficient, as they have found that the light curve of lamps

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with these filaments falls off early in the life of the lamp. It must be remembered that the object of treating or flashing a filament is not merely to fill up the small holes or irregularities in the original filament before it is treated. The prime reason for flashing is to deposit a layer of carbon on the surface which has a lower emissivity than the surface of the filament in its unflashed condition, and thus has a better efficiency at a lower temperature than the unflashed filament.

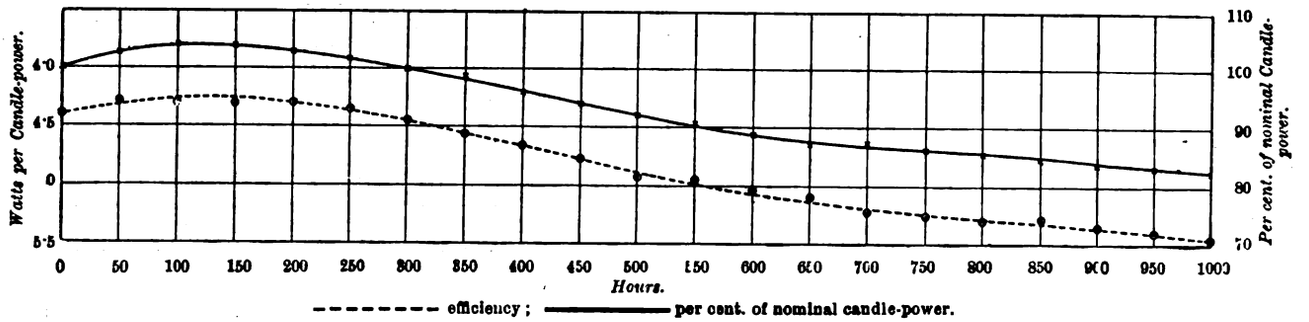

FIG. 16.—Average Light and Efficiency Curve of Six 200-volt 8-c.p. Unflashed Lamps. Nominal rating, 4½ watts per candle-power.

ment in unflashed lamps. As it comes from the baking pots, the carbon of the finer filaments is denser and has a lower specific resistance than that of larger filaments. We believe that no definite experiments have been made in this direction, but it is a fact that while these fine filaments are being baked in the pumps they are frequently run at a higher temperature than could be supported by thicker ones without injury, and that in consequence occasional batches of

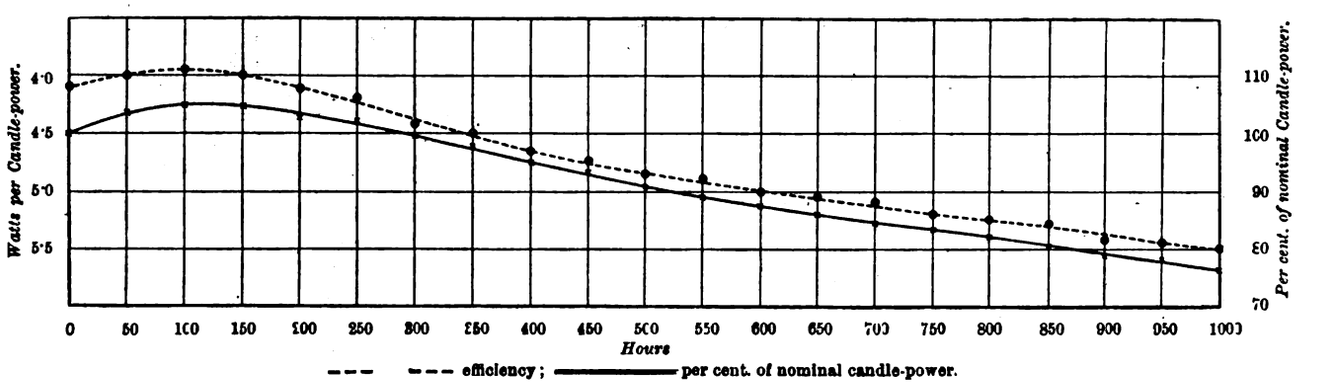

FIG. 17.—Average Light and Efficiency Curve of Six 200-volt 16-c.p. Unflashed Lamps. Nominal rating, 4 watts per candle-power.

Flashed lamps as a rule fall off less in candle-power than unflashed ones, but, probably owing to the longer filaments, it is contended that there are a greater number of premature failures. In this connection we may refer our readers to an article, from an American contemporary, on "The Advantages of Long Filaments in Incandescent Lamps," reprinted in another part of this issue, which clearly states the case from the point of view of the maker of flashed filament lamps. There is one point in the manufacture of filaments, however, which may possibly lead to considerable improvement in unflashed lamps. As it comes from the baking pots, the carbon of the finer filaments is denser and has a lower specific resistance than that of larger filaments. We believe that no definite experiments have been made in this direction, but it is a fact that while these fine filaments are being baked in the pumps they are frequently run at a higher temperature than could be supported by thicker ones without injury, and that in consequence occasional batches of 8-c.p. high-voltage lamps have actually been found to be even better than the average 16-c.p. high-voltage lamp. This is a suggestion only, although made to us by a gentleman with long experience in lamp manufacture; as already stated, it has not yet been made the subject of systematic experimental investigation, and there may after all be nothing in the idea.

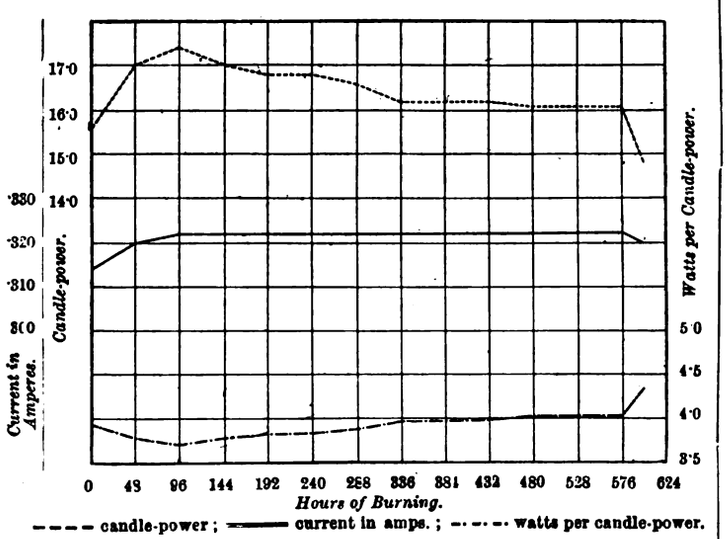

FIG. 18.—Test of a good English 200-volt 16-c.p. Lamp, taken by the Electric "Tested Lamp" Co.

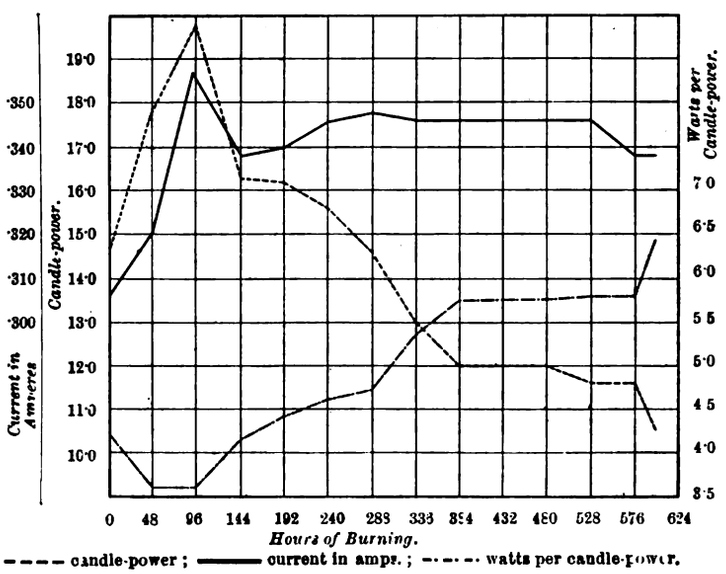

FIG. 19.—Test of a bad 200-volt 16-c.p. English-made Lamp, taken by the Electric "Tested Lamp" Co.

We have been fortunate enough to obtain interesting particulars relative to the sales of high and low-voltage lamps

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from various makers, and other miscellaneous information. The enormous sale of 100-volt Ediswan lamps has not yet been surpassed by that of the high-voltage lamp, but the output of the latter type is increasing daily. Eight candle-power high-voltage lamps have not been so much in demand as sixteens until during the last year. The Robertson Co. estimate that about half their output is in high-voltage lamps. They also notice an increase in the demand for the frosted and half-frosted types, and will welcome the demand for 240 volt lamps which may be prophesied to come soon from those desiring to make use of the maximum "declared" pressure allowed by the Board of Trade. Mr. Robertson recommends an efficiency of 4 watts per candle for 16-c.p. lamps of high voltage, and that this figure should be allowed to increase somewhat, say to 4·5 watts per candle, for candle-powers of 8 and less. As all other makers, however, he is willing to make lamps of better efficiency and shorter useful life if this be specified. Mr. Stearn informs us that about 80 per cent. of the lamps he manufactures are for voltages of 200 and over. The Sunbeam Co. choose as their standard efficiency 3·75 watts per candle-power for 16, 25, and 32-c.p. lamps, but for 8-c.p. lamps do not recommend a higher efficiency than 4 watts per candle-power. They have found in their own testing rooms that such lamps have practically as good a life curve as an ordinary low-voltage lamp, and that the efficiency is certainly well maintained in a 500 or 600 hours run with a drop of not more than 3½ candles, at which point, of course, consumers should renew their lamps. Smaller lamps than 8-c.p. have not such a good efficiency To be satisfactory a 5-c.p. lamp requires some 4·5 to 4·75 watts per candle-power. The Berrenberg Co. promise great things as regards efficiency, promising 2 and 2·5 watts per candle-power for 16-c.p. and 8-c.p. lamps over a fairly long life. Messrs. Goossens, Pope and Co. make their standard lamps of the following efficiencies: 5-c.p., 4·5 watts per candle; 8-c.p., 4 watts per candle; 16, 25, and 32 c.p., 3·5 watts per candle; 50 and 100 c.p., 3·3 watts per candle. They find that the sales of their high-voltage lamps are increasing at a rapid rate, and that quite two-thirds of their present manufacture is in lamps of this type.

Of course it is well known that the relation between life, light, and efficiency of lamps depends entirely on the constancy of their pressure. Many supply stations allow their pressure to vary considerably beyond the 4 per cent. limit prescribed by the Board of Trade, and in consequence the efficiency and useful life of lamps on these mains is considerably lowered. The Electric "Tested Lamp" Co., whose business may be styled that of "expert" lamp buyers, have inaugurated a system of tests in which account is taken of pressure variations, the standard of variation taken by the company being that delivered from the mains of the Westminster Electric Supply Corporation to the basement of No. 15, Victoria-street. They buy their lamps only subject to their being up to a specification which includes that a certain number be tested and found satisfactory. Mr. A. W. Gattie, the manager, informs us that the company numbers among its clients Her Majesty's Office of Works, the Crown Agents for the Colonies, the Crystal Palace, Madame Tussaud's, and other places of amusement and theatres. After testing the lamps for vacuum by placing a tray containing 200 of them upon a shelf connected to a terminal of an induction coil (the bad lamps, of course, showing a distinct glow), they are connected to the mains above-mentioned, from which each lamp is removed once in 48 hours to be tested for candle-power and efficiency. Mr. Gattie informs us that, tested in this way, the lamps usually fall far short of the figures given by the makers as results of tests. We reproduce three curves which he has placed at our disposal. Fig. 18 shows an extremely good test, considering the variations of pressure, which Mr. Gattie informs us are considerable, while Fig. 19 is an example of one of the worst batches of lamps his company have tested. Fig. 20 represents a bad lamp of Austrian manufacture, although some of the foreign-made lamps the company receives are as good as the English ones. The apparent peaks on the curves are not actually discontinuities; the curves shown are simply the lines joining the observations made at 48 hours intervals. From Mr. Gattie's tests he informs us that, as a general rough-and-ready rule, he finds that those lamps whose candle-power rises least with a slight increase of voltage give the best curves under his system of testing.

The "Tested Lamp" Co. has lately been directing its attention to improving and developing a device of Mr. A. G. Seaman's, which is intended to be placed between the supply mains and the consumer's distribution board to prevent the over-running of the lamps. This voltage regulator is an automatically adjusting rheostat connected to a voltmeter relay of foreign manufacture. The rheostat is a set of resistance coils in series with one of the mains, and the ends of each coil are connected to a pair of mercury cups. Around a ring situated above the cups and movable up and down are copper short-circuiting pieces of gradually diminishing length, so that the number of coils short-circuited depends on the height of this ring. The ring is moved up or down by one of two vibrators not very different from an ordinary bell make-and-break, the one controlling the upward movement being connected to the "too much" side of the voltmeter

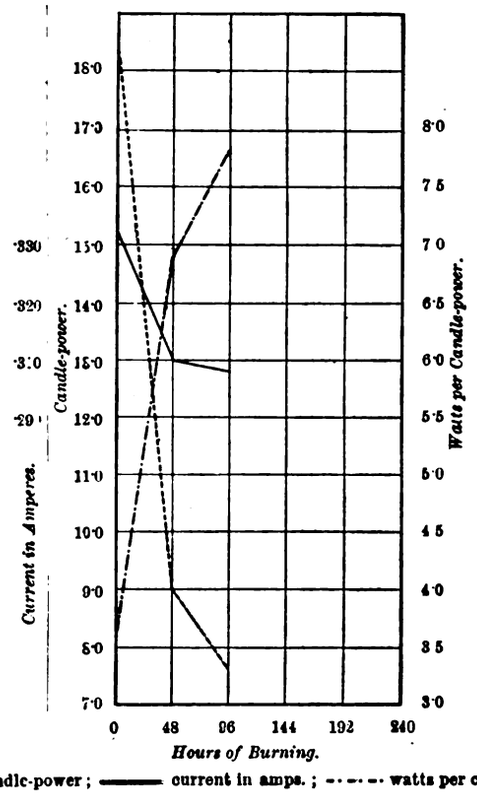

FIG. 20.—Bad Example of an Austrian Lamp.

relay, and the other to the "too little" side. These vibrators are connected through a differential bevel gear the middle wheel of which gears by a pawl action into two toothed wheels which cause to move up or down a rack connected to the ring above mentioned. The weight of this ring is relieved by a counterweight. This apparatus would, of course, be too expensive for an ordinary consumer, but the company thinks that in the case of large consumers the device will have a great future before it.

Before closing this article there is one more point to which we would allude—viz., the difference between the English standard candle and the Hefner amyl-acetate standard. This difference is well known, but what is not so well known is that some English makers employ the latter standard in rating their lamps. A 16-c.p. lamp, if named according to the Hefner unit, will only give some 14 candle English standard power, and a lamp requiring 3½ watts per Hefner standard requires nearly 4 watts per English candle-power. This difference should be borne in mind when ordering not only foreign but also English-made lamps.

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THE ADVANTAGES OF LONG FILAMENTS IN INCANDESCENT LAMPS.*

During the past 20 years the incandescent lamp has been the object of as elaborate investigation and experimentation as any other one product of the mechanical arts, and an enormous amount of time, money, and labour has been spent in its development, and with no mean results; but even at the present day, although lamps can be made for 240 volts, difficulties are encountered in making as good a lamp for the original standard pressure of 110 volts as can be made for lower pressure.

One of the difficulties in the way of raising the voltage of incandescent lamps may be illustrated as follows:—Assuming that the lamp is to be of 16 c.p. and of 3·5 watts per candle, its total consumption of power will be 16 × 3·5, or 56 watts. If burned on a circuit of about 56 volts this power will require 1 ampere, and the resistance of the lamp filament will have to be about 56 ohms. If, however, it is to burn on a circuit of 112 volts the power can only be kept down to 56 watts by cutting down the current to ½ ampere and the resistance of the lamp will have to be raised to 224 ohms. Thus it will be seen that doubling the voltage increases the necessary resistance four times; which is in accordance with a general law of purely resistive apparatus that the resistance must be varied as the square of the pressure to maintain the absorbed power constant. If the lamp is designed for a 220-volt circuit the current will have to be reduced to about ¼ of an ampere, and the resistance will have to be raised to the extremely high value of practically 900 ohms to give the same economy of current. As the resistance of the carbon falls with increased temperature, the resistance cold is practically twice this, or, in the last case, 1,800 ohms.

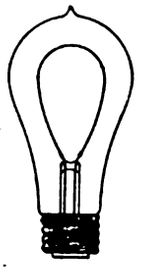

FIG. 1

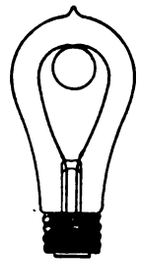

FIG. 2

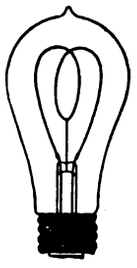

FIG. 3

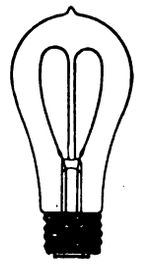

FIG. 4

The only way to obtain the high resistances of from 200 to 300 ohms necessary for lamps of 100 to 120-volt circuits is by using either a material of high specific resistance or of great length and fine diameter. Extended experiments in the direction of finding a suitable material of high specific resistance by means of incorporating more highly resistive substances with carbon, or otherwise, have uniformly proven in vain; the only material as yet found available being carbon in two of its allotropic forms. One of these is a variety similar to very dense charcoal, and formed by the carbonisation of the original cellulose thread of which practically all filaments nowadays are made. This form is known by lamp makers as "base" carbon. The other is a form of carbon closely resembling ordinary graphite.

All lamp filaments must contain as a foundation a central core of the former, or "base" carbon, filaments constituted wholly of graphite being impossible to make, since the graphite can only be obtained in the filament form by depositing it upon a skeleton structure of "base" carbon. This deposition is done by means of what is called the "flashing" or "treating" process. The carbonised cellulose thread is raised to high incandescence by electric current in a chamber through which is passed a current of gasolene vapour. The white-hot filament decomposes the hydro-carbon vapour, depositing the carbon as graphite upon its surface.

* From the *American Electrician*.

The "base" carbon has about six times the specific resistance of the graphitic carbon, so that filaments consisting wholly or largely of the former can be made much shorter and thicker for the same resistance than those containing a greater percentage of graphite. Unfortunately, however, the "base" carbon is much poorer in the qualities of economical light emission and life. This is not due, as many suppose, to any difference between the light-giving powers of graphite and charcoal; in fact it is generally admitted that all substances, no matter what their colour—white, grey or black—shine with the same intensity when raised to the same temperature of incandescence. But the graphite gives to the surface of the carbon a grey, metallic, steel-like appearance which can be plainly seen in all new lamps, and this grey surface, in conformity with a general law of physics, radiates much less heat when raised to a given temperature than does a dead black or sooty surface such as that of the "base" carbon or that of an old lamp in which the surface of the graphite may have been reduced to the charcoal form. A filament therefore with a metallic grey surface requires less energy to supply this heat waste and raise it to the proper temperature of incandescence, such, for example, as to radiate one candle-power for every 3½ watts supplied, hence the superiority of the graphite for the economical emission of light.

Another superiority of the flashed or treated filament is mechanical. The graphite tube or sleeve which surrounds the "base" carbon is more dense and stiff than its central core, and hence holds the filament more rigidly against vibrations which tend to throw it against the glass, and also prevents it from sagging when the lamp is burned in a horizontal position. The graphite tube, deposited as it is at a high temperature, is a good resistant of the disintegrating effects of heat, and maintains the filament probably after the core of "base" carbon within it is broken down, thus greatly prolonging the life.

As stated above, the graphite is a good conductor of electricity as compared with "base" carbon, and hence, if much of the cross-section of the filament is graphitic, the diameter of the whole will have to be small and the length great in order to obtain the necessary 200 or 300 ohms. The greater the amount of graphite and the less the amount of "base" carbon the better is the lamp for reasons pointed out above, and the general rule may be laid down that for a given voltage a lamp with a long filament is better than a lamp with a short filament, provided—and this is an important provision—the long filament is properly supported.

From the inception of the industry until a few years ago most incandescent lamps had filaments of the plain loop or shoe-shoe type, such as is shown in Fig. 1 of the accompanying cut. The filaments were thick and short, and little or no treatment was employed. As the superiority of the longer type became apparent the filament was given a loop or coil which allowed its length to be increased without enlarging the bulb, and its percentage of graphitic low-resistance carbon to be increased with it so that this filament took the familiar form shown in Fig. 2. A variation upon it was the addition of more turns in the coil.

While this form is still made, it is largely giving way to another type developed by increasing the diameter of the coil and anchoring its lowermost point, as illustrated in Fig. 3, this being known as the oval-anchored type. This allows a further increase of the length and percentage of low-resistance graphite, and is made in spite of several disadvantages. One of these is the impossibility of practicably anchoring the filament during the process of flashing so that unsupported this process cannot be carried on at as high a heat as is desirable without badly warping the filament. The graphite deposited is more dense and stable with the higher temperatures of flashing which cannot be obtained on the oval-anchored filament. The cement used at the anchored point also causes trouble. This point being distant from the glass supporting the anchor wire, and being heated in two directions and cooled in only one, rises to a high heat, throwing off gases within the bulb which combine with the carbon on the surface of the filament to darken the latter, thereby tending to spoil the metallic gray finish which gives the lamp a high efficiency by reducing the amount of energy necessary to maintain the filament at the proper temperature as pointed out above. In spite of these faults, however, the perfected oval-anchored type is far superior to its predecessors, solely because a greater proportion of the filament's bulk is of the purer, denser form of carbon.

A further step in the support of long filaments is taken by making the filament in two pieces connected in series with each other, as shown in Fig. 4, which illustrates what is commonly known as the double filament type. This double filament consists practically of two 8-c.p. 50 to 60-volt filaments connected in series with each other by means of a short piece of wire bedded in the glass and cemented at its two ends respectively to one end of each filament. In this lamp there is no oval coil to twist out of shape and short circuit on itself. The loop shape of the two filaments allows the deposit of graphitic carbon to be made at a higher temperature, making it dense and hard and durable.

For high voltage—that is, those intended for 200 to 240-volt circuits—mechanical difficulties of course, arise in making and sup-

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porting filaments of twice the length and half the cross-section of those for 100 to 120-volt lamps. The result is that comparatively little or no "treatment" can be applied to such filaments without making their resistance too small, which accounts for their failure to equal 100 to 120-volt lamps in the qualities of efficiency and longevity. Still other expedients of support have to be used with these high voltage filaments, such, for example, as anchoring two points, &c.

An idea of the proportions of graphitic to "base" carbon in modern 3·1-watt, 16-c.p. 100-volt lamps can be gained from the fact that lamps of the oval-anchored type are treated down to approximately $\frac{1}{3}$ of the original resistance of the base of the filament, while those of the double filament type are treated down to less than $\frac{1}{4}$ of the original resistance, this reduction being accomplished by depositing a tube or sleeve of graphitic carbon with a thickness of about $\frac{1}{16}$ of the diameter of the finished filament, thus making about $\frac{1}{3}$ of its cross-section graphite, the inside $\frac{5}{8}$ diameter or $\frac{3}{8}$ cross section being "base" carbon.

THE ELECTROLYTIC TREATMENT OF COMPLEX SULPHIDE ORES.*

BY SHERARD COWPER-COLES.

(Concluded from page 113.)

Zinc Sponge.

The chief difficulty met with in obtaining good deposits of zinc is the formation of zinc sponge. The following is an analysis of zinc sponge deposited from a solution containing about 30oz. of zinc sulphate to the gallon, and about 2oz. of ferrous and ferric sulphate, and small traces of copper.

	Per cent.
Zinc oxide	63·53
Zinc	2·90
Sulphuric anhydride (SO_3)	10·05
Silica	1·05
Copper oxide	0·80
Lead oxide	0·07
Alumina	1·20
Ferric oxide	0·60
Lime	0·45
Chlorine and carbonic acid	traces.
Moisture and organic matter	19·35
	100·00

The author has substituted zinc sponge for zinc dust, with satisfactory results, in his regenerative electro-zincing process. Zinc dust of grey zinc has of late been in strong demand, no supply being available. One reason for this is probably due to the fact that at the very low prices that have prevailed some producers gave up the production, whilst others, in rebuilding their furnaces, adopted the Belgian-Silesian system, whereby smaller quantities of zinc dust are produced. Zinc dust, in addition to being used for the Cowper-Coles galvanising process, is employed for the refining of carburetted hydrogen oils and zinc-ethyl, and is also largely used in indigo dying. Zinc dust is also used for the extraction of gold and silver from photographic waste, and for the manufacture of paint in America. The production of zinc dust in Upper Silesia amounts to from 1,500 to 2,000 metric tons per annum. A number of samples of zinc dust obtained from various sources averaged from 96 to 97·5 per cent. zinc; they all contained traces of cadmium.

The vexed question of what the formation of zinc sponge is due to has been investigated by Mylius and Fromm, Siemens and Halske, Nahnsen, Ashcroft, and others. The two former attribute it to the oxidation of the zinc. Nahnsen holds similar views—viz., that zinc sponge is the result of the decomposition of the water. Siemens and Halske, on the other hand, attribute it to the existence of zinc hydride, ZnH_2, which they say effects a molecular change in the zinc deposited.

Experiments made by the author to determine if it was possible to prevent the formation of zinc sponge by passing a suitable gas over the cathode were described in *The Electrician*, Vol. XLI., p. 382.

Messrs. Foerster and Günter have lately carried out some experiments in connection with the electro-deposition of zinc from chloride solutions and the nature of spongy zinc. A zinc cathode was suspended in a perfectly neutral purified zinc chloride solution, containing 5·46 grams of zinc per litre, between two anodes of pure electrolytic zinc. The current density was 1·4 ampere per square decimetre (equal to 15·5 amperes per square foot). A smooth compact deposit was obtained on the cathode for the first six or seven hours, but after thirty hours spongy zinc was deposited, and the solution was turbid from the presence of suspended basic zinc chloride. On filtering off the precipitate, and inserting a new cathode, a good deposit was obtained during the first few hours; the electrolyte then became turbid, and at the same time the deposit showed signs of becoming spongy. Schnabel† states that the formation of spongy zinc may be prevented by the addition of chlorine or bleaching powder to the solution. The method proposed by Mylius and Fromm, of keeping a solution of zinc sulphate constantly acid to prevent the formation of zinc sponge, has been tried. A small quantity of chlorine was constantly evolved in the cell from two small platinum anodes, which were connected with the positive pole of the accumulators, whilst the negative pole was attached to a large zinc plate, which thus served as cathode for both pairs of anodes. The formation of spongy zinc, however, could not be prevented in neutral solutions by this arrangement.

The oxygen of the air easily oxidises zinc in the presence of zinc chloride, and a certain quantity of the oxide formed is dissolved by the solution, forming basic zinc chloride. Deposition of spongy zinc only occurs when the excess of oxide begins to render the electrolyte turbid, and if this precipitation is prevented by the periodic addition of hydrochloric acid, good deposits of zinc can be obtained. Messrs. Foerster and Günter therefore recommend that the electrolyte should contain a quantity of free hydrochloric acid, corresponding to a one-twentieth to one-thirtieth normal solution. The acid may be increased until it represents one-tenth normal acid, but it should not be allowed to fall below one-hundredth to one three-hundredth normal.

If this slightly acid electrolyte is used in conjunction with the arrangement for liberating free chlorine, still better deposits of zinc are obtained. When the solution contains 0·2 gram of free chlorine per litre, the hydrogen evolved at the cathode does not remain sticking to the electrode long enough to impair the surface of the deposit. Although the main body of the electrolyte remains slightly acid, it sometimes happens that bad—that is, spongy—deposits of zinc are obtained. This is accounted for by the fact that the layer of electrolyte in contact with the cathode becomes deprived of its free acid, but this difficulty may be overcome by sufficiently agitating or circulating the electrolyte. On substituting anodes of commercial zinc for the pure zinc anodes, the zinc deposited on the cathodes was found to be entirely free from arsenic.

Messrs. Foerster and Günter have also found that the addition of 1 per cent. of a perfectly neutral solution of zinc chloride furnished good deposits of zinc on electrolysis, whilst on the addition of 0·025 per cent. of hydrogen peroxide the formation of spongy zinc was observed after electrolysing 10 minutes.

Cost of Depositing Zinc.

Nahnsen states that he is able, by using condensing engines, to deposit one ton of zinc at an expenditure of from 3 to 3½ tons of coal, according to the calorimetric value of the fuel. In one experiment, conducted at a temperature of 92°C. and with a current density of 100 amperes per square metre (9·29 amperes per square foot), the deposit was not spongy.

In an article which recently appeared in *Engineering* the cost of electrical energy necessary for depositing one ton of zinc from a zinc sulphate solution was arrived at as follows:—The theoretical energy required is 2,619 E.H.P.; the cost of this at 0·10d. per E.H.P. would be £1. 1s. 10d. An energy efficiency of 33 per cent. is, however, the average efficiency obtained in the electrolytic copper-refining industry, and it is unlikely that this will be exceeded in any zinc-depositing process. Multiplying the above estimate by 100/30, the total comes to £3. 5s. 6d. as the probable minimum expenditure per ton of zinc for electrical energy alone, even when generated from water power.

The theoretical amount of electricity necessary to separate 1lb. of zinc in solution of the sulphate can be calculated by aid of the electro-chemical equivalent of zinc, 1,000 amperes per hour separating 2·674lb. of zinc. The decomposition value of zinc sulphate, as determined by Le Blanc, is 2·35 volts. In practice 3·75 volts are required when lead anodes are used. Assuming that the cost of a Board of Trade unit is ½d., the theoretical electrical cost of producing one ton of zinc would be £3. 5s. 5·31d., 3141·36 B.T.U., 4210·93 E.H.P. being required for the purpose.

Weight of Zinc Deposited.

There is found to be very little difference between the actual weight of zinc deposited and the theoretical amount. In practice it it found difficult to make any accurate determinations of the actual amount deposited as compared to the theoretical, except for a period extending over a month or more. According to Messrs. Foerster and Günter, when a 40 per cent. boiling solution of zinc chloride is saturated with zinc oxide (the cadmium being subsequently removed by treatment with pure zinc), electrolysed at 90°C., with insoluble (platinum) anodes, good deposits of zinc are obtained. The quantity of zinc thus deposited, when compared to the amount of coppre deposited by the same current in a copper voltameter, was found to be in good agreement with Faraday's law. Ashcroft† on electrolysing a similar solution, found that the zinc deposited in the first

* Abstract of a Paper read before the Society of Engineers, Nov. 6.

* "Handbuch der Metallhüttenkunde," II., p. 114.

† Schnabel's "Handbuch der Metallhüttenkunde," II., pp. 214, 215.

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two hours was 49 per cent., during the next two hours 37 per cent., and during the third two hours 14 per cent. in excess of that required by Faraday's law, whilst in the last two hours the theoretical amount was deposited.

Some careful laboratory experiments have been made by the author to determine the actual weight deposited as compared with the theoretical, with varying percentages of free acid, the results of which are set out as a diagram in Fig. 6. Another set of experiments was made under the following conditions :—

The electrolysis was carried out in a small cell having a capacity of approximately one gallon. The anode consisted of a sheet of lead, the submerged area being approximately 10⅛in. by 4½in., and the cathode consisted of a sheet of aluminium with a submerged area of 10⅛in. by 4⅜in., equal to 45·9295 sq. in., weighing 290·262 grams. The current density was approximated to 15 amperes per square foot of superficial area on the side exposed to the anode only. For convenience of accurate measurement the actual current was approximated as near as possible to 4·5 amperes. By means of a hand resistance this was kept constant to the normal, as far as possible ; the actual variation, due to the uneven working of the generator employed, after subtracting the deficiency from the excess, leaves a balance to be added of only 0·0255 ampere hours, which is exceedingly minute, but which has been taken account of in the calculations. The plates were adjusted to one inch apart, and the time of the test was four hours. The rate of flow of the solution through the cell was ¼ gallon in 18min. and 53·2sec., equal to 0·794 gallon per hour, so that the number of gallons treated, inclusive of the quantity in the cell at the start, was approximately 4·176.

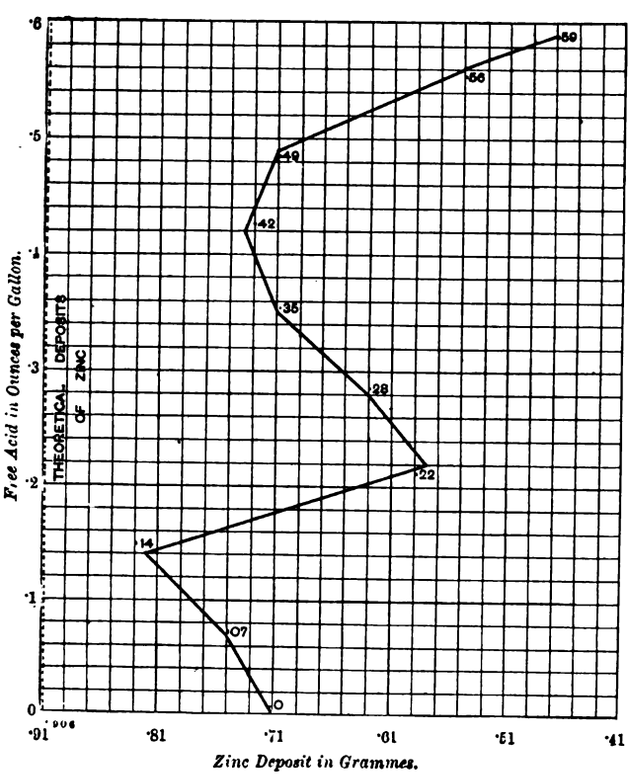

FIG. 6.

During the test charts were made of the temperature of the solution, and also of the volts and amperes. At the end of four hours the zinc cathode was immediately removed and washed, and carefully dried. There was a bluish-white deposit of zinc, which appeared very even, over the surface, and had crept very slightly behind the plate : the deposit appeared rather thicker at the bottom than at the top, and had a tendency to become crystalline and form trees at the bottom, and a small amount of zinc may have been lost owing to this. The actual weight of zinc deposited was 20·697 grams, as against a theoretical deposit for the same number of ampere-hours of 21·87 grams, showing thus a loss of 5·3634 per cent., or an efficiency of 94·636 per cent.

Manufacture of Zinc White.

Zinc carbonate of excellent colour has been made by precipitating the zinc from the zinc sulphate solution by adding sodium carbonate after the iron, copper, and manganese have been removed, the iron being precipitated with bleaching powder and the manganese thrown down as manganic hydrate or as a so-called calcium manganite,

$$2FeSO_4 + MnSO_4 + 3\,CaO + 2\,CaCl_2O = MnO_2 + Fe_2O_3 + 3\,CaSO_4 + 2\,CaCl_2$$

by the addition of lime. The copper is removed by passing the solution over beds of metallic zinc. The carbonate, after being precipitated, is dried on filter beds, the moisture being driven off in suitable drying ovens ; the weight per cubic foot when dried being 29lb. The carbonate is then removed to a muffle-furnace, and brought to a red heat to convert the carbonate into oxide. In practice considerable difficulties are experienced, both chemical and mechanical, in obtaining a perfectly white carbonate and oxide.

Dr. Schnabel, in company with Mr. Hampe, has patented a process for the reduction of zinc sulphate by calcination after admixture with carbon, the idea being that desulphurisation would be accomplished at a low temperature. Mr. Ashcroft has patented another process, which consists in evaporating the solution to syrup consistency (about 250 gallons per litre), thickening to a paste by the addition of zinc oxide, drying in the air, and furnacing. Mr. Ingalls maintains that zinc sulphate can be completely converted into zinc oxide if sufficient time is allowed, at a bright red heat (1,000°C.). Zinc oxide made by the distillation process is sometimes found to have a yellow tinge, due to the presence of sulphide of cadmium—even 0·003 per cent. being found to discolour the product—not to the presence of iron.

Zinc Sulphate.

Zinc sulphate is readily made by running the zinc sulphate solution after filtration into cooling and crystallising pans. If a pure zinc sulphate is required, the iron and manganese are separated by precipitation and filtration. Taking the price of metallic zinc at £23 per ton, the value of crystallised zinc sulphate would be £5. 4s. 2d. per ton, and the value of amorphous zinc sulphate £9. 5s. 9d. per ton.

Leaching Out the Lead.

The lead is leached out with a caustic soda solution containing 16oz. per gallon. The leaching vat is made of iron, and is cylindrical in form and provided with a false bottom, the ore being leached by percolation. The solution is worked hot, at a temperature of about 200°F. The time required is found to be about 20 hours. The ore, previously to being placed in the leaching vat, is mixed with the required quantity of calcium oxide to convert the sodium silicate which is formed into calcium silicate. The precipitated calcium silicate is suitable for the manufacture of cement. The following is an analysis of a sample thus obtained :—

		Deductory H_2O and CO eliminated by burning.	Ideal cement.
H_2O	19·2	...	...
CO_2	14·2	...	...
$Al_2O_3Fe_2O_3$	7·0	10·5	10·0
CaO	48·8	73·2	65·0
SiO_2	8·2	12·3	22·0
Na_2O, K_2O, SO_3, MgO	by diff. 2·6	4·0	3·0

The solution is then ready for being electrolysed, or can be run into suitable vessels and litharge formed or white lead precipitated. If any zinc goes into solution, it is found in practice to give rise to no difficulties, as the lead can be deposited free from zinc. The theoretical voltage required to deposit the lead is 1·12, and the zinc 1·85, the actual voltage required being from 1·4 to 1·6 for the lead and about 2·8 for the zinc. If the sodium plumbite solution is electrolysed only, the caustic soda can be used over and over again, being occasionally regenerated with barium oxide.

Deposition of the Lead.

Lead is deposited from the sodium plumbite solution on revolving iron cathodes, the lead sponge being removed by scrapers. It is pressed and dried, and then melted. Lead sponge is readily melted, the loss being very small. Iron anodes are used in the depositing cell ; a small quantity of iron is found to go into solution. The voltage at the terminals of the bath is 2·2 ; the best results have been obtained with a current density of about 10 amperes. The revolving cathodes are caused to make about two revolutions per minute. The construction of the cells is very similar to that used for zinc deposition.

A sample of pig lead produced by this process gave on analysis the following result :—

	Per cent.
Copper	0·0800
Cadmium	Trace.
Bismuth	Trace.
Antimony and tin	0·0024
Iron	0·0117
Nickel	Trace.
Zinc	0·0150
Lead, by difference	99·8929

Cost of Depositing Lead.

The cost of depositing lead is far less than that of zinc, as the current that would deposit one ton of zinc will deposit three tons of lead. Tommasi claims to be able to deposit lead at a cost of 6s. 8d.

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per ton of 2,240lb. inclusive. The theoretical amount of electrical energy required to deposit one ton of lead is 263·5 kilowatts, which at ½d. per kilowatt equals 11s. per ton of lead deposited.

Manufacture of White Lead.

The sodium plumbite solution is run into cylinders, through which CO_2 is blown so as to precipitate the lead in solution as white lead. The cylinders are provided with mechanical stirrers, and fitted with discharge cocks, through which the precipitated white lead is drawn off on to filter cloths, where it is drained and washed and finally dried. The CO_2 is made by drawing off the sulphurous fumes given off from the roasting furnace, the sulphurous fumes being forced through water by means of a gun-metal pump. Carbonate of lime is added to the sulphurous acid, the lime combining with the sulphur dioxide to form calcium sulphite, the carbonic acid gas being given off mixed with a certain amount of the sulphurous acid. These two gases are then passed through a vessel containing sodium plumbite, lead sulphite being precipitated, any lead carbonate that may be precipitated being re-dissolved by the

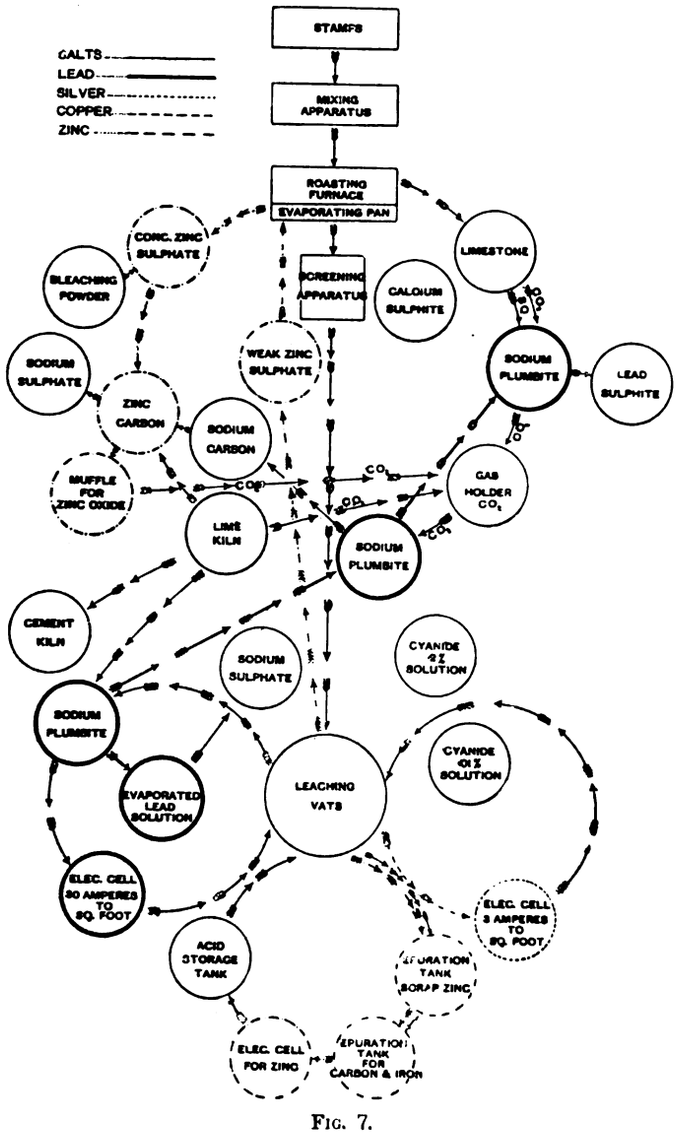

Fig. 7.

sulphurous acid. The CO_2 drawn through the solution is then passed through a second cylinder containing sodium plumbite, the lead in solution being precipitated as white lead. Care must be taken not to pass the CO_2 in for too long a period, otherwise the lead is precipitated in a crystalline form, which is not suitable for the manufacture of white lead. Temperature also has a marked effect on the structure of the precipitated white lead, as is shown in the following analyses. A solution of caustic soda (1lb. to the gallon) saturated with PbH_2OPbCO_3 was used for the experiments.

		Microscopic appearance.
Precipitated at 20°C. ...	No. 1 A.	Very crystalline, slightly amorphous.
	No. 1 B.	Decidedly crystalline.
Precipitated at 50°C. ...	No. 2 A.	Slightly crystalline, very amorphous.
	No. 2 B.	Very slightly crystalline, very slightly amorphous.
Precipitated at 80°C. ...	No. 3 A.	Not decidedly crystalline, fairly amorphous.
	No. 3 B.	Very amorphous.

Formation of Litharge.

Litharge of excellent quality can readily be formed by running the sodium plumbite into an evaporating pan and cooling and crystallising troughs, when litharge crystallises out, the supernatant liquor being run off, and mixed with fresh solution, and again evaporated. Litharge produced by this process is free from red lead and silver, and contains only a small portion of silica. The colour of the protoxide of lead varies according to the mode of its preparation. The litharge obtained by the oxidation of lead in a current of air is generally of a lead colour, due to the presence of a small quantity of minium. If the oxidation is effected at a lower temperature than that required for the fusion of the oxide, the yellow powder termed massicot is obtained. Litharge obtained from a sodium plumbite solution is in nearly transparent anhydrous dodecahedral crystals, or the crystals are rose-coloured or of a golden colour, which when heated assumes a brown-red colour, which disappears again on cooling.

Although zinc may be present in the sodium plumbite solution, the litharge is found to be quite free from zinc. The solution is evaporated down to one-half of its volume, and then left to crystallise. A scum forms on the surface of the liquid at the point of sufficient evaporation. Solid matter accumulates at the bottom of the evaporating pans, which is found to consist mostly of sodium sulphate. The sodium sulphate can be readily separated by dissolving the deposit in boiling water and cooling the clear solution thus obtained to a temperature of about 10°C. Assuming the value of lead to be £13. 7s. 6d. per ton, the lead in pure litharge would be worth £12. 8s. 3d.

Leaching out the Silver.

The ore, after being thoroughly washed, is then leached with a solution containing about 0·2 per cent. of cyanide of potassium, and finally leached with a weaker solution containing about 0·01 per cent, and then washed. A perfect leach can be obtained in about five to six hours, there being no traces of silver left in the ore.

Deposition of the Silver.

The silver cyanide solution thus obtained is run into electrolysing cells and circulated over and under alternate plates of silver and lead, the lead plates being the anodes and the silver the cathodes. A current density of 0·04 ampere per square inch is used, the voltage at the terminals of the electrolysing cell being about 2 volts. The silver is deposited on to the thin silver sheets. When the deposit has attained the desired thickness they are removed from the suspension clips and melted down.

Fig. 7 is a diagram of the Cowper-Coles process, which shows the different stages of the various operations, also the different cycles, both for the zinc depositing, zinc oxide, metallic lead and white lead.

THE COST OF STEAM RAISING.*

BY JOHN HOLLIDAY, ASSOC.M.INST.C.E.

In the earlier days of the steam engine it was customary to measure the efficiency of steam plant by the amount of work done by a given weight of coal, and this was expressed by giving the weight of coal consumed per horse-power per hour, allowance sometimes being made for the quality of the coal used. The practice has now arisen of expressing the efficiency of an engine by stating the quantity of steam it uses per horse-power per hour, thus eliminating entirely all questions of the quality of the fuel, the efficiency of the boiler for transmitting the heat of that fuel to the water, and of the furnace and stoker, whether human or mechanical, in evolving from the fuel all the heat it contains. We have therefore on record the results of many engine trials, given in figures which take no account of the performances of the boiler by which the steam they used was supplied, and we have also many recorded tests of steam boilers determined quite apart from any question of power involving the employment of a steam engine. Again, we have many instances given of the cost of steam power, the best of which are summed up by Prof. Unwin in Chapter III. of his work on the Development and Transmission of Power; but in all these cases, in order to arrive at the cost of the steam power, it has been, of course, necessary to include the working and cost of both engine and boiler; and whilst a steam engine cannot perform any useful work when dissociated from the steam boiler, the boiler can, and often does, perform many useful functions other than the production of power by means of a steam engine, and it is to the cost of producing steam, quite apart from the question of power, that attention is directed in this Paper. A ton of coal may cost, say, 8s., when delivered on the stokehold floor, and we may, in a general way, consider steam delivered from the boiler into the steam main as the manufactured article of which the coal is the chief but not the only raw material used in the process of manufacture: the question

* Paper read before the Institution of Electrical Engineers, November 23rd. Slightly abridged.

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then becomes, What is the increased value of this ton of coal when delivered in the form of steam into the steam mains? The other items which, with the cost of fuel, go to make up the total cost of steam produced are working expenses, maintenance of boiler and plant, capital charges, rents, rates, taxes, &c. In almost all cases the cost of the fuel is by far the greatest part of the whole cost, and it can only be in the centre of the coal fields, or some other equally favoured spot, where it is probable that the cost of the fuel will be anything less than 50 per cent. of the total cost, exception being, of course, made to those cases in which waste materials, by-products, or

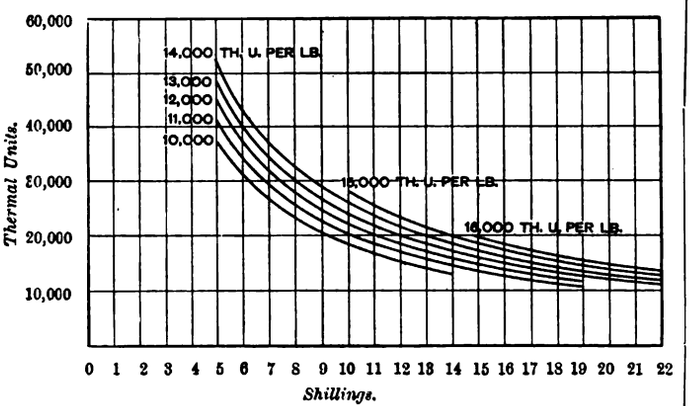

FIG. 1.

refuse, which might otherwise have to be removed at some expense, are used as fuels for steam raising. This being the case, the cost of fuel required to convert a given quantity of water at a given temperature into steam at a certain pressure gives a fairly relative idea of the cost of raising steam in districts where similar conditions and prices of fuels obtain. Mr. Bryan Donkin, M.Inst.C.E., has largely used, as a basis of comparison, the cost of fuel required to evaporate 1,000 gallons, the water being at a temperature of 60°F. and the steam evaporated at 60lb. per square inch above the atmosphere, or else the temperature of the water is taken at 212°F. and

This figure gives, not the cost of evaporating 1,000 gallons, but only the cost of the fuel required to evaporate 1,000 gallons of water.

Mr. Bryan Donkin, M.Inst.C.E., has published figures from some tests he carried out with different kinds of fuel in the same boiler, the conditions in all cases being the same: the results are comparable on the basis of the cost of fuel required to evaporate 1,000 gallons.

	Kind of fuel.	Cost of fuel per ton.	Water evaporat'd per lb. of fuel.	Cost of fuel per 1,000 gallons evaporated.
A	Dust coke.....	5s.	6lb.	3s. 8d.
B	Dust Welsh coal.	10s.	8lb.	5s. 3d.
C	Large Welsh coal	22s.	9lb.	10s. 11d.

These figures go far to show the economy to be obtained by using inferior fuels, which, as a rule, are far cheaper on the basis of calorific power than the higher class fuels. No better example of this could be given than the comparison of experiments B and C in the table given above, where we see that a difference of 120 per cent. in the price of the fuel gives an increased efficiency of but 5·5 per cent. at an increase in cost of 108 per cent. A table showing the number of thermal units in one pennyworth of fuel of various qualities and prices was given by Mr. R. E. B. Crompton, past President, in his Paper on the cost of electrical energy read before this Institution in April, 1894.* Some figures from this table will be found set out in Fig. 1. These, like the preceding table, show the enormous advantage promised by the use of low quality and low-priced fuels, but, as there never was a gain without some loss, we may briefly inquire what the possible losses and disadvantages of cheap fuels are—and they are many.

In the first place, in order to get the same amount of heat with a low quality fuel as with a higher quality under similar conditions, more fuel must be burned in the same time; then, if the boilers and furnaces are already working up to their full power, either more boilers and furnaces must be put down, or the present furnaces must be enlarged, entailing an expenditure of capital, the interest of which must be set against the extra economy obtained; or else the fires must be worked harder, perhaps by the use of forced draught, causing the furnace gases to leave at a higher temperature and thus carry to waste a larger proportion of the heat in the fuel than formerly. The mere fact of more fuel having to be fired into the

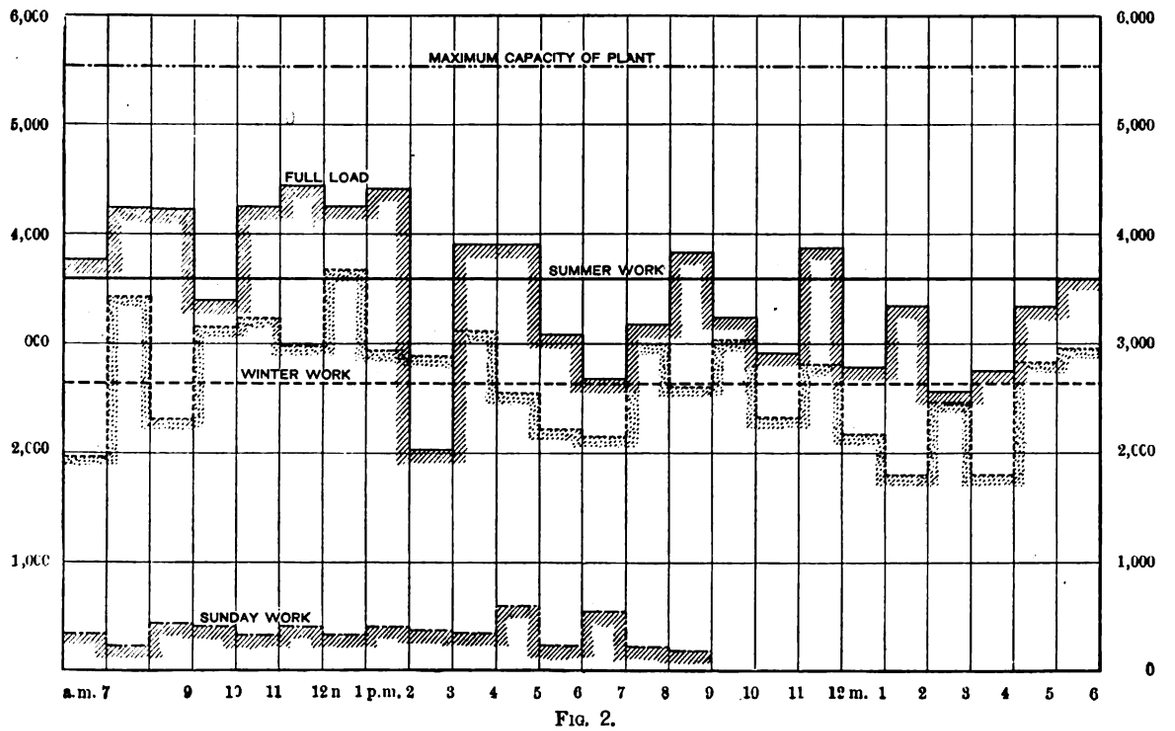

FIG. 2.

evaporation at atmospheric pressure, or, in other words, evaporation is from and at 212°F.; in any case a reduction to a common basis is easy when the conditions are known.

The following formula gives a ready means of obtaining the cost of fuel to evaporate 1,000 gallons of water when the price of the fuel and the quantity of water evaporated per lb. of fuel are known.

Let C = cost of evaporating 1,000 gallons in shillings.
" P = price of coal per ton in shillings.
" W = lbs. of water evaporated per lb. of coal.

Then $C = \frac{P}{W} \times \frac{10.000}{2,240} = 4{\cdot}464\ P/W.$

furnaces every hour will entail more work on the stoker, for which extra wages will have to be paid either to the same or to additional men. The extra amount of fuel will cause the fire doors to be opened, in the case of hand-fired furnaces, more frequently or for longer periods, both for firing and for cleaning fires, whilst the extra amount of refuse taken from the furnaces will carry to waste a correspondingly large amount of heat, and, what is of more importance, will often cost a great deal more in removal, particularly in busy manufacturing centres. Extra storage and space for fuel may have

* [See *The Electrician*, Vol. XXXII., p. 725. This table is referred to as Table I.—ED. *E.*]

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Table II.—*Forced Draught Boilers. Nos. 1, 2, and 3.*

Boiler.		Fuel.						Water.				Cost of fuel.	Working Expenses.																	
Date.	Time.	Breeze.	Large coke.	Total.	Av. price per ton.		Refuse.	Evaporated.	Used by fan engine.	Net evaporation.	Evap. per hour per boiler.		Wages of stokers and cleaners.			Fuel weighing and distribution			Removal of refuse.			Water.			Light.			Stores.			Total.		
1895.	Boiler hours.	Tons	T'ns	Tons	s.	d.	Tons	Gals.	Gals.	Gals.	Gals.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
Jan.	1,867	515	...	515	3	6	122	715,850	46,675	669,175	358	90	2	6	23	6	11	2	4	5	12	4	0	11	18	7	2	7	0	1	5	9	53	6	8
Feb.	1,615	390	...	390	3	6	93	542,100	40,375	501,725	311	58	16	0	25	19	0	1	11	4	9	6	0	9	0	8	2	10	0	0	18	3	49	5	0
March	1,265	289	...	289	3	6	140	401,710	31,625	370,085	293	50	11	6	28	17	3	1	4	5	14	0	0	6	13	11	1	0	4	1	7	4	53	3	3
April	1,866	443	...	443	3	6	102	615,770	46,650	569,120	305	77	10	6	24	14	0	2	12	3	10	4	0	10	5	3	1	11	0	1	0	4	50	6	10
May	1,927	433	19	452	3	9	102	640,174	48,174	592,000	307	84	16	0	24	1	0	2	10	3	10	4	0	10	13	5	0	15	4	1	14	6	49	18	6
June	1,315	292	...	292	3	6	95	405,880	32,875	373,005	284	51	2	0	25	1	4	0	19	9	9	10	0	6	15	3	0	13	0	1	5	9	44	5	1
July	1,855	361	99	460	4	9½	95	701,374	46,374	655,000	353	110	4	0	15	12	5	2	10	11	9	10	0	11	13	10	1	3	0	1	6	1	41	16	3
Aug.	1,994	344	138	482	5	2½	96	756,368	49,850	706,518	354	125	15	0	17	16	9	2	9	11	9	12	0	12	12	2	1	2	0	0	11	4	44	4	8
Sept.	1,903	280	140	420	5	6	85	671,440	47,575	523,865	323	115	10	0	20	4	9	1	4	10	8	10	0	11	3	10	1	2	0	0	18	11	43	5	0
Oct.	1,814	236	176	412	6	0½	78	682,856	45,350	537,506	351	124	18	0	21	19	2	2	3	3	7	18	0	11	7	7	1	1	4	2	3	4	46	12	8
Nov.	1,338	291	12	303	3	9	92	433,030	33,450	399,580	299	84	3	6	25	4	2	1	4	7	9	4	0	7	4	4	1	5	4	3	10	11	44	2	8
Dec.	1,840	442	...	442	3	6	102	514,380	46,000	568,380	309	77	17	0	24	10	6	2	12	3	10	4	0	10	4	8	1	15	4	0	6	8	49	13	5
Av. & total	20,599	4,316	584	4,900	4	3½	1,203	7,180,932	514,973	6,665,959	323	1,051	6	0	277	7	6	23	8	2	120	6	0	119	13	6	16	6	10	16	9	2	573	11	2

Table III.—*Natural Draught Boilers. Nos. 4, 5, 6, 7, 8, and 9.*

Boiler.		Fuel.						Water.			Cost of fuel.	Working expenses.																			
Date.	Time.	Welsh.	Scotch.	Total.	Average price per ton.		Refuse.	Evaporated.	Evap. per pound of fuel.	Evap. per hour per boiler.		Wages of stokers and cleaners.			Fuel weighing and distributi'n.			Rem'val of refuse.			Water.			Light.			Stores.			Total.		
1895.	Boiler hours.	Tons.	Tons.	Tons.	s.	d.	Tons.	Gals.	lbs.	Gals.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
Jan.	2,351	487	...	487	14	6	47	892,320	8·18	380	353	1	6	23	8	2	2	2	0	4	14	0	14	17	6	2	19	0	0	14	3	48	14	11
Feb.	2,234	408	...	408	14	6	48	819,592	8·97	367	295	16	0	26	13	0	1	12	9	4	16	0	13	13	0	3	9	0	0	13	3	50	17	0
March	2,944	536	...	536	14	6	70	1,103,084	9·18	375	388	12	0	23	17	5	2	5	4	7	0	0	18	7	8	3	11	0	2	1	4	57	2	9
April	2,296	436	...	436	14	6	49	889,596	9·11	387	316	2	0	29	19	4	2	11	6	4	18	0	14	16	6	1	18	8	0	15	1	54	19	1
May	3,034	525	...	525	14	6	54	1,098,106	9·34	362	382	12	6	16	19	4	2	18	3	5	8	0	18	6	0	1	3	8	1	13	7	46	8	10
June	3,005	492	...	492	14	6	52	1,084,922	9·84	361	356	14	0	14	16	11	1	13	4	5	4	0	18	1	7	1	10	0	1	15	1	43	0	11
July	3,135	526	86	612	14	3½	72	1,381,211	10·07	440	437	13	0	25	3	2	3	7	8	7	4	0	23	0	5	1	15	2	1	9	5	61	19	10
Aug.	3,282	587	...	587	14	6	72	1,343,916	10·22	409	425	11	6	32	4	6	3	0	9	7	4	0	22	7	11	1	17	0	0	7	8	67	1	10
Sept.	3,399	609	...	609	14	6	73	1,345,900	9·86	396	441	10	6	22	2	5	1	15	11	7	6	0	22	8	7	2	0	4	1	0	2	56	13	5
Oct.	3,409	619	...	619	14	6	71	1,360,745	9·81	399	448	11	6	31	11	0	3	5	0	7	2	0	22	13	6	2	0	0	2	17	8	69	9	2
Nov.	3,266	440	70	510	14	3½	71	1,232,619	10·80	377	364	17	0	16	8	6	8	6	1	7	2	0	20	10	10	2	11	4	3	6	7	58	5	4
Dec.	2,702	332	156	488	14	0½	66	1,035,130	9·47	383	342	18	0	25	8	9	6	0	9	6	12	0	17	5	0	2	12	0	0	2	1	58	0	7
Av. & total	35,057	5,997	312	6,309	14	5¼	715	13,594,141	9·62	388	4,553	19	6	288	12	6	38	19	4	74	10	0	226	8	6	27	7	2	16	16	2	572	13	8

to be provided, and the wear and tear of the furnaces increased according to the extra amount of fuel used, and not according to the amount of steam produced. Low quality fuels too, as a rule, require a stronger draught to burn them to the best advantage than better qualities: this may necessitate an expenditure for more chimney power in the case of natural draught, and larger fans and engines, of course using more steam to drive them, in the case of forced draughts. In substituting inferior for better-class fuels we may expect a reduction in the cost of the fuel, depending on the differences in the ratio of calorific value to price of the two fuels, and an increase in working expenses, &c., depending on the increased amount of fuel used.

It may not be out of place to give here a word of warning to those who are invited by the manufacturers of special furnaces to enter into contracts with them, in virtue of which the manufacturer of the patent furnace shall take as his remuneration for fixing the furnace, free of charge or at cost price, a definite proportion of the ascertained saving in the fuel bill from the time the new appliance was put in as compared with a previous period: such an arrangement may seem very fair and reasonable, but if the reduction of the fuel bills is accomplished by the use of inferior fuel, there must inevitably be increased incidental expenses, the whole burden of which will fall on the steam user, and from which the furnace manufacturer will be entirely free. Still more to be deprecated is any arrangement based on a comparison of the amount and cost of fuel consumed on two trials, one made before the introduction of the special appliance and the other after it, for, in addition to other disadvantages to the steam user, it is reasonable to assume that the furnace manufacturer will take pains to secure those conditions under which his furnace works best, whilst a furnace about to be discarded is scarcely likely to be either in the best possible order or worked to the best advantage.

It sometimes happens that a single range of boilers has to supply steam to a number of more or less different and independent concerns, each of which has to bear its own share of the expenses of producing the steam it uses, so that it becomes necessary to determine the total cost of the steam produced and divide that sum amongst the different concerns as nearly as possible according to their respective consumptions. This has been the case with a range of boilers in which the author has been directly interested for the last six years. Failing to find any records of determinations of the proportion which the fuel bill bore to the total cost of the steam delivered into the steam main, he has collected the data on which the following statements of costs have been made out.

The plant consists of nine Lancashire boilers in the main boiler house, and four spare boilers in another house, connected to the same system of steam mains, but the latter used only as spare to the nine boilers in the larger house. The nine Lancashire boilers are of various makes and ages, none of them being modern, and vary in size from 6ft. 6in. to 7ft. in diameter, and from 28ft. to 30ft. in length. They are arranged in two groups, Nos 1, 2, and 3 being fitted with Perret's water-cased grates for burning inferior fuels and delivering their products of combustion into a separate main flue and chimney from the other six, which are fitted with ordinary bars and hand fired, Martin's balanced doors being used in the 12 furnaces of these six boilers. The boilers are all loaded to 60lb. pressure per square inch, and feed water is delivered to the Lancashire boilers from a common feed main through three steam heaters, which, being supplied with steam up to 12lb. per square inch above the atmosphere, heat the feed water to an average of 220°F. after it passes the feed pump on its way to the boilers. The demand for steam is fairly constant during the 24 hours (*see* Fig. 2), so that it is not necessary to bank up any of the fires during any portion of the day or week except between six o'clock a.m. and six o'clock p.m. on Sundays, when two boilers only are kept under very easy steam.

In working these boilers it has all along been recognised that steam was produced much more cheaply by the forced draught than by the natural draught furnaces, consequently they were always worked up to their full power, and, as the minimum demand for steam almost always exceeded, except on Sundays, the amount they by themselves were capable of producing, they were seldom even damped down, and therefore worked under conditions extraordinarily favourable to economy; whilst the natural draught furnaces, having to make up the difference between the demand for steam and that produced by the forced draught furnaces, being fitted for that purpose with an automatic damper, were constantly varying between partial and full load, so that losses by unconsumed gases and radia-

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tion were abnormally great. This fact must be kept in mind and allowed for in comparing the results obtained in the two systems, and it will be seen that the six boilers fitted with natural draught furnaces gave much better results when doing the largest amount of work.

at the rate of about 3,800lb. of water per hour per boiler, equivalent to 190 H.P. at 20lb. of steam per horse-power per hour, or 11·7 per cent. more power per boiler than in the case of the boilers fired with breeze. We have therefore two ranges of boilers, one using a cheap fuel and producing steam at a cost for fuel of 2s. 8¼d. per 1,000

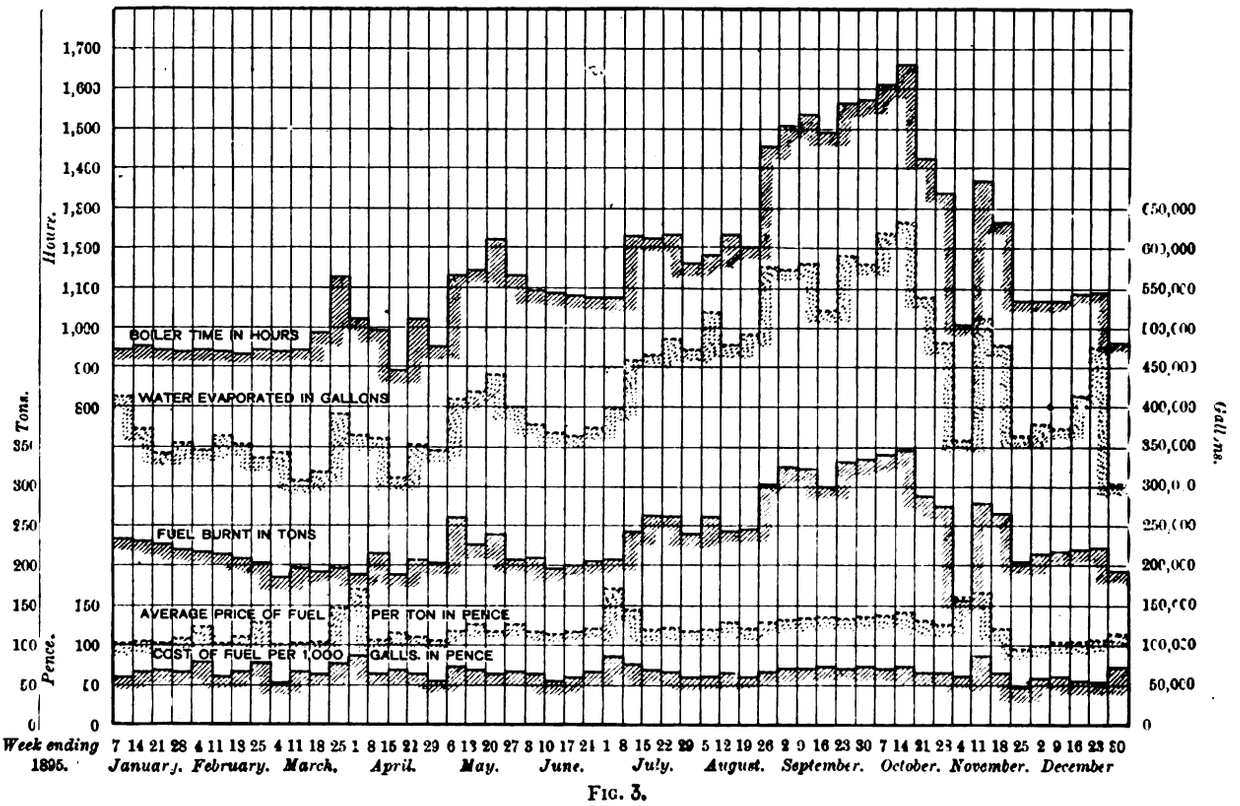
Hours.
Tons.
Pence.
Gallons.
BOILER TIME IN HOURS
WATER EVAPORATED IN GALLONS
FUEL BURNT IN TONS
AVERAGE PRICE OF FUEL PER TON IN PENCE
COST OF FUEL PER 1,000 GALLS. IN PENCE
Week ending 1895.
January. February. March. April. May. June. July. August. September. October. November. December

FIG. 3.

During seven months of the year seven boilers working together are able to supply the demand for steam, but during the later summer and autumn months the requirement is much greater, and nine boilers have to be worked heavily, and sometimes even more, which fact justifies the existence of the four reserve boilers, which might otherwise constitute an extravagantly large spare plant.

The fuel generally used for the boilers with Perret furnaces is breeze, which is delivered in front of the boilers at the price of 3s. 6d. per ton. This fuel contains a large amount of incombustible material, from 22 to 25 per cent.; the amount burnt is about 15 tons in 24 hours, or 1,400lb. per hour, or 18lb. per hour per square foot of grate surface, the total area of the six furnaces being 78 square feet, and evaporate from 5·5lb. to 6lb. of water per lb. of fuel: taking this at 5·8, the cost of fuel to evaporate 1,000 gallons is, by the formula given above—

$$C = 4{\cdot}464\ P/W = 4{\cdot}464 \times 3{\cdot}5/5{\cdot}8 = 2{\cdot}69 \text{ shillings} = 2s.\ 8\tfrac{1}{4}d.$$

The quantity of water evaporated is about 3,400lb. per hour per boiler, equivalent to 170 H.P. at 20lb. of steam per horse-power per hour—a low result, which eventually makes itself felt as one of the drawbacks to the use of inferior fuels. There being a plentiful supply of this breeze, it has been used almost invariably during the period of these observations for these three boilers, other fuels being tried at various times, but none were found able to compete with it. The air pressure used for the Perret furnaces averaged about 1·1in. of water column as measured under the fire bars, and was produced by a 36in. fan driven by a belt from a special engine, the steam for which was taken from the boiler, and its amount is included in the figures given above, but for which due allowance is made in the proper place, both for the cost of the steam used and the interest on the capital sunk in the fan engine and other special appliances.

For the other six boilers various fuels have been used at different times, at prices varying with the state of the fuel market; in 1895, however, most of the work was done with a South Wales coal, consisting of about 30 per cent. large, the rest fine, which was delivered at the boiler at the price of 14s. 6d. per ton; this fuel contained about 10 per cent. of incombustible, and under the existing conditions evaporated about 9·5lb. of water per pound of fuel. Taking the cost of evaporating 1,000 gallons of water with this fuel, as was done above for the breeze, we have

$$C = 4{\cdot}464 \times P/W = 4{\cdot}464 \times 14{\cdot}5/9{\cdot}5 = 6{\cdot}81 = 6s.\ 9\tfrac{3}{4}d,$$

which is in remarkable contrast to the 2s. 8¼d. found to be the cost of the breeze to do the same work. In these boilers evaporation is gallons evaporated at a rate equivalent to 170 H.P. per boiler, and the other producing steam at a cost for fuel of 6s. 9¾d. per 1,000 gallons evaporated at a rate equivalent to 190 H.P. per boiler.

(To be concluded.)

CORRESPONDENCE.

FOREIGN COMPETITION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: With reference to the letter of the British Insulated Wire Co., Limited, appearing in the issue of your journal of the 17th inst., our clients, the National Conduit and Cable Co., instruct us to state that the facts alleged therein are inaccurate and the conclusions drawn are misleading; and we have already, upon their instructions, commenced an action for libel against the British Insulated Wire Co., Limited. We are to ask you to be good enough to insert this letter in your next issue, together with a statement that your journal must in no sense be taken to concur in the imputations or purport of the British Insulated Wire Co.'s letter.—Yours, &c.,

London, Nov. 20, 1899. RENSHAW, KEKEWICH AND SMITH.

[Views expressed in these Correspondence columns are, of course, our correspondents' views. Questions of fact are a different matter; and if the writers of the above letter, or their clients, desire to correct any specific inaccuracies in the British Insulated Wire Co.'s communication, we shall be pleased to afford them every facility for doing so.—ED. *E.*]

New Wheel Pit at Niagara Falls.—The contract for building a new wheel pit for the Niagara Falls Power Co. has been awarded, and the work will be commenced at once. The wheel pit construction alone will cost nearly $1,000,000. The pit will be located on the east side of the inlet canal, and a power-house similar to the present one will be erected over it. The initial installation in the pit and power-house will be six turbines and six dynamos. The contract for these machines has not yet been awarded. It is expected that the work will be completed in the spring of 1901.

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LEGAL INTELLIGENCE.

Southampton Tramways Co. v. The Mayor, &c, of Southampton.

In the Appeal Court, on Friday, Lords Justices A. L. Smith, Collins and Vaughan Williams heard an appeal by the Southampton Tramways Co. from the judgment of Mr. Justice Bruce and Mr. Justice Ridley upon a case stated by Sir Henry Oakley, the umpire appointed under the Southampton Corporation Tramways Act, 1897, to decide certain points arising between the company and the Corporation as to the price to be paid by the Corporation in taking over the undertaking of the company. The questions the Court were asked to decide were (1) whether, in determining the price to be paid, the arbitrators and umpire should treat the undertaking as an undertaking which the company only enjoyed subject to being compelled to part therewith under the terms of Sec. 43 of the Tramways Act, 1870; or (2) whether, in determining such price, the arbitrators and umpire should treat the undertaking as one which the company enjoyed free from all obligation to part therewith otherwise than under the terms of the Act of 1897 itself. If the first question was answered in the affirmative, the umpire fixed the price at £51,505; and, if the second were answered in the affirmative, the price fixed was £109,963. The company was formed in 1877 to construct and maintain tramways, and the Lands Clauses Consolidation Acts, 1845, 1860, and 1869, and parts 2 and 3 of the Tramways Act, 1870 (which included Sec. 43), were expressed to be incorporated with the company's Act of incorporation and to form part thereof except where expressly varied by the Act. By Sec. 48 of the Southampton Street Tramways Act, 1877, in case the Corporation should at any time after 11 years from the completion of any portion of the tramways within the borough, but not later than 21 years after the passing of the Act, desire to purchase the tramways, and the works, material, and equipment connected therewith, and any lands or buildings acquired for the purposes of such tramways, and should apply to Parliament for powers to do so, and to enable the company to sell the same, the company should not oppose such application, and in the event of such powers being obtained, should sell the tramways and premises to the Corporation, the terms of such purchase failing agreement, to be determined by arbitration in manner provided. The Act received the royal assent on Aug. 10, 1877, so that the 21 years would have expired on Aug. 10, 1898. Sec. 43 of the Tramways Act, 1870, which was incorporated with the Southampton Street Tramways Act, 1877, empowered the local authority within six months after a period of 21 years from the time when the company were empowered to construct the tramway, and within six months after the expiration of every subsequent seven years, to require the company to sell their undertaking upon the terms therein mentioned. In 1894 the House of Lords decided that Sec. 43 of the 1870 Act empowered the local authority to buy the tramway upon the terms of paying only for the value of the structure and plant. In 1897 an Act was passed enabling the Southampton Corporation to purchase the tramways, the purchase to be completed on June 30, 1898. By Sec. 4 of the empowering Act it was provided that "the undertaking of the company shall become, and shall on and as from the transfer day be transferred to and vested in the Corporation, subject to and according to the provisions of this Act, and free, as between the company and the Corporation, from the mortgage debt of the company and all current debts and pecuniary liabilities of the company at the transfer day, and from that day the Corporation shall hold the undertaking subject to and shall take over, perform, and satisfy all duties, contracts, engagements, obligations, and liabilities of the company in relation to the undertaking transferred other than and except the debts and liabilities aforesaid." On June 30, 1898, the undertaking was transferred to and vested in the Corporation.

It was contended by the company that the price to be paid by the Corporation should be calculated as if the company enjoyed the rights and privileges of the undertaking free from all obligation to part therewith other than the obligation that was created by the Act of 1897—that, in fact, the company were entitled to be paid as though they were selling a concession of their privileges in perpetuity. For the Corporation it was urged that the company had a concession liable to be determined under Sec. 43 of the Tramways Act, 1870, at the end of 21 years, and after that at the end of each subsequent seventh year, and that that was all the company had to sell, and that therefore the smaller figure mentioned in the umpire's award—(£51,505)—was the proper purchase price. Justices Bruce and Ridley adopted the view of the Corporation, and the company now appealed.

Lord Justice A. L. SMITH said the case was a perfectly plain one. There were two contentions put before the umpire, and he found two amounts according as the Court thought which was the right contention. It was clear that the company held their property fettered with the condition contained in Sec. 43 of the Tramways Act, 1870, and that all the company had to sell was an undertaking clogged with that condition. It was clear to him that, when that Act empowered the Corporation to buy the undertaking, it was an undertaking fettered with this condition, and there was nothing in the Southampton Corporation's Act of 1897 to show that the undertaking to be sold was to be free from the fetter.

Lord Justice COLLINS and Lord Justice VAUGHAN WILLIAMS having concurred, the appeal was dismissed with costs.

National Telephone Co. (Limited) v. the Constables of St. Peter Port (Guernsey).

On Tuesday, before the Judicial Committee of the Privy Council (consisting of the Lord Chancellor, Lords Hobhouse, Macnaghten, Morris, Shand, Davey, Brampton, and Robertson), the National Telephone Co. appealed from a decision of the Court of Judgments, Guernsey, of June 15, 1897, which affirmed a judgment of the Royal Court.

The original action was brought by the company against the Constables of the parish of St. Peter Port, to recover £250 damages and costs for loss incurred owing to the Constables having illegally ordered certain telephone wires to be cut down. The Constables claimed, by a general ordinance of 1840, to be the highway authority of the parish. In 1896 the company desired to establish a telephone exchange in Guernsey, and their district manager had explained to the Constables the method by which they proposed to erect their wires. The Constables contended that the permission given by them on a particular occasion did not amount to a general concession, and that their consent must be obtained in each case when a wire crossed a public thoroughfare. The company considered that permission unnecessary, and erected wires over certain thoroughfares. The Constables gave notice to remove them, which the company disregarded, and the Constables then cut down all the company's wires in the parish. The company based their claim on the licences of the Postmaster-General to create and work a telephone service in the United Kingdom. The Constables pleaded that the company's right to carry on their business was restricted to specified areas, of which Guernsey was not one, that the company had no power to carry on business in the island, and that they had no right to carry wires over the streets without specific permission. The Royal Court gave judgment for the Constables, with costs, and that decision was upheld by the Court of Judgments.

At the close of the arguments the LORD CHANCELLOR intimated that their lordships reserved judgment.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers, or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London:—

NOW READY.

"The Electrician" Electrical Trades' Directory and Handbook for 1899.—The *Second Edition* of the "Big Blue Book" for 1899 is now ready. The volume contains the large Sheet Tables of Electricity Supply Stations and Electric Railways and Tramways. The price of the Directory and Handbook is now reduced to 5s. post free 5s. 9d.; abroad, post free, 6s. 6d. (United States 7s. 6d.).

"Submarine Cable-Laying and Repairing."—By H. D. Wilkinson. M.I.E.E., &c., fully illustrated; price 12s. 6d. This work gives a detailed technical summary of modern practice in manufacturing, laying, testing, and repairing submarine telegraph cables.

"Practical Notes for Electrical Students."—By Messrs. A. E. Kennelly and H. D. Wilkinson. Price 6s. 6d., post free. The authors give in a clear and concise manner a good summary of the general principles of electrical science.

"Magnetic Induction in Iron and other Metals."—By Prof. J. A. Ewing. Price 10s. 6d., post free. *New Edition nearly ready.*

"The Incandescent Lamp and its Manufacture."—By Gilbert S. Ram. Price 7s. 6d., post free. The principles underlying the manufacture of the incandescent lamp are carefully and fully dealt with in this volume.

"The Steam Engine Indicator and Indicator Diagrams."—Edited and enlarged by W. Worby Beaumont. Price 3s. 6d., post free. This work is a concise guide to the objects, construction, and use of the steam engine indicator and to the interpretation of indicator diagrams.

"The Art of Electrolytic Separation of Metals."—A second issue of Dr. Gore's book is now ready, price 10s. 6d., post free. The author treats fully both the theoretical principles of the art of electrolytic separation of metals and the practical rules and details of technical application on a commercial scale. The work is adapted to the use of the manufacturer as well as the student.

"The Manufacture of Electric Light Carbons"—A Practical Guide to the establishment of a Carbon Manufactory. Fully illustrated, price 1s 6d.; post free, 1s. 9d. In this work the author gives useful hints as to the manufacture of electric light carbons, including the preparation of material, firing, saturating, and coring, together with a description and estimate of cost of the plant required.

"The Centenary of the Electric Current, 1799-1899."—By Dr. J. A. Fleming. Price, paper covers, 1s. net, post free 1s. 3d.; strong cloth, 2s. 6d., post free.

"Localisation of Faults in Electric Light Mains."—By F. C. Raphael. Price 5s., post free. The book deals with the important subject of localising faults in electric light and power cables; and the various methods of insulation testing are here collected and discussed.

"Motive Power and Gearing for Electrical Machinery."—By E. Tremlett Carter, C.E., M.I.E.E. Price 12s. 6d, post free. In this comprehensive work an account is given of the scientific principles and modern practice in the use of engines for dynamo driving, not only for isolated power plants, but also for public electric lighting and power stations. The various forms of gearing in the power station and for electric motors are also dealt with; and the book contains, in addition, numerous tables giving exact data of the equipment and working of electric power stations.

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"THE MANUFACTURE OF CARBONS FOR ALL ELECTRICAL PURPOSES."—By Francis Jehl. 10s. 6d., post free. This is a practical handbook, giving a complete description of the art of making carbons for electric lighting, electrodes, &c., with particulars of the various gas generators and furnaces used in carbonising. The work also contains particulars of the cost, &c., of erecting and working carbon works, and plans of a model factory.

"THE ELECTRICIAN" PRIMERS.—In Two Volumes. Vol. I., Theory. Vol. II., Practice. Price, stout paper cover, 2s. 3d. each, post free; cloth. 2s. 9d. Single Primers, 3d. each, post free.

"THE POTENTIOMETER AND ITS ADJUNCTS": A Universal System of Electrical Measurement.—By W. C. Fisher. Fully illustrated. Price 6s., post free.

"ARMATURE WINDINGS OF ELECTRIC MACHINES."—By H. F. Parshall and H. M. Hobart. This work has been compiled from notes made by Mr. Parshall in his capacity as Chief Designing Engineer of the Edison and General Electric Companies of America, and is intended to serve as a working treatise on dynamo design. Large 4to, 370 pages 140 full-page illustrations and 65 full-page tables, 30s., post free.

IN THE PRESS.

"THE ELECTRIC ARC."—By Mrs. Ayrton.

"SECONDARY BATTERIES, THEIR DESIGN AND MANUFACTURE."—By E. J. Wade.

"PRIMARY BATTERIES: THEIR CONSTRUCTION AND USE."—By W. R. Cooper. *Nearly ready.*

"PRACTICAL TELEPHONY."—By Dane Sinclair and F. C. Raphael.

"'THE ELECTRICIAN' WIREMAN'S POCKET-BOOK."—Edited by F. C. Raphael. *Nearly ready.*

TENDERS INVITED.

Extension of Time.—The Council of the county borough of *West Ham*, London, E., invite tenders for (*a*) three 84-kilowatt steam dynamos, boosters, switchboard, steam exhaust and feed-water pipes; (*b*) accumulators; (*c*) water-cooling and condensing plant; (*d*) motors; (*e*) telephones. Plans of the station, specification, &c., can be obtained at the borough electrical engineer's office, Abbey Mills, West Ham, and tenders must be sent in to Mr. Fred. E. Hilleary, town clerk, Town Hall, West Ham, E., not later than 4 p.m. of Friday, Dec. 8. An advertisement elsewhere sets out some conditions of contract, &c.

The *Plymouth* Corporation invite tenders for tramcars, trucks, motors, trolley arms, &c. An advertisement contains further particulars, and specifications, &c., can be obtained from the borough electrical engineer (Mr. John H. Rider), Prince Rock, Plymouth. Tenders must be delivered to the town clerk (Mr. J. H. Ellis), Town Hall, Plymouth, by Dec. 8.

The *Woking* Electric Supply Co. invite tenders for a 150-kw. steam alternator and a 75-kw. steam alternator. Specifications may be obtained from the consulting engineers (Messrs. Preece and Cardew), 13, Queen Anne's-gate, Westminster, S.W., to whom tenders must be sent by 5 p.m. on Monday, Dec. 11. An advertisement contains additional particulars.

The *Rathmines* and *Rathgar* (Co. Dublin) Electric Lighting committee invite tenders for additional feeding and distributing mains, including trenching, troughing, cables, joint boxes, jointing and house services. Further particulars are given in an advertisement, and specifications, &c., may be obtained at the offices of the consulting engineer (Mr. Robert Hammond), 64, Victoria-street, S.W., after 25th inst. Tenders to the clerk (Mr. F. P. Fawcett), must be delivered at the Town Hall, Rathmines, not later than 4 p.m. of Dec. 13.

The *Stockport* Gas and Electricity department invite tenders for the supply of about 1,150 yards of three-wire feeder cables, particulars of which are given in an advertisement. Specifications, &c., can be obtained from Mr. S. Meunier, Portwood Gas Works, Stockport, and tenders (addressed Chairman Gas and Electricity committee, Stockport) must be in before 29th inst.

The directors of the *Midland Electric Corporation for Power Distribution (Limited)*, who are about to erect a power-house containing plant and machinery capable of an output of 10,000 e.h.p., together with conductors for the distribution of this power in the districts in which the company possess statutory powers, invite tenders from contractors who have previously carried out work on the same scale for the supply and erection of the requisite plant and conductors. Further particulars are given in an advertisement, and specifications and form of tender can be obtained after the 27th inst. from the secretary of the company (Mr. G. Carpentier), 11, Cornhill, London, E.C. Specifications and drawings may be inspected at (but not obtained from) the offices of the engineers, Messrs. Kincaid, Waller and Manville, 29, Great George-street, Westminster, S.W., and tenders must be delivered to the secretary before 4 p.m. on Monday, December 18.

The *Gloucester* Electricity Supply committee invite tenders for (*a*) one Lancashire boiler and accessories and mechanical stokers; (*b*) one 300-kw. steam dynamo and accessories, steam, exhaust, &c., pipes, valves, &c.; (*c*) extensions of switchboard; and (*d*) condensing plant. Further particulars are given in an advertisement, and specifications, &c., can be obtained at the offices of the consulting engineer (Mr. Robert Hammond), 64, Victoria-street, London, E.C., after Dec. 1. Tenders to the town clerk (Mr. George Sheffield Blakeway), Guildhall, Gloucester, before Dec. 28.

The *Blackburn* Corporation invite tenders for the supply and delivery of overhead line equipment. Specifications, &c., can be obtained at the offices of the consulting engineers (Messrs. Lacey, Clirehugh and Sillar), 2, Queen Anne's-gate, Westminster, S.W., after 27th inst. An advertisement contains further particulars, and tenders must be delivered at the offices of the town clerk (Mr. Robert E. Fox), Town Hall, Blackburn, by Dec. 23.

The *Blackpool* Corporation invite tenders for the supply, delivery, and erection of the following plant: (*a*) four boilers, accessories, pumps, and piping; (*b*) two 600-kilowatt steam alternators with condensers (or alternatively one 1,200-kilowatt steam alternator); (*c*) switchboard; (*d*) mains: (*e*) transformers; (*f*) storage battery. An advertisement contains further particulars, and specifications can be obtained from the borough electrical engineer (Mr. Robert C. Quin, M.I.E.E., M.I.Mech.E.), Corporation electricity works, Blackpool. Tenders must be in by 10 a.m. of Dec. 15.

The *Oatlands Park Hotel Co. (Limited)* invite tenders for wiring and fitting 473 lamps at the Oatlands Park Hotel, Weybridge. Tenders by noon of Monday, December 4. Specifications, &c., can be obtained from the consulting engineers (Messrs. O'Gorman and Cozens-Hardy), 66, Victoria-street, London, S.W. See advertisement.

The directors of the *Caledonian Railway Co.* invite tenders for the supply of stores for 12 months from Feb. 1, 1900. Amongst the company's requirements are telegraph and electrical appliances, hardware, india-rubber and asbestos goods, screws, copper and iron rivets, galvanised wire, &c. Specifications and forms of tender may be obtained after 27th inst. from the stores superintendent (Mr. James Lorimer), Charles street, St. Rollox, Glasgow. Tenders to the secretary (Mr. J. Blackburn), 302, Buchanan-street, Glasgow, by Monday, Dec. 11. An advertisement contains further particulars.

The directors of the *Great Northern Railway Co* invite tenders for the supply of new and the purchase of old stores for 12 months from Jan. 1st next. A list of the contracts, &c., may be had on application to Mr. Weeks, stores superintendent, Doncaster, who will furnish all information. Tenders must be addressed to the Stores committee, and must be sent to the company's offices, King's Cross, London, not later than 10 a.m. of Wednesday, Dec. 6. Mr. William Latta is secretary to the company. An advertisement on another page gives further particulars.

The *Cheshire* Lines Committee require tenders for telegraph materials, instruments, wire, &c. Tenders by noon of Dec. 1.

The *Manchester* Tramways committee invite tenders for the supply of 5,000 tons of steel girder tramway rails and about 250 tons of steel fish plates. Tenders (addressed to chairman of committee, Town Hall, Manchester) before Dec. 2.

The directors of the *Harrow* Electric Light and Power Co. (Limited) invite tenders for the supply and erection of a 150-kilowatt steam dynamo and extensions to switchboard. Tenders to the office, West street, Harrow-on-the-Hill, by Dec. 4.

The *York* Corporation invite tenders for wiring and fitting up the Mansion House, the Guildhall, municipal offices, &c., for the electric light. Tenders by December 4.

The *Pontefract* Guardians invite tenders for the electric lighting of their workhouse infirmary buildings and premises. Tenders to the clerk (Mr. W. A. Glover), Poor Law Offices, Pontefract, by 10 a.m. of 24th inst.

The *Newcastle-upon-Tyne* Electric Tramways committee invite tenders for two 1,000-H.P. generators. Tenders (addressed to the committee) must be left at the office of the town clerk (Mr. Hill Motum), Town Hall, Newcastle-upon-Tyne, by noon of Nov. 30.

The *Battersea* (London) Vestry require tenders for arc lamps and arc lamp-posts. Tenders to vestry clerk (Mr. W. Marcus Wilkins), Municipal Buildings, Lavender-hill, London, S.W., by noon of Dec. 4.

Tenders are invited for electric lighting and driving plant at the *Cork* Lunatic Asylum. Tenders to resident medical superintendent by 28th inst.

The *Birkenhead* Corporation invite tenders for condensing plant, re-cooling tower, &c., overhead travelling crane, feeder mains, &c. Tenders by December 12.

The *Darwen* Corporation require tenders for a Lancashire boiler and a tramway switchboard. Tenders to town clerk by 27th inst.

The *Whitechapel* (London) District Board of Works require tenders for erecting electricity station buildings. Tenders to clerk (Mr. A. Turner), 15, Great Alie-street, by Dec. 4.

The *Londonderry* Corporation invite tenders for the supply of carbons for the year to Dec. 31, 1900. Tenders to the town clerk (Sir R. Newman Chambers), Guildhall, Londonderry, by 30th inst.

The Governors of *Felsted* School, Essex, invite tenders for the supply and erection of electric lighting plant. Tenders by Nov. 27

The *Hackney* (London) Vestry require tenders for refuse destructors. Tenders to vestry clerk by 4 p.m. of Dec. 12.

The *Lambeth* (London) Vestry require tenders for 25 arc lamp posts. Tenders to Vestry Hall, S.E., by Dec. 6.

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TENDERS RECEIVED AND ACCEPTED.

The Battersea (London) Vestry have accepted the following tenders for works in connection with the erection of the electric light station :—

H. Young and Co. (wrought-iron floor plates with hoppers and stay rods)	£1,143 7 6
Clark, Bunnett and Co. (wrought-iron doors and windows)	757 7 6
M. T. Shaw and Co. (roofs over engine and boiler house)	3,151 19 11

The Hammersmith Vestry on Wednesday referred the following tenders for wiring and supplying fittings for the electric lighting of the Vestry's stables depôt to committee :—

National Electric Wiring Co.	£197	17	0	H. J. Godfray	£163	0	0
Peto and Radford	185	0	0	Newsome, Pinching & Co.	159	6	0
Electrical Transmission Co.	170	0	0	A. Thatcher and Co.	153	17	10
A. Hunt and Co.	168	10	0	Russell and Russell	133	0	0
W. J. Adams	167	16	9	Allam and Co.	132	0	0
Vaughan and Brown	165	10	0	Foote and Milne	129	0	0
H. Beare and Co.	165	0	0	T. H. Hellyar	105	5	0
				J. Bakewell and Co.	103	2	0

The London School Board have received seven tenders for wiring the Paragon School, New Kent-road, S.E. Two sets of tenders were submitted, one for wiring the school and the other for lighting the offices, playgrounds, &c. The lowest tender for wiring the school was £266, and the highest £438 ; the lowest for the offices and playgrounds was £115, and the highest £202. There are to be 293 lights in the school.

The Poplar (London) District Board of Works have accepted the tender of the British Insulated Wire Co. for supplying and laying the cables required for the Board's electricity scheme. The cost of the whole of the works will be £35,485.

The Llandudno Council have accepted the tender of the India Rubber Co. for the supply of three 150-kilowatt steam dynamos (with Allen engines), motor and boosters, at £4,022. Twenty-four tenders, varying in amount from £3,632 to £6,606, were received, and the lowest but one was accepted.

The Leeds Guardians have accepted the tender of Mr. E. C. Wallis for supplying a system of telephones and alarm bells at the workhouse, for £350.

The Electric Lighting committee of the Swansea Corporation recommend the acceptance of the tender of the British Schuckert Electric Co. for the supply of engines and dynamos for their electricity supply station, at £8,422.

The Wigan Corporation have accepted the tender of the Electrical Power Storage Co., for the supply of a storage battery for their electricity supply undertaking at £1,563. 6s. 8d.

APPOINTMENTS VACANT AND FILLED.

The Urban District Council of Radcliffe (Lancs.) require an electrical engineer with lighting and tramway experience. An advertisement elsewhere gives some further particulars, and applications have to be sent to Mr. James Sharples, clerk to the Council, not later than Dec. 5.

The County of London Electric Lighting Co. invite applications for the position of chief engineer. Applications to the secretary, Moorgate-court, Moorgate-place, London, E.C., by Dec. 4. See advertisement.

A provincial electric supply company require an assistant electrical engineer for their mains department. See advertisement.

The Buxton District Council invite applications for the position of resident electrical engineer. Applications to the clerk to Council (Mr. Josiah Taylor), Town Hall, Buxton, by 28th inst.

The City and South London Railway Co. require two shift engineers. An advertisement contains further particulars, and applications must be sent to the engineer (Mr. P. V. McMahon), 195, Clapham-road, London, S.W.

An assistant is required in the electrical engineering department of the City and Guilds Technical College, Exhibition-road, London, S.W. Applications to Prof. W. E. Ayrton.

Mr. A. Hattersley has been appointed engineer-in charge at the electricity works of the Leyton District Council.

Mr. A. G. Cooper, at present electrical engineer to Messrs. Davy Bros. (Limited) and formerly station superintendent of the Sheffield Electric Light Co., has been appointed electrical engineer to the borough of Colne (Lancs.) to design and lay down a combined plant for electric lighting and traction.

Mr. H. Chilvers has been appointed draughtsman of the Keighley electricity works.

BUSINESS NOTICES.

The extensive showrooms and depôt of the Edison and Swan Co. at 53, Parliament-street, London, S.W., have recently undergone alterations and complete renovation. A fine collection of the latest designs in electric fittings is assembled, of which inspection is invited.

Messrs. H. G. Massingham and F. H. Rippon, electricians and electrical engineers, trading as Massingham, Rippon and Co., at 82, Fore-street, Exeter, have dissolved partnership.

Messrs. Herbert John Dowsing and William Snowdon Hedley, electrical engineers, 24, Budge-row, Cannon-street, E.C., and Uxbridge-road, Ealing, W., London, trading under the style of Herbert John Dowsing, have dissolved partnership. Debts by Mr. Dowsing.

BANKRUPTCIES, LIQUIDATIONS, &c.

Under the failure of E. C. Glass, electrical engineer, 6 and 7, Nevill's-court, Fetter-lane, London, debtor attended at the London Bankruptcy Court and was examined upon accounts showing a deficiency of £1,098. He purchased the business in October, 1896, for £2,000, and afterwards invested a further £1,000, but in Nov., 1898, he transferred it to his sister for £3,000, which she had previously advanced. He kept in the business on the purchaser's behalf until last March. The failure is attributed to heavy interest charges and excess of expenditure over profits. Hearing adjourned to Dec. 7.

The creditors of E. A. M. Winter, electrical engineer, Amberley House, Norfolk-street, London, W.C., met at the London Bankruptcy Court on 17th inst., and deputed the Official Receiver to administer the estate. The debtor started business in May, 1897, with between £700 and £800, as the Imperial Electric Light and Power Co. Liabilities £1,550, deficiency £975.

It has been decided to wind up Heath, Snoxell and Co. (Limited) voluntarily, and Mr. C. Richards, C.A., Cobden-chambers, Corporation-street, Birmingham, is liquidator.

Creditors of W. and J. Robinson and Co. (Limited), electrical and mechanical engineers, &c., must send particulars of claims to Messrs. A. Bicket and R. T. Rowbotham, 103, Miller's Bridge, Bootle, by Dec. 23.

J. Stewart Edwards, electrical engineer and commission agent, Moorgate-court, Moorgate-place, E.C., was examined at the London Bankruptcy Court last week. Unsecured liablities £14,389, assets £775

The public examination of W. H. F. Bowman, electrical engineer, &c., 3, Foster street, Gainsborough, will take place at the Sessions House, Lincoln, on 28th inst.

Claims against the estate of Benjamin Wild and J. H. Clark, trading as Wild, Rathwell and Co., electrical and general engineers, Atlas Works, Virginia-street, Southport, must be sent to the trustee (Mr. N. Yates, C.A.), 4 and 6, Wood-street, Bolton, by Dec. 9.

A meeting will be held at Royal Insurance-buildings, Church-street, Sheffield, on Dec. 22, to receive an account of the winding-up of the Sheffield Electric Light and Power Co. (Limited).

Sale by Auction.—Messrs. Fuller, Horsey, Sons and Cassell will sell by auction (unless previously disposed of by treaty), at the premises of the Maskelyne British Typewriter Co., 64, Hammersmith-road, London, W., on Thursday the 30th inst., at 11 a.m., a quantity of engineers' tools and stock. Some particulars are set out in an advertisement, and catalogues may be had on the premises, or of the auctioneers, 11, Billiter-square, London, E.C.

Sale of Second-Hand Cable.—The Leeds electric lighting department have some second-hand lighting cable for sale, particulars of which are given in an advertisement.

Water Power Wanted.—An advertiser requires water power, developed or undeveloped, capable of giving 2,000 H.P. to 3,000 H.P., within easy reach of the coast of Great Britain or Ireland, with site for works, &c.

Sale of Acetylene Works.—The undertaking of the Midland Acetylene (Parent) Syndicate (Limited), Cradley Heath, was offered for sale by auction at the Grand Hotel, Birmingham, on Thursday last, by Mr. H. Humphries, of Brierley Hill. The lot comprised the freehold works, with the whole of the electrical plant, steam engines, boilers, &c. A fairly large company was present, but not a single bid was made. The works will, we understand, now be dismantled and sold piecemeal at any early date. Mr. Humphries will be pleased to give intending purchasers further particulars as to the forthcoming sale.

Winding-Up Petition.—A petition has been presented to the High Court of Justice, Dublin, by Messrs. David King and Sons, of Glasgow, for the winding-up of Dobsons and Curtis Bros. (Limited), electrical engineers, of Dublin. The petition will be heard by the Vice-Chancellor on 23rd inst.

Dynamo Brushes.—Mr. C. Ford 27, Clement's-lane, London, E.C., has sent us two samples of laminated copper brushes intended for dynamos. These brushes, which are of German manufacture, are made of electrolytic copper sheet 0·0025in. thick, which is doubled backwards and forwards to form a strip 0·025in. thick. The strips are then fixed together to form the required thickness for the brush, and the whole soldered together at one end.

E.C.C. Continuous-Current Dynamos and Motors.—A useful illustrated list of the well-known E.C.C. standard continuous-current dynamos and motors is just issued. A table is devoted to the standard machine for each voltage, in which is given the speed

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at which the various standard sizes must be run to produce given outputs.

Lundell Motors.—Messrs. J. H. Holmes and Co., the sole owners and patentees for the United Kingdom, &c., of the Lundell continuous-current motors, have forwarded a well-arranged catalogue of Lundell motors. The illustrations include photographic representations of these motors applied to various industrial purposes from sewing machines to the largest class of printing machinery. A series of efficiency curves is also given. The catalogue is well got up.

"Beez" Pocket Volt and Ampere Meters.—A new list of particulars and prices of the new "Beez" pocket volt and ammeters is just issued by Messrs. Polland and Co., 5, St. Nicholas-buildings, Newcastle-on-Tyne. Electric dry cells have for some time past been used to ignite the gas mixture of benzine and petroleum used in motor-cars and motor-tricycles, and these have acted satisfactorily when tested to supply the necessary intensity of current. It is claimed by Messrs. Polland and Co. that the "Beez" instruments have been largely used in testing the efficiency of dry cells for this purpose.

Scientific Apparatus Catalogue.—Part 3 of Messrs. John J. Griffin and Sons' illustrated catalogue of scientific apparatus is to hand, as well as a catalogue of X-ray apparatus and appliances. Part 3 deals with magnetism, electricity, and "galvanism," and contains a mass of particulars of various classes of apparatus for use in schools and colleges. A section of the catalogue deals with miscellaneous apparatus for accomplishing interesting popular electrical experiments for lecture illustration, &c. The catalogue of Röntgen apparatus contains several more than usually gruesome "skiagrams."

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Nov. 15 to Nov. 21, with the ports of destination :—

Africa—Alexandria, £993; Cape Town, £25; Durban, £191 (including £106 telegraph material); East London, £546. *Argentina*—Buenos Ayres, £317 (including £92 telegraph material). *Australasia*—Adelaide, £56; Lyttleton, £2,910 (telegraph material); Melbourne, £200 (including £110 telegraph material); Nelson, £25; Otago, £36; Perth, £65; Port Chalmers, £2,920; Sydney, £210; Wellington, £540. *Belgium*—Ostend, £139. *Brazil*—Rio Janeiro, £775 (telegraph material). *British Guiana*—Demerara, £30. *Colombia*—Santos, £70 (telegraph material). *Denmark*—Copenhagen, £323 (including £299 telegraph wire). *Germany*—Hamburg, £240 (including £230 telegraph material). *Gibraltar*—£84. *Holland*—Amsterdam, £554 (including £45 telegraph material). *Hong Kong*—£42 (including £8 telegraph material). *India*—Bombay, £47; Calcutta, £278. *Italy*—Genoa, £70 (telegraph wire). *Japan*—Tokyo, £1,442. *Madeira*, £30. *Malta*—£96. *Spain*—Barcelona, £117 (telegraph material). *Straits Settlements*—Singapore, £60 (telegraph material). *Sweden*—Gothenburg, £86 (including £19 telegraph material); Stockholm, £135 (telegraph material). *Trinidad*—West Indies, £80. *United States*—New York, £24. Total, £13,762, against £15,962 in the corresponding week last year (Nov. 23 to 29).

MUNICIPAL, FOREIGN, AND GENERAL NOTES.

Alleged Theft of Electric Current.—At West London Police Court, Alfred John Harrison, described as an electrical engineer, of King-street, Hammersmith, was charged with stealing electricity from the mains of the Hammersmith Vestry. Mr. A. B. Watson, for the Hammersmith Vestry, said prisoner rented two rooms in the house of a lady who had the electric light installed on her premises, and in consequence of a dispute an examination of the wires disclosed that the meter had been tampered with. Mr. G. Gilbert Bell, electrical engineer to the Vestry, said he went into the cellar and found the fuse-box broken. Larger fuses of a different material had been inserted with extra wires, allowing four times the quantity of electricity to be drawn from the supply. Prisoner was remanded.

Bahia Blanca (Argentina).—The municipal electricity works were recently inaugurated.

Battersea (London).—The Vestry have decided to oppose an application of the County of London Co. for a provisional order for Batterseа. The Lighting committee reported to the Vestry this week that they had been in communication with the Hart Accumulator Co. with reference to their contract for batteries. The company asked that certain clauses relating to maintenance might be inserted in the contract, and after report from Prof. Kennedy, it was decided to allow the contract to be amended as desired.

Bermondsey (London).—The Vestry's consulting engineers (Messrs. Kincaid, Waller and Manville) have been authorised to draw up specifications for the erection of a dust destructor in connection with the projected electric lighting station.

Bolton.—A lively debate took place at the Council meeting last week on a proposal that the Lighting committee, which is at present composed solely of members of the Gas committee, should be reconstituted so as to include representatives of the Electricity committee. The chairman of the Gas committee (Ald. Miles) opposed the motion, and said that until it could be shown that the Electricity committee could light the borough better and cheaper than the Gas committee he should strongly oppose any proposal to take the work from his committee. The chairman of the Electricity committee (Dr. Paulton) believed his committee could do the street lighting by arc lamps efficiently and at no great cost. Eventually the proposal was adopted.

Bournemouth.—Though the Council have hitherto managed to defeat all attempts to construct electric tramways in the town, they have now decided to themselves apply for electric traction powers

Burnley.—The mayoress (Mrs. Dickinson) on Friday performed the ceremony of starting two new generators, which have been erected at the electricity works. The original works were started in August, 1893, with plant capable of supplying current to about 6,000 8-c.p. lamps. The additional plant brings the capacity of the station up to 16,000 8-c.p. lamps.

Buxton.—Steady progress is being made with the electricity works, and the Council expect to be able to supply current in January.

Camberwell (London).—A special meeting of the Vestry is to be held on the 18th prox., to consider the purchase of so much of the undertaking of the County of London and Brush Provincial Co. as lies within the district. This is the outcome of a notification from the company that, as the Vestry had passed no resolution to act under the provisions of Sec. 6 of the Camberwell order, the directors could not comply with the request to give information upon matters affecting their business.

Cape to Cairo Telegraph.—In *The Electrician* for Aug. 18 last, p. 589, we referred at length to the progress of the Cape to Cairo telegraph. The expeditition had at that time reached the neighbourhood of Lake Tanganyika. News is now to hand that the expedition under Mr. Mohun has been attacked by natives, and has had to depart precipitately for a time. The report adds that the telegraph material and equipment has been looted or destroyed, although there is no guarantee for the accuracy of the report. This disaster, if true, follows upon the destruction by fire some months ago of an extensive store of telegraph line material, &c., at Kituta, when goods to the value of £10,000 were destroyed.

Carmarthen.—The town clerk has been instructed to approach the South Wales Electrical Power Distribution Co., to obtain their terms for supplying electric current in the district.

Cheadle.—Application is to be made by the Council for a provisional electric lighting order.

City of London.—Application is to be made to Parliament by the Corporation of the City of London for an Act empowering the Corporation

To make provision in, over, or under any streets in the City for the accommodation of electric lighting, telegraphic, telephonic, and other electric cables and wires and apparatus, and to make and maintain such underground accommodation, receptacles, galleries, and approaches as may be necessary or expedient; to require the several companies and other bodies and persons owning and using such wires, cables and appliances in the City, and who possess powers to break open or otherwise interfere with the streets in the City, to make use of such accommodation, galleries, &c., for the reception of such wires, cables, and apparatus, and to move into such underground receptacles all cables, wires, mains, and pipes already laid in any of such streets.

Further powers are sought to enable the Corporation

To amend or repeal the provisions of any Act of Parliament, letters patent, charter, or other authority, which would affect or interfere with the above-mentioned powers, whether relating to electric lighting, telegraphs, telephones, or any other works, and to limit the exercise of powers which any company or person may possess under any Act or other authority, and to authorise the Corporation to make charges to such companies or persons as may be incurred in carrying out the provisions of the new Act.

Further, the Corporation seek powers

To affix to any house, building, or premises such brackets, lamps, wires, pipes, and apparatus as may be necessary or convenient for the public lighting of the streets, without being liable for any claim for compensation or otherwise.

The City of London Electric Lighting Company also give notice of intention to promote a Bill for the compulsory purchase of lands in the parish of St. Saviour (Southwark) for the maintenance of existing and the construction of new generating stations, to relieve the company from all or any of the obligations imposed upon them by the City of London Electric Lighting Act (1893), and by the contracts made in 1890 and 1891 between the Brush Electrical Engineering Co. and the Commissioners of Sewers of the City of London, and between the Laing, Wharton and Down Construction Syndicate and the Commissioners of Sewers with respect to accounts and depreciation and reserve funds, and to repeal all or any of the provisions of Sec. 4 of the said Act, and to provide for the application to any purposes of the company any funds accumulated under the provisions of the said Act and contracts or otherwise, and to alter and amend the provisions of the said Act and of

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the City of London Electric Lighting (Brush) Order, 1890, and the City of London (East District) Electric Lighting Order, 1890, and of any other provisional order or provisional orders relating to the company or their undertaking.

Colwyn Bay.—An inquiry has been held into the application of the Council to borrow £5,120 for electric lighting purposes. The clerk (Mr. J. H. Roberts) said the contract of Mr. Bertram Thomas for the supply of plant at £3,678 had already been accepted. They had already applications for about 1,100 lights. Technical details were given by the consulting engineers (Messrs. Lacey, Clirehugh and Sillar). The station will have a capacity of 10,000 8-c.p. lamps. Slight objection was taken to the application, as a refuse destructor had not been included in the scheme.

Customs Tariff.—Under the New Zealand customs tariff electric batteries and motors for surgical purposes, and induction coils imported by themselves, have been classified as electric machinery and appliances, and are subject to a duty of 10 per cent. X-ray apparatus (contact breakers and regulators, and induction coils, when imported with and forming part of X-ray apparatus) are admitted free. Induction coils were inadvertently included in the free list in a previous notification by the Customs authorities.

Cork.—The Judicial committee of the Irish Privy Council have granted the application of the Cork Electric Tramways and Lighting Co. to extend their tramways along the Western-road to Sunday's Well.

Dublin.—The Corporation on Monday adopted the report of the Electric Lighting committee, which recommended the appointment of Mr. Robert Hammond as consulting engineer to the Corporation in connection with the scheme for extending the electricity supply undertaking. It is proposed to erect a new station at the Pigeon House Fort site, at an estimated cost of about £120,000.

Ealing.—The Council have decided to apply for powers to construct electric tramways. The London United Tramways are also seeking authority to extend their system in this district.

Electric Tramways in the Leeds District.—A joint committee of the Councils of Horsforth, Rawdon, and Yeadon have resolved to ask the Leeds Corporation to construct a trunk tramway line from the Abbey to Nunroyd Beck, with one loop line through Hawksworth-road, to Woodside, and to the top of Broadgate-lane, Horsforth; and another from the Rawdon Co-operative Stores to the Town Hall-square, Yeadon. If the Leeds Corporation do not construct these tramways, the committee propose to invite them to supply the necessary electric energy for working the lines, and the Councils of the respective districts will construct the permanent way and provide electric equipment.

Electric Lighting Notices.—Notice of intention to apply for provisional electric lighting orders has been given by the following:—

Corporations of Barnstaple, Boston, Hythe and Penzance.

District Councils of Barnet, Bredbury and Romiley, Egremont, Erdington, Farnham, Festiniog, Harrow, Hebburn, Leek, Littleborough, Liversedge, Llandilo, Nuneaton and Chilvers Coton, Romford, Sleaford, Tunstall (for Tunstall, Goldenhill and Chell), and Uckfield (for Rotherfield, Buxted and Mayfield).

County of London Co., for portion of Battersea (London); Vestries of Mile End and St. George's-in-the-East (London); South London Electric Supply Corporation, for the parish of Lambeth north of Westminster Bridge-road excepted from the Lambeth order (1892); Cobham Gas Co., for Cobham, Byfleet, &c.; Newhaven and Seaford Electric Lighting Syndicate, for Newhaven and Seaford; Newcastle-upon-Tyne Electric Supply Co., for Gosforth; Northern Counties Electricity Supply Co., for Barnard Castle, Cowpen, Malton, South Blyth, Spennymoor and Thirsk; Totnes Electricity Supply Co., for Totnes; Urban Electric Supply Co., for Weybridge; Uxbridge and District Development Syndicate, for Uxbridge and district; Tayside Electric and Gas Light Co., for Wormit and Woodhouse, Dundee; Twickenham and Teddington Electric Supply Co., for Twickenham and Teddington; Woking Electric Supply Co., for Woking, Horsell and Chertsey.

In the following cases procedure by Bill for further powers has been decided upon:—

Coventry Corporation, to authorise regulations in regard to electric light fittings in houses and buildings, to supply electrical fittings, and to authorise special charges or special provision in cases where consumers have independent installations; to alter the date of the annual accounts of the electricity undertaking, &c.

Lancaster Corporation, to supply electricity in neighbouring districts, &c.

London (City of) Corporation, to enable the Corporation to make provision for the accommodation of electric lighting, telegraphic, telephonic, &c., wires, cables, and apparatus in, over, or under any streets in the City, and to require companies or other bodies or persons owning or using cables and wires to make use of such public service works for the reception of their cables and wires, &c. (Further reference is made to this Bill on page 166.)

City of London Electric Lighting Co., to purchase the land compulsorily in St. Saviour's (Southwark), to extinguish obligations of company under existing Act and contracts, &c. (See also page 166.)

The Charing Cross and Strand Electricity Supply Corporation, to purchase land in West Ham for generating station, to supply electric current in City of London, and to connect station with company's present area of supply, &c.

Dublin Electric Lighting Co. (Limited), to incorporate company, to supply electricity in Dublin, New Kilmainham, Drumcondra, Clonliffe, Glasnevin, and Clontarf.

County of Durham Electric Power Supply Co., to incorporate company, to establish generating station, to supply electrical energy "in bulk" to local authorities, companies and other bodies, in parts of the county of Durham, &c.

Newcastle-upon-Tyne Electric Supply Co., to erect generating station, to supply electric current in Walker, Wallsend, and Long Benton, to enter into agreements with the Walker District Council and the Walker and Wallsend Union Gas Co., &c.

Lymington Corporation, to erect electricity supply works, to purchase gas undertaking, and to supply electricity and gas in Lymington, Boldre, and Milford.

Tottenham District Council, to establish electricity works and to supply electric current.

Tyneside Electric Power Co., to incorporate company, to establish generating station, to supply electricity in certain districts of Northumberland and Durham, &c.

County of London and Brush Electric Lighting Co., to purchase land compulsorily, to establish and work generating stations, to abstract water from the river Wandle and the Surrey and Regent's canals, &c.

Lancashire Electric Power Co., to incorporate company, to establish generating stations, to supply electricity in parts of the county of Lancashire, &c.

South Wales Electrical Power Distribution Co., to erect electricity supply works and to supply electrical energy in the county of Glamorgan and part of the county of Monmouth and the boroughs of Newport, Cardiff, Swansea, &c.

Walker and Wallsend Union Gas Co., to supply electricity in Jarrow and Hebburn.

Electric Traction Notices.—Tramway provisional orders are being applied for by the following authorities, who seek powers to construct and work tramways, to employ electric or mechanical traction, &c.:—

Huddersfield, Portsmouth and Sheffield Corporations; the Aston Manor, Bredbury and Romiley, Ealing, Hurst, Redditch and Walthamstow District Councils.

In the following cases powers to use electric traction are sought, the procedure being by private Bill:—

Aberdeen Corporation, to construct additional tramways, to attach brackets to houses, to lease lines, etc.

Baker-street and Waterloo Railway Co. (London), to construct new underground electric railways and subways, to acquire additional lands, to enter into agreements with the Great Western Railway Co., to obtain further capital powers, &c.

Barneley Corporation, to construct and work electric tramways.

Batley Corporation, to alter existing and to construct new tramways.

Belfast Corporation, to purchase undertaking of the Belfast Street Tramways Co., to construct additional lines, etc.

Brighton Corporation, to construct and work tramways, to purchase land in Southwick for generating station, &c.

Charing Cross, Euston, and Hampstead Railway Co. (London), to extend time, &c.

Cork Electric Tramways and Lighting Co., to construct additional tramways.

Croydon Corporation, to acquire undertaking of Croydon Tramways Co, to construct new lines, &c.

Dundee and South Forfar Tramways Co., to incorporate company, to construct tramways in Dundee, Broughty Ferry, &c.

Great Grimsby Street Tramways Co., to construct additional tramways.

Halifax Corporation, to construct tramways within and outside the borough.

Huddersfield Corporation, to construct new tramways within and without the borough.

Knott End Railway Co., to construct new railway.

Lancaster Corporation, to purchase undertaking of the Lancaster and District Tramways Co., to work tramways within and outside the borough, and to construct new lines.

Liverpool Overhead Railway Co., to construct new railways and widen existing line, to obtain further capital and borrowing powers, &c.

London, Barnes, and Richmond Tramways Co., to incorporate company, to construct tramways in Richmond, North Sheen, Kew, Mortlake, Barnes and Hammersmith.

London County Council, to authorise the construction of new tramways, to reconstruct and adapt existing lines for electric traction, to erect generating stations, &c.

The London County Council also propose to bring in a Bill to authorise the reconstruction and alteration of any tramways purchased or to be acquired by the Council under the Tramways Act, 1870, so as to adapt same for electric traction, &c.

London, Walthamstow and Epping Forest Railway Co, to construct portion of authorised railway in tunnel instead of cutting, to obtain further capital, extend time, &c.

Manchester-Liverpool Electric Railway Co., to construct an electric railway between Manchester and Liverpool, to incorporate company, &c.

Mersey Railway Co., to purchase land for generating station, &c.

Metropolitan District Railway Co., to acquire land for generating station, to abstract water from Chelsea Creek, to acquire powers as to electrically working the railways of the company and of the Metropolitan Railway, &c., also for extending time for the compulsory purchase of lands and completion of works for the railways and subways authorised by the Brompton and Piccadilly Railway Act (1897), and for the payment of interest out of capital during construction.

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Newport Corporation, to construct tramways.

Reading Corporation, to construct and work tramways.

Sandgate and Hythe Electric Co., to construct tramroads from New Romney to Folkestone.

Scarborough Corporation, to construct tramways, and to enter into agreements with the Scarborough Electric Supply Co. for the purchase of undertaking, &c.

Southport Corporation, to construct tramways and light railways in borough and in neighbouring districts.

Stockport Corporation, to construct tramways, to enter into agreements with adjoining local authorities for constructing and working tramways, &c.

Walsall Corporation, to construct tramways in Walsall and surrounding districts, to enter into agreements with local tramway companies, &c.

The South Eastern Metropolitan Tramways Co, to construct tramways in Lewisham, Penge, Bromley, Beckenham and Croydon.

The South Lancashire Tramways Co., to incorporate company, to construct tramways in St. Helens, Bolton, Leigh, Eccles, Haydock, Ince, Newton-in-Makerfield, Pemberton, Swinton, Tyldesley-with-Shakerley, Westhoughton, &c.

Wirral Railway Co., to acquire land for erecting generating station, &c., either separately or jointly with the Mersey Railway Co.

Vale of Rheidol Light Railway Co., to extend time for completion of line, and to substitute electric traction for steam.

Garston.—The terms for the transfer of the Council's provisional order to the Garston Electric Light Co. have been agreed upon.

Glasgow.—On Friday last week there were two temporary interruptions to the supply in Glasgow. The first occurred about seven o'clock in the evening and occasioned the shutting down of a 900 H.P. engine at the Port Dundas station, a bearing of which became heated. Another engine was run up to take its place, and the light was restored in about a quarter of an hour. The Port Dundas station is still in the builder's hands, and it is suggested that dust had got into one of the bearings of the engine. The second interruption occurred at half past eleven, and was due to the melting of a battery fuse. It also necessitated the partial shut-down for a quarter of an hour or twenty minutes.

Godstone.—The Council have resolved not to oppose the application of Edmundson's Electricity Suppy Corporation for a provisional order.

Greenock.—An electrical exhibition will shortly be held in the old post office, Greenock, and electrical energy will be supplied free of charge to exhibitors for one week. Particulars from the burgh electrical engineer (Mr. S. E. Fedden).

The official inauguration of the electricity works has been fixed for 30th inst.

Harrogate.—An inquiry was held here last week into the application of the Corporation to borrow £28,000 for putting down additional plant at the electricity works and extending the mains, &c. The town clerk (Mr. Taylor) and the borough electrical engineer (Mr. George Wilkinson) appeared in support of the application. Mr. Wilkinson said that at the present time there was the equivalent of 22,341 8-c.p. lamps connected, and the profit on the year's working, after allowing for interest and sinking fund, was over £700. There was no apposition.

Hastings.—The Local Government Board have sanctioned the borrowing of £38,344 for electric lighting extensions. The application was for £38,613, but the difference (£279), cost of obtaining electric lighting order, cannot properly be defrayed out of moneys borrowed under the provisions of the Electric Lighting Act, 1882.

Hammersmith (London).—At the vestry meeting on Wednesday it was decided to erect two new high-tension switchboards, and also to fix new low-tension regulating gear at an estimated cost of £150, after allowing for credit on the present gear.

Hornsey.—On Monday the Council resolved to engage an electrical expert to advise on the question of erecting electricity works. The Council already possess an order, and have received offers for a transfer from various companies, who have now been asked to submit further particulars.

Hythe.—A proposed application of the Folkestone Electricity Supply for a provisional order is to be opposed, and the Council will themselves apply for electric lighting powers.

Jamaica.—In a report presented to the Municipal Council by the recently-appointed special committee on overhead wires, the Council are advised to obtain legislative authority to control and regulate overhead wires in the city.

Keighley.—The Council propose to erect new municipal offices to be lighted electrically.

Light Railways.—Applications for light (electric) railway orders are being made by the following:—

Blackpool and Garstang (Electric) Light Railway Co., to construct three lines of light (electric) railway in Blackpool and neighbourhod.

Greenwood and Batley (Limited), to construct light railways in Kingston-on-Thames, Surbiton and district.

London County Council to construct a light (electric) railway from Highgate junction, along Archway-road, terminating at the county boundary; to construct four lines in Clapham, Battersea, Wandsworth, and Putney; four lines in Greenwich, Lewisham, Charlton, Kidbrooke, Eltham, and Woolwich; and two in St. Paul, Deptford, Lewisham, Lee, and Eltham (see further particulars in *The Electrician* for Oct. 20).

British Electric Traction Co., for power to construct light (electric) railways in Morley, Bradford, Drighlington, Gildersome, and West Ardsley.

The Bath Corporation notify that they will apply to the Light Railway Commissioners for power to construct light (electric) railways in the district.

The amended plans of the Rhyl-Prestatyn light (electric) railway have been approved by the Rhyl Council.

A proposal has been made to construct a light electric railway between Warrington and Northwich, and the scheme is under the consideration of the local authorities interested. The line will be constructed to the standard guage and on the highway.

Liverpool.—An inquiry has been held here into the application of the City Council to borrow £300,000 for electric lighting purposes. The town clerk (Mr. E R. Pickmere) supported the application, and said that in 1896 the Corporation purchased the undertaking of the Liverpool Electric Supply Co., and £500,000 was authorised to be raised for providing the purchase money and for making certain extensions. That money had been spent, as well as a further sum of £100,000. When the Corporation acquired the undertaking the equivalent of 41,515 16-c.p. lamps was connected to the mains. In 1897 the figure was 57,336, in 1898 74,227, and now it stood at about 100,000. In 1896 the charge for current was 7½d. per unit for lighting and 5d. for power. Now it was 4d. for public lighting and 2d. and 1d. for power. Notwithstanding this reduction, a profit of £8,000 was made in 1898, after providing for sinking fund and interest, and the demand for electric current was steadily increasing. An important factor was the acquisition by the Corporation of the tramways and the introduction of electric haulage, which made increasing demands upon the electric supply stations. Excluding Pumpfields station, which was erected out of money recently borrowed, the existing stations were producing 10 000 H.P. electrical energy, and the stations proposed to be erected would furnish about 15,000 H.P. further, of which about 5,000 H.P. would be required for tramways. The Corporation would require £388,000 to carry out the proposed extensions, and although it might seem a large sum, the Corporation would at no distant date have to ask for further sums. The cost of buildings, land, and sidings for Pumpfields, Lister-drive, Smithdown-road, Lodge-lane, and Lowhill stations came to £102,000; the plant would cost £167,300, and the mains £119,400. The sites of the Pumpfields and Lister-drive stations belonged to the Corporation, but the electric supply accounts would be charged a rental on the capital value. The city electrical engineer (Mr. A. Bromley Holmes) gave technical particulars in support of the application, which was unopposed.

Lincoln.—Application for parliamentary powers to establish and work electric tramways has been decided upon by the Council.

London County Council.—At Tuesday's meeting the Highways committee reported that it had been represented to them that it was doubtful whether, even if the Board of Trade licence were granted, the Council would have power without further Parliamentary authority to interfere with the public streets in connection with the use of electric traction on the tramways between Westminster and Tooting. The committee recommended that such powers be sought. The recommendation was approved.

Loughborough.—A sub-committee has been appointed to report upon the question of putting the Council's electric lighting powers into force.

Mansfield.—A committee has been formed to consider and report upon the electric tramway scheme which was recently put before the Council by Mr. C. H. Gadsby, and which provides for the construction of a system of electric tramways from Sutton-in-Ashfield, through Mansfield, to Mansfield Woodhouse.

Mexico City.—For the lighting of this city in 1898 480 2,000-c.p. and 120 1,200-c.p. arc lamps and 49 50-c.p. incandescents were employed. Gas has been entirely superseded, but a large number of naphtha and turpentine lamps are still employed. Electric current is supplied by a German company. A number of new industries have been started during the past few years in the Mexico valley, and the employment of electric motive power on a considerable scale is stated to be under the consideration of the owners of many enterprises in this district.

Morecambe.—An inquiry was held on Tuesday into the Council's application to borrow £25,390 for electric lighting extensions. The Council's electrical engineer (Mr. C. F. Parkinson) appeared in support of the application, and said the Council had already expended £33,418, of which £1,389 was in excess of loans already sanctioned. There was a constantly increasing demand for current, and the undertaking was in a satisfactory position. There was no opposition.

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Newcastle-on-Tyne.—The Corporation have re-leased the whole of their tramway lines within the city to the Newcastle and Gosforth Tramways and Carriage Co. until Dec. 1, 1900, and from that period the lease will be continued subject to three months' notice from the Corporation. The rent is £1,272 to March 1, 1900, and thereafter a sum equal to 4 per cent. upon the purchase money paid by the Corporation.

Oswestry.—The Corporation are applying for a provisional order for sanction to purchase the Oswestry Electric Lighting and Power Co.'s undertaking and to carry out certain extensions.

Paisley.—A further loan of £25,000 to £30,000 to meet expenditure connected with electric lighting and gas undertakings is to be raised by the Corporation.

Penge (London).—A proposal having been made by the Beckenham Council for the supply of electric current in this district, the Lewisham Council have decided to postpone consideration of the matter until the position of Penge with regard to the Lewisham district under the new London Government Act has been defined.

Penrith.—The Council have resolved to apply for a provisional order. Originally it was intended to include the neighbouring parishes of Brougham and Yanwath, but this part of the scheme has been dropped for the present.

Presentation.—Mr. Joseph Dorrington, chief superintendent of the Postal Telegraph office, Birmingham, who has just retired, has been presented with a gold watch and silver cigar case from the male staff and female staff of the telegraph department. In 1854 Mr. Dorrington entered the service of the International Electric Telegraph Co. After a lapse he, in 1858, returned to this service, and early in 1859 went to Birmingham where for forty years he has been in the local telegraph service.

Preston.—A special meeting of the Council has approved the Corporation's Electric Tramways Bill.

Railway Station Lighting.—Ludgate Hill station, London, is now illuminated electrically, and arrangements for similarly lighting the adjacent St. Paul's station are being made.

Redcar.—A provisional order is to be applied for by the Council.

Rhyl.—The Council recently canvassed the residents to ascertain the amount of support likely to be accorded an electric lighting scheme, and the result is of a very satisfactory character. It is stated that nearly every tradesman has promised to take current, and also a very large percentage of private residents.

Rosario (Argentina).—The principal tramway routes in the city have been acquired by a local firm, which is said to be acting on behalf of an English syndicate who propose to convert them into electric lines.

St. Annes-on-Sea.—An inquiry was held here yesterday (Thursday) into the application of the District Council to borrow £18,386 for electric lighting.

Seaford.—The Council have assented to the application of the Newhaven and Seaford Electric Lighting Syndicate for a provisional order.

Salford.—The Mayor (Ald. S. Rudman) last week gave a summary of the various works which will be carried out as soon as the necessary Parliamentary powers are obtained. The work comprises relaying existing tramlines, the construction of new routes, and the electrical equipment of the whole system, at an estimated cost of £550,000. Extensions of the electricity works are also to be carried out, at an estimated cost of £270,000.

Sevenoaks.—The Council, having received a request for sanction to an application for a provisional order, have decided to engage an electrical expert, at a fee of 25 guineas, to advise them.

Shoreditch (London).—The Vestry on Tuesday continued the discussion of the report of the Lighting committee as to the allocation of the surplus £6,463 of the electric lighting department. The recommendations of the committee are set out in our issue of Nov. 10, p. 98. As an amendment to these recommendations Mr. Winkler now proposed (1) the rescision of a resolution passed last May deciding that the accounts of the dust destructor and electric lighting undertaking should be combined; (2) that all profits made by the electric lighting department up to March 25 last be appropriated to liquidate the losses and deficiencies incurred by the destructor; (3) that henceforth all profits up to £1,000 derived from the joint undertaking should be transferred to a reserve fund; and that (4) all surplus beyond the £1,000 should be paid into the general rate account. The amendment was lost. The debate on the recommendations of the committee then proceeded, and after two further amendments had been disposed of, the committee's recommendations were adopted by a small majority.

Telegraphs in Angola.—In addition to its cable communication by the West African Telegraph Co.'s line connecting the Cape and Eastern systems with Europe, Angola (the Portuguese possession on the West Coast of Africa) has its own internal telegraphic communication established and maintained by its Government. There are at the present time about 20 telegraph stations open to the public, as well as two telephone stations. During 1899 Ambriz, about 80 miles from Loanda, has been connected up to the system; and the line is to be extended to Ambrizette and finally to the mouth of the Congo, 180 miles north of Loanda.

Telephone Facilities in London.—In reference to the circular letter of the Postmaster-General which appeared in *The Electrician* on Nov. 10, p. 84, Mr. W. E. L. Gaine, general manager of the National Telephone Co., has notified the 41 London local authorities that, according to the view held by the directors of the National Co., the Postmaster-General is under an absolute covenant to delegate his powers to the company whenever called upon by the company so to do. Under the Telegraph Act, 1892, the Postmaster-General is empowered to delegate to any licensee of his any powers contained in the Telegraph Acts for breaking up streets, but in the metropolitan area these powers can only be exercised with the consent (*a*) of the London County Council and (*b*) of the road authority for the district. As the company has hitherto been unable to secure the consent of the London County Council, it has not hitherto called upon the Postmaster-General to exercise his powers. Mr. Gaine points out that nobody or person has the legal right to break up a public highway without statutory powers, and that practically the only body having such rights is the road authority. He further claims that if the road authority give the company permission to put down pipes and wires at the company's own risk, the road authority is at perfect liberty to do so. As to the rentals which the company intend to charge in the metropolitan district, the rates are to be the same as those fixed by the Post Office authorities, and the company are awaiting the publication of these rates before themselves taking action. The company propose to introduce a message rate in addition to their regular rental system, and users of the telephone will be able to adopt either method of payment.

Telephony in the Manchester District.—The Moss Side Council have passed a resolution supporting the application of the Mutual Telephone Co. to the Postmaster-General for a telephone licence for this district.

Torquay.—The Local Government Board have sanctioned the borrowing of £7,000 for extensions to electricity supply.

Uddingston (Glasgow).—A small plant has been erected by Mr. J. Watson for supplying current to three blocks or buildings now being erected by him in the main street, and also for lighting the main street. A gas-driven generator and a battery of accumulators has been provided. The contractors are Messrs. Hunter and Jack, Glasgow, and the consulting engineer, Mr. T. Crichton Fulton.

Wellingborough.—The Council have authorised their building inspector (Mr. de Key) to obtain particulars and estimates of the plant necessary for their proposed electric lighting scheme.

Wigan.—The Corporation last week accepted tenders for electric lighting plant, and application has been made for a loan of £85,000 for carrying out the scheme.

Electro-Harmonic Society.—A ladies' night concert takes place at Café Monico, Piccadilly-circus, London, W., this (Friday) evening, at eight o'clock.

COMPANIES' MEETINGS AND REPORTS.

Aron Electricity Meter (Limited).

The second ordinary general meeting of this Company was held yesterday, under the presidency of Sir JAMES PENDER, Bart., M.P.

Mr. MAURICE ARON (general manager and secretary) having read the notice convening the meeting,

The CHAIRMAN said: The balance-sheet now presented is the first since our formation, and covers a period of 21 months. I trust you will agree that we have every reason to congratulate ourselves on the satisfactory result of the working of the business up to date. You will remember that our prospectus stated the highest profits ever made in one year were for the year 1897, giving the net profit as £18,550. 5s. 4d., without, however, allowing for the remuneration of Dr. Aron. In dealing with the profit and loss account for 1898 we have a profit of nearly the same amount, namely, £17,731. 17s. 6d. It is easily seen why the rate of increase that was shown in the prospectus for the years up to 1897 was temporarily checked during the transitory year of 1898. Firstly, the organisation was that of a private concern, and the absence of Dr. Aron and Dr. Juttke from business during the time of negotiating the formation of the Company in 1898 led to a temporary falling off in output. Up to the beginning of 1893, the bulk of the profits derived by Dr. Aron from his business were made out of his old type clockwork meter. When, however, through the formation of the Company, the new type of meter was brought to the front the Continental engineers suddenly stopped ordering the old type meter in large quantities, and instead gave orders for samples of the new type meters, which for some time caused a decrease in the returns of the German business, which even the rapid increase in the Austrian and English business could not cover. Considering all this it is a matter for congratulation that the reduction in the net profits for 1898 is only a question of a few hundred pounds. For

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the last nine months, during which your Directors had been responsible for the result of working, we had nothing but unqualified success to report. We had made during that period a trade profit of £18,391. 14s. which practically means an increase of 25 per cent. on the very best year mentioned in the prospectus, and we would probably have to account for a very much larger profit had we not met with some difficulties which it may be interesting to you to hear of. After the payment of the last instalment to the vendor at the beginning of January, we made a trip to Berlin. Mr. Wallace went to Schweidnitz to inspect the works and assets of the business and to look into the organisation of all matters of accounts. We also had to arrange such systems as would enable us to see from week to week the progress of the business in all parts of the Continent. We found that to further our object best in Germany it was necessary to form a German company under the name of H. Aron (Limited) the shares of which are held by us as trustees for the English Company. This enables us to trade on the Continent with a German name. We have found that in order to meet the growing demand and orders for the new type meter we have had to considerably increase our works, our staff, our tools and our stock; in fact, no increase of profits could be expected unless we increased the rate of manufacture which would enable us both to produce cheaper and to keep pace with orders. That our efforts have been so far successful is proved by the figures we have for the last few months; but the coming year will, of course, reap the bulk of the benefits of this reorganisation. At the present moment the rate of taking orders is progressing from month to month. We are not aware of having lost a single central station that has taken our meters, and we are getting new ones every day in every part of Europe. We have made the necessary arrangements that during the next 12 months we shall be able, not only to cope with new orders, but to execute orders in arrears. A very reasonable amount has been placed to our reserve, and we have made a contract for the sale of the American patents, according to which in the course of the present year our assets ought to be increased by a sum of about £9,000 in cash and about £33,000 in shares. We consider the business in America important, not only on account of the profit-earning capacity there, but also on account of the moral effect it will have in our favour if we compete successfully with the present American meters in their own home. We hope in due course to be equally successful in disposing of our patents in other countries, thus creating a large reserve without unduly trenching on our trading profit. In conclusion, I beg to move the adoption of the report and accounts.

Mr. R. W. WALLACE, Q.C., in seconding the motion, said that the board had received loyal support from Dr. Aron and Dr. Juttke, and had found that all their statements with reference to the business were well founded.

After a short discussion, in the course of which Mr. HERDMAN congratulated the Directors on the result of the past 21 months' working, the motion was adopted. The proposed payment of a dividend on the Ordinary shares, at the rate of 6 per cent. per annum was also agreed to.

The proceedings terminated with a vote of thanks to the Chairman.

The report of the directors for the 21 months to Sept. 30 states that the balance to credit of profit and loss amounts to £25,107. 9s. 2d., out of which £9,829. 19s. 5d. (less £2,416. 1s. 11d. cost of establishing the Schweidnitz factory), representing the net profit for the nine months prior to the formation of the company, will be put to reserve. This leaves £16,277. 9s. 9d., out of which the interim dividend on the Preference shares was paid, absorbing £2,509. 18s. 8d., leaving £13,767. 11s. 1d. to be carried forward. The directors recommend a dividend at the rate of 6 per cent. per annum on the Preference shares for the six months ended Sept. 30 (absorbing £3,750), and a dividend at the rate of 6 per cent. per annum for the year ended Sept. 30 on the Ordinary shares (absorbing £7,500), leaving £2,517. 11s. 1d. to be put to reserve.

Blackheath and Greenwich District Electric Light Co. (Limited).

The report of the directors of this company for the period from May 11, 1896, to Sept. 30, 1899, just issued states that the total expenditure to the last-mentioned date was £84,809. 4s. 1d. The main buildings of the company's generating station at Blackwall Point are practically finished, and provide engine and boiler space for plant capable of supplying about 8,000 8-c.p. lamps Generating plant of a capacity of about 50,000 8-c.p. lamps is now being installed, and the contractors expect to have two machines at work at an early date. About 16 miles of the principal streets of Blackheath, Greenwich, and Lee have been opened up, and 42 miles of cable laid therein. In Blackheath and Lee a temporary supply of electric energy, obtained from a neighbouring company, has been available since July 18 last. The lighting of the district by electricity has therefore commenced, and will be speedily extended from the company's own station. 140 applications were received up to Oct. 31, equivalent to 6,896 lamps of 8-c.p., of which 3,625 were then connected to the company's mains. Applications for motor power have been received to the extent of 40 H.P.

The company's area of supply has been largely extended by the Lee (extension) provisional order, which empowers the company to supply electric energy in those parts of the parishes of Lee, Eltham, Kidbrook, and Charlton which were not comprised in the company's order of 1897. To carry out the provisions of the new order, and to complete the necessary extensions, further capital will be required. The directors will shortly consider the question of raising such capital. The application made to made to Parliament last session by the County of London and Brush Provincial Co. for powers to supply electric energy in part of this company's area was successfully opposed. The company also successfully opposed the inclusion in the provisional order promoted by the Board of Works for Lewisham of the Blackheath portion of the Lewisham district comprised in the company's provisional order of 1897.

RENEWABLE ELECTRIC LAMP CO. (LTD.).—Mr. J. Atherton presided at the statutory meeting of this company on Wednesday. No opportunity was offered our representative of attending the meeting, but (according to the *Financial News*) Mr. Atherton stated that a suitable site for works had been secured by the company at Brunswick-place, City-road, Shoreditch, London. The Directors had taken the advice of an expert lamp maker, a man who had been connected with this business for the greater portion of his lifetime, and he expressed the view that the works were capable of taking machinery for the supply of about 10,000 lamps per day. The lease had 50 years to run, and they had the option of buying the ground rent any time during the first seven years at a price of £4,000. They had been successful in finding a man to take charge of the works whose credentials were satisfactory. He was now in charge of the works. They had also appointed a general manager to look after the commercial side of the question, and he had gone so far as to lay out the works for equipment with the most modern machinery for producing lamps, so that they were now an up-to-date lamp manufacturing company. He had the benefit of the experience of the gentleman who was acting as managing director, who has been connected with the electrical industry for a great many years, and, perhaps, with one of the most successful supply stations in London. They hoped to begin turning out lamps in fairly large quantities within three months from the present time. In the meantime, they had made an engagement with a friendly English lamp manufacturing company to supply them with 2,000 lamps per week, in order that they might furnish the various supply stations, companies, hotels, clubs, and very large consumers of lamps with small parcels, in order to give them some practical experience pending the time that the lamp works at Shoreditch were fully equipped. Important large contracts had been entered into with public bodies in various parts of the country and in London; they had, in fact, more orders than they could execute at the present time, and many large buyers were waiting for the time when they could give them deliveries. It was now customary for supply companies to include their lamp in the price for supply of current, and in the near future it was expected that their business would be done with these public companies, who were anxiously looking forward to an efficient lamp at a moderate price, and one that could be renewed over and over again.

WESTERN UNION TELEGRAPH CO.—The annual report of the president of this company for the year ended June 30, submitted at the meeting of the stockholders on the 11th ult., stated that the capital stock outstanding is $97,370,000·00, of which $29,260·35 belonged to and was in the treasury of the company. During the year there was no change in the capital stock outstanding. The bonded debt at the close of the year was as follows:—

Bonds due March 1, 1900, 6 per cent.	$761,076 00
Bonds due May 1, 1900, 7 per cent.	4,920,000 00
Bonds due May 1, 1902, 7 per cent.	1,163,000 00
Bonds due January 1, 1938, 5 per cent.	8,502,000 00
	$15,346,076 00
Less balance of sinking funds appropriations not yet used for redemption of bonds	490,153 86
	$14,855,922 14

During the year £2,100 sterling bonds (due March 1, 1900) were redeemed by the sinking fund trustees. Tables accompanying the report show practically the same mileage of poles as in 1898, an increase of 30·213 miles of wire, and also an increase of 75 offices. The number of messages transmitted in 1899 was 775,592 less than in 1898. This decrease was accounted for by the extraordinary number of Press messages concerning the Spanish war last year. The company handled, however, 3,246,473 messages more in 1899 than in 1897. The revenues for the year were $38,579·27 more than for 1898, notwithstanding the decrease of Press traffic, which was more than offset by an increase of $140,069·68 for ordinary commercial messages. There was also an increase of $178,495·98 in the revenues from leased wires. To provide for these increases in the ordinary commercial business the item for operating and general expenses was $205,492·79 larger than for 1898. The cost of maintenance and reconstruction was increased $65,128·37. The payments for taxes were $25,478·46 less, because of the settlement of sundry disputed accounts in 1898, but the amount paid in 1899 ($540,746·05) showed a steady increase in the tax charges against the company. There was an increase of $17,066·58 for equipment of offices and wires, and a decrease of $2,212·11 for rentals paid for leased lines. The net increase in expenses for the year was $259,997·67 compared with preceding year. The net profit for 1899 was $5,868,732, which provided for the interest on the bonds and the dividend of 5 per cent., and carried $103,692·41 to surplus account. The average tolls received were 30·8 cents per message, as against 30·1 cents in 1898. The average cost per message was 25·1 cents, as against 24·7 cents in 1898. These increases were caused by the larger number of full-rate commercial messages and the smaller number of Press messages transmitted in 1899. The outlay for construction of new property for the year was $820,190·69, principally for additional copper wires on trunk lines. The lines of the company are in excellent condition.

NEW COMPANIES, STATUTORY RETURNS, &c.

DUBLIN ELECTRIC LIGHTING SYNDICATE (LIMITED).—This company was registered in Dublin, on November 17, with a capital of £5,000 in £1 shares, to carry on the business of electricians, electrical, hydraulic, and general engineers, suppliers of electricity, &c. The subscribers are C. W. Hely, V. W. Brown, Sir H. Cochrane, J. D. Wallis, J. D. Chaytor, D. Kellett, and W. Fitzgerald. The first directors are Sir H. Cochrane, D.L., C. W. Hely, and V. W. Brown.

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CHARLES NOYCE AND SONS (LTD.).—This company was registered on Nov. 16, with a capital of £6,000 in £5 shares, to carry on the business of electricians, electrical and general engineers, &c.

WESTMACOTT, STEWART AND CO. (LIMITED).—This company was registered on November 13, with a capital of £6,000 in £1 shares, to acquire the undertaking and the assets and liabilities of A. Westmacott, in connection with the business of Vril Launches (Limited), and to carry on the business of launch, boat, carriage, and vehicle manufacturers, suppliers of electric and other power, &c. The first directors are A. Westmacott (chairman), W. B. Stewart, and J. Westmacott.

CITY NOTES.

MEMORANDA.—Bank rate 5 per cent. (since Oct. 5, 1899). Price of silver 27$\frac{5}{16}$d. per oz. (Nov. 23). Consols (2$\frac{3}{4}$ per cent.) 102$\frac{7}{8}$—103$\frac{1}{8}$ for money, 103—103$\frac{1}{8}$ for account; 2$\frac{1}{2}$ per cent. 100$\frac{1}{4}$—100$\frac{3}{4}$ (Nov. 23). Stock Exchange Settling Days: Consols, Dec. 1; Stocks and Shares Continuation Days, Nov. 28 and Dec. 12; Ticket Days, Nov. 29 and Dec. 13; Pay Days, Nov. 30 and Dec. 14; Mining Share Carry-over Days, Nov. 27 and Dec 11.

BRITISH ELECTRIC TRACTION CO. (LIMITED).—This company have invited subscription for a further 20,000 Six per Cent. Cumulative Preference £10 shares at £12 per share. The lists closed on Tuesday.

ELECTRICAL CASTINGS AND ENGINEERING CO. (LTD).—Subscriptions are invited for 20,000 Ordinary shares of £1 each in this company, which is formed to carry on the business of manufacturers of castings, forgings, and apparatus for electric lighting, transmission of power, railways, tramways, electro-chemical, electro-metallurgical purposes, &c. The registered offices of the company are at Wednesfield. Subscriptions close at 12 noon to-morrow (Saturday).

RICHARD HORNSBY AND SONS (LTD.).—For the year to Sept. 30 a profit is shown of £47,932, after writing off the usual depreciation and paying interest on debentures and mortgage loan and directors' remuneration. Adding £2,137, balance from last account, gives a disposable balance of £50,069; and the directors recommend, after payment of dividend on Six per Cent. Preference stock, a dividend of 8s. per share on the Ordinary shares, placing to reserve £25,000 and carrying forward £7,069.

LONDON ELECTRIC SUPPLY CORPORATION (LIMITED).—It is announced that additional capital is required to meet the increase in the Corporation's business, and the directors are prepared to receive applications for £50,000 Four per Cent. Mortgage Debenture stock, ranking with the £200,000 already issued. The existing shareholders are to have an opportunity of subscribing for this issue at par. Interest is payable on Jan. 1 and July 1.

OFF THE REGISTER.—The Registrar of Joint Stock Companies gives notice that the following companies have been struck off the register:—

- Blot Electric Accumulator.
- British and Foreign Chemical.
- British Electrical and Industries.
- British Electrical Cycle and Motor Engineering.
- Electrical Investments Trust.
- Electrical and General Exploring Syndicate.
- Electric Transformer System.
- Improved Lighting Syndicate.
- Leatherhead Electric Lighting and Power.
- Maxim Foreign and Colonial Motor Syndicate.
- Pittsburgh Reduction Syndicate.
- Practical Primary Electric Battery Syndicate.
- Randall Telephone Syndicate.
- Rottingdean Electric Lighting and Power.
- South Manchester Electric Supply.
- Walton-on-Thames Electric Lighting and Power.
- X-Ray Syndicate.

STOCK EXCHANGE NOTICE.—Application has been made to the Stock Exchange committee to appoint a special settling day in, and to grant a quotation to, the further issue of 15,000 Fully-paid £10 Ordinary shares (Nos. 60,001 to 75,000) of the *British Electric Traction Co. (Ltd.)*.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	1899	£	£		£	£
*Birmingham Tramways.	Nov. 18	3,826	− 51	20	83,281	+ 8,369
Blackpool Corporation...	...	...	...	...	...	...
Blackpool and Fleetwood	„ 18	172	− 29	20	19,415	+ 5,819
Bradford Corporation ...	„ 19	348	+ 74	66	21,907	...
Brisbane Trams	Oct. 4	1,510	+ 682	1	1,510	+ 682
*Bristol Trams & Carriage	Nov. 17	4,898	+2,230	20	64,102	+ 8,053
*Buenos Ayres & Belgrano	Oct. 22	2,252	+ 801	42	90,200	+41,352
City & South London Ry.	Nov. 19	1,046	+ 2	21	20,452	+ 49
Dover Corporation	„ 18	153	+ 9	33	7,304	...
Dublin United	„ 17	2,606	+2,473	...	...	...
Dublin Southern Dist....	„ 17	700	+ 20	...	...	...
*Glasgow Corporation ...	„ 18	8,856	+ 577	...	...	...
*Liverpool Corporation...	„ 11	7,356	+1,434	45	310,249	+36,638
Liverpool Overhead Rly.	„ 19	1,438	+ 80	21	34,261	+ 1,233
*Sheffield Tramways	„ 19	1,761	+ 606	46	65,755	+19,031
*South Staffs. Trams....	„ 17	654	+ 23	46	30,750	+ 1,569

* Partly electrical.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	NAME.	Previous Week's Price, Nov. 15.		Price Wednesday, Nov. 22.		Rate per Cent. Yield £ s. d.	Dividend Due.	Business Done During Week Ending Nov. 22. Highest	Lowest
			TELEGRAPHS.								
£110,900	100	4%	*African Direct Telegraph 4% Mort. Deb. (red.)	100	104	100	104	3 16 11	January and July	101	...
25,000	10	...	Amazon Telegraph	3	4	3	4	...	June and December	...	...
£125,000	100	5%	Do. 5 per Cent. Debentures	85	90	85	90	5 11 1		...	...
£875,520	Stock	15/0	Anglo-American	66	69	66	69	5 0 5	Feb., May, Aug., Nov.	68$\frac{1}{4}$	67
£3,062,240	Stock	30/0	Do. Preferred	117	118	117	118	5 1 11	„ „	118	117$\frac{1}{4}$
£3,062,240	Stock	18/0	Do. Deferred	17$\frac{1}{2}$	18	17$\frac{3}{4}$	18$\frac{1}{4}$	4 18 7	...	19$\frac{3}{8}$	17$\frac{5}{16}$
205,993	10	5/0	Brazilian Submarine	15	15$\frac{1}{2}$	15$\frac{1}{2}$	15$\frac{7}{8}$	4 8 11	Mar., June, Oct., Dec.	15$\frac{7}{16}$	15$\frac{5}{16}$
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1900)	107	111	107	111	4 11 6	June and December	...	...
$10,000,000	$100	1\frac{1}{4}$	Commercial Cable Capital Stock	190	200	198	202	3 19 9	Jan., Apr., July, Oct.	201	...
£1,332,823	Stock	4%	* Do. 4 per Cent. Debenture Stock	103	105	103	105	3 16 6	„ „	104$\frac{1}{2}$	103$\frac{3}{4}$
16,000	10	8/0	Cuba Submarine Ordinary	9	10	9	10	8 0 0	February and August	9$\frac{7}{8}$	...
6,000	10	10/0	Do. Preference 10 per Cent.	19	20	19	20	5 0 0	„ „	...	...
12,931	5	2/0	Direct Spanish Ordinary	4	5	4	5	4 0 0	April and October	...	...
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference	9	10	9	10	5 0 0	„ „	...	...
£30,000	50	4$\frac{1}{2}$%	Do. 4$\frac{1}{2}$ per Cent. Debentures	103%	107%	103%	107%	4 4 1	January and July	...	...
60,710	20	3/0	Direct United States Cable	12	12$\frac{1}{2}$	12	12$\frac{1}{4}$	5 12 0	Jan., Apr., July, Oct.	12$\frac{1}{8}$	12$\frac{1}{16}$
£120,000	100	4$\frac{1}{2}$%	Direct West India Cable 4$\frac{1}{2}$% Reg. Deb. (red.)	101	104	101	104	4 7 10	June and December	...	...
£4,000,000	Stock	5%	Eastern Ordinary	157	162	158	163	4 6 3	Jan., Apr., July, Oct.	161	158
£1,795,000	Stock	3$\frac{1}{2}$%	Do. 3$\frac{1}{2}$ per Cent. Preference Stock	99	102	99	102	3 8 8	„ „	100$\frac{1}{2}$	...
£1,432,268	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.)	117	122	117	122	3 5 7	May and November	120	...
250,000	10	2/6	Eastern Extension	15$\frac{1}{2}$	16	15$\frac{1}{2}$	16	4 7 6	Jan., Apr., July, Oct	16	15$\frac{3}{4}$
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	118	123	118	123	3 5 7	February and August	...	...
£16,200	100	5%	* Do. 5% (Austln. Gov. Sub.) Deb., 1900 (reg.)	99	103	99	103	4 17 4	January and July	...	...
£64,400	100	5%	Do. (Bearer)	100	103	100	103	4 17 1	„ „	...	...
£17,400	100	5%	*Eastern and S. African 5% Mort. Deb., 1900 (reg.)	99	103	99	103	4 17 1	„ „	...	...
£24,500	100	5%	Do. (Bearer)	100	103	100	103	4 17 1	„ „	...	...
£300,000	100	4%	* Do. 4 per Cent. Mortgage Debentures, 1909	101	104	101	104	3 16 11	February and August	103$\frac{1}{2}$	101$\frac{1}{2}$
£200,000	25	4%	Do. 4 per Cent. Mauritius Sub. Debs. (red.)	101%	104%	101%	104%	3 16 10	May and November	...	...
180,227	10	1/9	Globe Telegraph and Trust	11$\frac{1}{4}$	11$\frac{3}{4}$	11$\frac{1}{4}$	11$\frac{3}{4}$	4 9 4	Jan., Apr., July, Oct.	11$\frac{1}{2}$	11$\frac{5}{8}$
180,042	10	3/0	Do. 6 per Cent. Preference	15$\frac{1}{2}$	16	15$\frac{1}{2}$	16	3 15 0	„ „	15$\frac{7}{8}$	15$\frac{5}{8}$
150,000	10	5/0	Great Northern of Copenhagen	30	32	31	33	3 15 9	January and July	...	...
£89,500	100	4$\frac{1}{2}$%	Halifax & Bermuda Cable 4$\frac{1}{2}$% 1st Mort. Deb. (red.)	100	103	100	103	4 7 5	...	...	...
17,000	25	12/6	Indo-European	48	52	48	52	4 16 2	May and November	...	...
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904	106	109	106	109	5 10 1	March and September	...	...
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.)	103	106	103	106	3 15 6	June and December	...	...
11,839	8	4/0	Reuter's	7	8	7	8	5 0 0	April and October	...	...
3,381	£100 Cert.	6%	Submarine Cables Trust	129	134	130	135	4 9 1	„ „	...	...
15,609	10	...	West African Telegraph	2$\frac{1}{2}$	3$\frac{1}{2}$	2$\frac{1}{2}$	3$\frac{1}{2}$	4 9 3	December and July	...	...
£200,000	100	5%	* Do. 5 per Cent. Debentures (red.)	99	102	99	102	4 18 0	March and September	...	...
30,008	2$\frac{1}{2}$	...	West Coast of America	$\frac{1}{2}$	1	$\frac{1}{2}$	1	...	...	...	...
£150,000	100	4%	* Do. 4 per Cent. Debentures	102	105	102	105	3 16 8	January and July	...	...
88,321	10	2/6	West India and Panama	1$\frac{1}{8}$	1$\frac{3}{8}$	1	1$\frac{1}{8}$	...	May and November	1$\frac{1}{8}$	1$\frac{1}{16}$
34,563	10	6/0	Do. 6 per Cent. 1st Preference	10$\frac{1}{4}$	10$\frac{1}{2}$	10$\frac{1}{4}$	10$\frac{1}{2}$	5 11 6	„ „	...	...
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	9	10	9	10	6 0 0	„ „	...	...
£80,000	100	5%	* Do. 5 per Cent. Debentures	105	108	105	108	4 13 11	January and July	...	...
£289,731	Stock	4%	Western & Brazilian 4 per Cent. Debenture Stock	104	107	104	107	3 15 0	June and December	...	...
£159,100	100	6%	*Western Union 6 per Cent. Sterling Bonds (red.)	98	103	98	103	5 16 6	March and September	...	...

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	NAME.	Previous Week's Price, Nov. 15.	Price Wednesday, Nov. 22.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Nov. 22. Highest	Lowest
			TELEPHONES.			£ s. d.			
44,000	£5	3/0	Chili Telephone (fully paid)	2 3	2 3	6 13 4	August	...	...
221,850	10s.	0/1½	Consolidated Telephone Const. & Manufacturing	¼ ¼	¼ ¼	4 15 3	July	...	...
71,000	1	0/6	Monte Video Telephone Ordinary	¾ ¾	¾ ¾	5 0 0	October	...	...
84,000	1	1 0	Do. 5 per Cent. Preference	¾ 1	¾ 1	5 0 0	...	...	...
490,000	5	3/0	National	5 5½	5 5½	5 14 3	February and August	5½	5 7/16
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Preference	14 15	14 15	4 0 0	,, ,,	...	...
15,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference	14 15	14 15	4 0 0	,, ,,	...	...
250,000	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref.	5½ 5½	5½ 5½	4 10 11	,, ,,	5⅜	...
1,329,471	Stock	3½%	* Do. Debenture Stock 3½ per Cent. (red.)	100 102	100 102	3 8 8	June and December	101	...
171,504	1	0/4	Oriental	¾ 1	¾ 1	5 0 0	April and October	...	...
58,000	5	6/0	United River Plate	4¾ 5¼	4¾ 5¼	5 14 3	July	4¾	...
16,639	5	...	Do. 5% Cumulative Preference (£3. 10s. paid)	3¼ 3¾	3¼ 3¾	...	...	...	...
£179,947	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	105 108	105 108	4 13 9	June and December	...	...
			ELECTRICITY SUPPLY COMPANIES.						
100,000	1	...	Bl'ckh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.)	¾ 1	¾ 1	...	...	...	...
6,000	10	7/9⅜	Bournemouth and Poole Electricity Supply Ord.	12¾ 13¼	12¾ 13¼	2 18 10	...	...	...
6,000	10	4/6	Do. 4½ per Cent. Cumulative Preference	10 11	10 11	4 1 10	...	...	...
19,661	5	2/6	Brompton & Kensington Electricity Supply Ord.	7½ 8	7¾ 8¼	3 10 7	...	...	...
12,000	5	3/6	Do. 7 per Cent. Preference	9 10	9 10	3 10 0	March and September	...	...
20,000	5	...	Calcutta Elec. Supply Ordinary (£4 paid)	5½ 6	5¼ 6	...	...	...	...
30,000	5	4/0	Charing Cross & Strand Electricity Supply Corp.	10 11	10 11	4 1 10	February & August	10¾	10⅛
20,000	5	...	Do. (Nos. 3,001 to 50,000)	9½ 10½	9½ 10½	...	...	...	...
20,000	5	2/3	Do. 4½ per Cent. Preference	5¼ 6¼	5¾ 6¼	3 12 0	,, ,,	...	...
34,000	5	2/6	Chelsea Electricity Supply Ordinary	8 9	8 9	3 6 8	March	...	...
£100,000	Stock	4½%	* Do. 4½ per Cent. Debenture Stock (red.)	111 113	111 113	4 0 9	June and December	...	...
$1,200,000	$1,000	5%	Chicago Edison 1st Mort. 5% 30 year Gold Bonds (red.)	100 110	100 110	4 10 11	April and October	...	...
60,000	10	7/0	City of London Electric Lighting Ordinary	11½ 12	11½ 12½	4 16 0	February and August	12 7/16	11⅛
40,000	10	6%	Do. 6 per Cent. Cumulative Preference	13 14	13 14	4 5 9	January and July	13⅛	...
£400,000	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	125 130	125 130	3 17 5	June and December	...	...
40,000	10	...	County of London and Brush Prov. Ordinary	10½ 11	10½ 11½	...	...	10⅞	...
20,000	10	6/0	Do. 6 per Cent. Cumulative Preference	13 14	13 14	4 5 9	March and September	...	...
£200,000	Stock	7/8	Do. 4½% Deb. Stock Certs. (all pd.) (red.)	111 114	111 114	...	...	112	...
15,000	5	10%	Kensington and Knightsbridge Ordinary	12½ 13½	12 13	4 4 7	...	...	...
10,000	5	6%	Do. 6 per Cent. 1st Preference	7½ 7¾	7½ 7¾	3 17 5	January and July	...	...
110,000	3	...	London Electric Supply Ordinary	3½ 3¾	3 2¾	...	...	3⅜	...
48,050	5	3/0	Do. 6 per Cent. Preference	6½ 6¾	6 6¼	4 12 2	...	6¼	6⅜
£100,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures	104 106	104 106	3 16 4	Mar., June, Sept., Dec.	...	...
62,500	10	5/0	Metropolitan Elec. Supply Ord. (Nos. 1 to 62,500)	15 16	15 16	3 2 6	April and October	15⅞	15⅝
22,500	10	3/7½	Do. (Nos. 62,501 to 85,000)	14 15	14½ 15½	3 3 10	...	15	...
£220,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage	117 119	117 119	3 15 7	June and December	118	...
6,452	10	6/0	Notting Hill Electric Ordinary	15⅛ 16⅛	15½ 16½	3 15 0	March	...	...
10,000	5	5/0	Oxford Electric Ordinary	6¾ 7¼	6¾ 7¼	3 9 0	,,	...	...
300,000	1	8%	Rand Electric	⅜ ½	⅜ ½	10 13 4	...	...	...
£130,070	Stock	5%	River Plate El. Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb.	80 90	80 90	5 11 1	...	...	...
150,000	$100	$2	Royal Electric Company of Montreal Shares	160 180	160 180	4 8 11	...	...	...
£123,200	100	4½%	* Do. 4½ per Cent. 1st Mortgage Debentures	103 105	104 106	4 5 6	April and October	...	...
31,980	5	5/0	St. James's and Pall Mall Electric Ordinary	15½ 16½	16 17	4 5 4	February and August	16⅜	16⅛
20,000	5	3/6	Do. 7 per Cent. Preference	9 9½	9 9½	3 13 8	,, ,,	...	...
65,000	5	...	South London Electric Supply Ordinary (£4 paid)	3½ 4	3½ 3¾	...	...	3 9/16	...
79,900	5	5/0	Westminster Electric Supply Ordinary	14½ 15½	14½ 15½	3 17 5	March and September	14¾	14½
			ELECTRIC MANUFACTURING, &c., COMPANIES.						
125,000	1	...	Aron Electricity Meter 6 per Cent. Cum. Pref.	13/16 15/16	13/16 15/16	...	...	...	...
40,000	5	5/0	British Insulated Wire Ordinary	11 12	11½ 12½	4 0 0	...	...	...
27,500	5	3/0	Do. Preference	6½ 6¾	6¾ 6¾	4 8 11	...	...	...
90,000	2	2/0	Brush Electrical Engineering	1¾ 2¼	1¾ 2¼	4 14 1	September	...	...
90,000	2	1/2⅝	Do. 6 per Cent. Pref. Non-Cumulative	2¼ 2½	2¼ 2½	4 16 0	,,	2⅜	2 5/16
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Deb. Stock	110 115	110 115	3 18 5	February and August	...	...
£50,000	Stock	4½%	* Do. 2nd Debenture Stock (red.)	104 107	104 107	4 4 11	June and December	...	...
20,000	5	5/0	Callender's Cable Construction Ordinary	13 14	13 14	5 7 2	,, ,,	13¼	...
20,000	5	...	Do. 5 per Cent. Cumulative Preference	5½ 6	5½ 6	...	...	...	...
£90,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb. (red.)	113 116	113 116	3 18 7	November and May	...	...
300,000	1	0/9⅜	Castner-Kellner Alkali Co. (fully paid)	1⅛ 1⅜	1⅜ 1⅝	4 18 6	...	1 7/16	1 5/16
60,000	1	0/7½	Chadburn's Ship Telegraph Ordinary	1 1¼	1 1¼	...	...	...	...
60,000	1	0/7½	Do. 6 per Cent. Cumulative Preference	1 1¼	1 1¼	4 16 0	...	...	...
32,098	3	2/11½	Crompton and Co. (Nos. 1 to 32,098)	3¾ 4	3¾ 4	4 10 9	January and July	...	...
£100,000	100	5%	* Do. 5 per Cent. First Mortgage Deb. (red.)	100 103	100 103	4 17 10	,, ,,	...	...
60,000	1	0/3	Davis and Timmins 6 per Cent. Cum. Pref.	¾ 1	¾ 1	...	...	...	...
99,261	5	1/9⅜	Edison and Swan United ("A" Shares) (£3 paid)	2 2¼	2 2¼	7 4 0	February and August	2⅛	...
17,139	5	2/9⅜	Do. (£5 paid)	4 5	4½ 4¾	6 13 4	,, ,,	4 1/16	3 15/16
£314,023	Stock	4%	Do. 4 per Cent. Mortgage Deb. Stock (red.)	95 97	95 97	4 2 6	June and December	...	...
26,100	5	5/11½	Edmundson's Electric Corporation Ord. (fully pd.)	5 5¼	5 5¼	5 9 1	Half-yearly	...	...
112,100	2	1/2⅞	Electric Construction Co. (Limited)	2 2¼	2 2¼	5 2 3	January and July	...	...
25,000	2	2/9⅜	Do. 7 per Cent. Cumulative Preference	3 3¼	3 3¼	4 0 0	July	...	...
182,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	104 107	104 107	3 15 8	January and July	...	...
91,195	1	...	Elmore's Patent Copper Depositing	½ ½	½ ½	...	...	...	...
15,900	10	8/0	Henley's Telegraph Works Ordinary	...	...	...	February and August	...	...
3,000	10	9/4	Do. 7 per Cent. Preference	...	...	...	,, ,,	...	...
£50,000	Stock	4½%	Do. 4½ per Cent. Mortgage Deb. Stock (red.)	111 114	111 114	3 19 6	,, ,,	...	...
50,000	10	5/0	India Rubber, Gutta Percha, &c., Works	21 22	21 22	4 8 11	,, ,,	21⅜	21 1/16
£300,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	100 104	100 104	3 16 11	March and September	...	...
37,350	12	12/0	Telegraph Construction and Maintenance	37 41	37 41	4 8 3	March and July	37½	37
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909	103 106	103 106	3 15 6	...	.. ½	...
20,000	5	4/5⅜	Do. Manufacturing Ordinary	9¼ 9⅜	9¼ 9⅜	4 2 1	...	...	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5½ 6	5½ 6	4 3 4	...	...	...
30,000	5	5/0	Willans and Robinson Ordinary	10½ 11	10½ 11	4 1 10	April and October	10⅝	...
30,000	5	3/0	Do. 6 per Cent. Cumulative Preference	7 7½	7 7½	4 0 0	,, ,,	...	...
£100,000	Stock	4¼%	Do. 4½ per Cent. 1st Mortgage Debentures	106 108	105 108	3 18 8	May and November	...	...
			ELECTRIC RAILWAYS, TRAMWAYS, &c.						
12,000	10	6/0	Blackpool and Fleetwood Tramways	18 20	19 20	4 0 0	...	...	...
£167,900	100	5%	Brisbane Tramway 5 per Cent. Debentures	104 106	104 106	4 14 4	...	...	...
50,000	10	7%	Bristol Tramways and Carriage Ordinary	23 24	23 24	2 17 2	February and August	...	...
25,000	10	...	Do. Cumulative Preference (£4 paid)	4⅜ 4⅝	4⅜ 4⅝	...	...	...	...
£100,000	Stock	4%	Do. 4 per Cent. Debentures	118 119	118 119	3 7 3	...	...	...
30,000	10	9/0	British Electric Traction Ordinary	16½ 17½	16½ 17	3 10 7	...	17⅛	16½
30,000	10	6/0	Do. 6% Cum. Pref. (Nos. 30,001 to 60,000)	13½ 14	13¼ 13¾	4 7 3	...	13 15/16	13¼
£200,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures	126 129	126 129	3 17 10	...	...	...
40,000	5	1/9	Buenos Ayres & Belgrano 6% "A" Cum. Pref.	5½ 5¾	5½ 5¾	5 9 1	...	...	...
27,500	5	...	Do. "B"	5 5½	5 5½	...	...	...	...
265,585	Stock	5%	Do. 5 per Cent. Debentures	108 111	108 111	4 10 1	...	...	...
35,250	10	3/0	Central London Ordinary	10¼ 10¾	10½ 10¾	2 15 10	June and December	10⅞	10½
178,303	10	2/4 1/10	Do.	...	...	...	,, ,,	...	...
£855,000	Stock	2½%	City and South London Railway Con. Ordinary	63 66	63 66	3 4 6	January and July	64½	...
37,500	10	...	Do. (Nos. 22,501 to 60,000) (£4. 10s. paid)	3½ 4½	3½ 4½	...	...	...	...
£150,000	Stock	5%	Do. 5 per Cent. Perpetual Preference (1891)	143 145	143 145	3 8 0	January and July	...	...
£200,000	Stock	5%	Do. (1896)	135 140	135 140	3 11 11	...	...	...
£187,701	Stock	4%	Do. 4 per Cent. Perpetual Debenture	132 134	132 134	2 19 9	May and November	...	...
20,000	10	7½%	Imperial Tramways Ordinary	23 24	23 24	...	March and September	...	...
10,000	10	6%	† Do. 6 per Cent. Preference	15½ 15¾	15½ 15¾	3 13 10	,, ,,	...	...
£200,000	Stock	4½%	† Do. 4½ per Cent. Debenture	115 116	115 116	3 18 0	January and July	...	...
37,500	10	2½%	Liverpool Overhead Railway Ordinary	9 9¼	9 9¼	3 10 3	February and August	...	...
10,000	10	5%	Do. 5 per Cent. Preference	13¼ 13½	13¼ 13½	3 12 9	,, ,,	...	...
125,000	Stock	4%	Do. 4 per Cent. Debenture	104 106	104 105	3 16 3	January and July	...	...
24,000	5	...	New General Traction Ordinary	3¾ 4¼	3¾ 4¼	...	...	...	...
30,000	5	6/0	Do. 6 per Cent. Cumulative Preference	5½ 5¾	5½ 5¾	5 4 4	May	5 1/16	...
13,334	10	...	Potteries Electric Traction Ordinary	13 14	13 14	...	...	...	...
20,000	10	5/10	Do. 5 per Cent. Cumulative Preference	10½ 11	10½ 11	4 10 11	...	...	...
£340,000	Stock	3%	Waterloo and City Ordinary	101 103	101 103	2 18 0	June and December	102	...

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

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THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,124. [Vol. No. 6. XLIV.] FRIDAY, DECEMBER 1, 1899. PRICE SIXPENCE (by post, 6½d.), Abroad, 8d., or 15 cents. or 80fr., or 70pf.

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NOTES.

Two articles on double-current generators which we publish this week are well worthy of the attention of supply station engineers, especially of those contemplating the employment of a polyphase system of generation and transmission coupled with continuous-current distribution. It will be seen that the machine, which can be employed either as a continuous or polyphase-current dynamo, or as a rotatory converter to transform polyphase into continuous current and *vice versâ*, is likely to be a most useful adjunct to polyphase stations—even more useful than the now popular combined balancing transformer and boosters employed on three-wire continuous-current systems.

THE art of depositing zinc electrolytically has been much studied of late years, and with noteworthy results. Already electro-zincing is replacing ordinary hot galvanising for a variety of purposes, more particularly for special classes of goods where the known deteriorating effect of galvanising is to be avoided. No one has done more work in this direction than Mr. COWPER-COLES, who has tried a variety of means to improve the quality and adhesiveness of electro-deposited zinc. A recent experiment of his, which is described in another column, consists in depositing zinc electrolytically under hydraulic pressure. Using a pressure of one ton per square inch and the high current density of 50 amperes per square foot he was able to obtain a satisfactory deposit, smooth and close-grained. The quantity of metal thrown down was, however, less than one-third of the calculated amount. It is not easy to see how the use of hydraulic pressure can affect the quality of the zinc deposited, but, if it is found in practice to lead to good results, we may be content to seek an explanation at leisure and apply the observation forthwith. A more obvious method of producing a good deposit would be to burnish it by mechanical pressure, as in the Elmore copper process, such burnishing being designed to hinder the formation of small prominences which, when once started, tend in the usual process of electrolysis to grow rapidly. It is possible that Mr. COWPER-COLES, or some other inventor, has already endeavoured to utilise this idea.

APPLICATIONS have been made to the various electricity supply undertakers interested for a further subscription of £10 towards the defence fund in the action Rucker *v.* the London Electric Supply Co. The supply companies and municipalities concerned will no doubt be prepared to present a bold front when the case comes on for hearing This is not likely to be before Christmas, however, as the position of the case in the Cause List has been altered. It will now be heard by the new judge (Mr. Justice FARWELL), before whom the interesting meter patent action, Chamberlain and Hookham *v.* The Bradford Corporation (British Thomson Houston Co., third parties) will also be heard.

IN another column is described an interesting "penny-in-the-slot" telephone call-box which has become very popular in Copenhagen. The chief disadvantage of the type at present employed by the National Telephone Co. in this country is that it is not quite suitable for erection in the most public places, as anybody can call up the exchange without the investment of copper coins, merely by turning the handle of the magneto, whether he wants a subscriber or not. In the Copenhagen instrument no ringing current is transmitted by turning the handle unless the caller has already placed a penny in the slot. If the subscriber he wants is engaged, the caller has only to press a button and his coin is returned to him. This is still open to one objection, however. When the public begin to be familiar with the apparatus, those of them who love practical jokes will have ascertained that they can get their penny back again after ringing. Thus a caller could cause considerable trouble to the exchange by the following *modus operandi*. He could

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first place his nickel in the slot, ring up, and ask for a number. When the operator had made the "engaged test," ascertained that the subscriber's line was free, and asked the caller to press the left-hand button, the latter individual could then press the right-hand button instead, recover his nickel, and walk away. It should be easy to add a simple polarised locking device, controlled from the exchange, to prevent the recovery of the coin without the permission of the operator.

CASES of fatal shock from low pressures are fortunately rare, and the evidence (published in another column) at the inquest held at Bradford last week should be carefully considered. The fatal shock was obtained from a continuous current system at a pressure not higher than 225 volts; but it should be remembered that the unfortunate victim was in a condition in which he would establish particularly good contact between one point of a faulty circuit and earth. Medical men recognise that the current flowing through the body must have a certain minimum value before it can be fatal; but, Mr. GIBBINGS notwithstanding, it has happened before in exceptional circumstances that sufficiently good contact has been established for this limit to be reached with similar low voltages. The most recent we can recall was a succession of four deaths in a German sugar factory where the maximum pressure could not have been greater than 230 volts alternating, and possibly did not exceed 115 volts. In the case at Bradford the wiring certainly left a great deal to be desired, for it appears that the outer covers of the lamps formed part of the circuit, or were at any rate not insulated from one of the lamp terminals. There is another possibility which Mr. GIBBINGS does not consider. The unfortunate man may have broken the circuit of the lamps and caused a momentary E.M.F. considerably higher than the E.M.F. of the dynamo. Such accidents as these are happily rare, however, and need create no panic either within or outside the electrical engineering profession.

Northampton Institute.—The annual prize distribution and members' and students' conversazione will be held at the Northampton Institute on Friday next the 8th inst. Sir Henry Roscoe, F.R.S., will distribute the prizes.

Opening of the Greenock Electricity Works.—The official switching on of the current at the Greenock electricity works took place yesterday afternoon, and was followed by the opening of a small electrical exhibition in another building in the town.

The Institution Dinner.—Our readers are reminded that the annual dinner of the Institution of Electrical Engineers will be held at the Hotel Cecil on Wednesday next, December 6th. Those who wish to be present and have not yet applied for tickets should do so at once.

Departure of Telegraphists to the Front.—The telegraph detachment of the 24th Middlesex Rifle Volunteers, with some of the 2nd Telegraph Battalion Royal Engineers, about 110 strong, left Aldershot yesterday, under the command of Captain Fowler, R.E., for service in South Africa.

Alleged French Cable Enterprise.—Rumours have been current that a scheme is on foot for laying a number of submarine cables by French capitalists, but our information is that the Minister of Commerce, M. Millerand, knowing the difficulties in the way of any successful development of French enterprise in this direction, does not at present intend to take any action.

The Pollak-Virág System of Telegraphy.—It is reported from New York by a Laffan's telegram that the first tests of this system in the United States have been made between Chicago and Buffalo, a distance of 1,062 miles, and that a speed of 90,000 words an hour was attained. Between Chicago and Milwaukee 140,000 words were sent in the hour. Herr Virág superintended the experiments personally.

University of London.—The Education Board of the London County Council has been in correspondence with the Commissioners of the London University, suggesting the creation of a faculty of commerce and a faculty of engineering. The Commissioners having agreed, the Board has passed resolutions allocating to each faculty £2,500 per annum for maintenance. Every opportunity is to be given to those attending evening classes to become internal students of the University.

Iron and Steel Institute.—It having been decided that it would be to the advantage of the Iron and Steel Institute to be incorporated under a Royal Charter, Mr. E. P. Martin, the President for the period 1897–1899, addressed a petition, on behalf of himself and the other members of the Institute, to Her Majesty in council; and the Royal assent having been obtained, the Institute is now incorporated under Royal Charter similarly to the Institution of Civil Engineers.

Wireless Telegraphy in the Navy.—It is reported as probable that the Admiralty will decide to equip all the more modern war-vessels with wireless telegraph apparatus.——The Berlin correspondent of the *Standard* states that the German naval authorities are negotiating with Mr. Marconi with a view to providing all German warships with his apparatus.——We have been unable to obtain confirmation of either of these statements. Both Governments have been in negotiation with the Wireless Telegraph and Signal Co., but we understand that no definite conclusion has been arrived at.

Falcon Works Engineering Society.—This society held its inaugural meeting of the present session on Wednesday last week, when Mr. R. Percy Sellon delivered his presidential address. There was a large attendance of members. Mr. Sellon passed in review the chief events of electrical engineering interest during the past year, and pointed out the tendencies of demand for electrical plant and their relation to the manufacturing industry. He laid stress on the necessity of specialising and standardising lines of manufacture to enable British firms to meet competition from the United States, Germany, and Switzerland, and concluded his address by explaining in detail the nature and objects of the extensions which the Brush Co. contemplate making to the Falcon Works.

Cable Interruptions.

Latakia—Cyprus	June 21, 1899
Cayenne—Pinhieros	Oct. 11, 1899
Zanzibar—Mombassa	Oct. 27, 1899
Aden—Zanzibar	Nov. 26, 1899

The Aden–Zanzibar section of the Eastern Telegraph Company's cables became interrupted on Saturday evening last. Traffic with South Africa and all places on the east coast has been maintained by the west coast cable. The first section of the new cable now being laid between South Africa and England (Cape Town–St. Helena) was completed and opened for traffic on Sunday. On her way home the c.s. "Anglia" will take soundings between St Helena and Ascension. The c.s. "Scotia," with the second portion of this cable on board (St. Helena–Ascension), has arrived at St. Vincent, and it is expected that traffic on this second section will be opened by the end of the year.

Institution of Electrical Engineers and the Paris Exhibition.—It is proposed to hold a meeting of the Institution in Paris, on August 16, 1900, or on August 16th and 17th. Among the various congresses to be held during the Paris Exhibition is one for electricians, from August 18th to 25th. In announcing this at the meeting of the Institution on November 23rd, the President (Prof. S. P. Thompson) remarked that no doubt a number of the members would be desirous of paying their visit to Paris at this time, so that they might be present at one or more of these conferences. The meeting of the Institution of Electrical Engineers had been arranged for August 16th, which would give them time to meet and discuss anything they wished to discuss before the congress of electricians

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itself took place. It was also possible that one sitting of their own meeting would be held in common with the members of the American Institute of Electrical Engineers, a number of whom would be in Paris at that time; indeed, the President of the American Institute (Mr. Kennelly) had written and asked if such a joint meeting could be arranged. Of course the Council would be most happy to have a joint meeting if it can be arranged, and had replied to Mr. Kennelly to this effect. In order that a preliminary estimate may be formed of the number of members of all classes who will take part in the Institution meeting, the Council would be glad to receive at an early date the names of those who think it likely that they may attend.

M. Turpain's Work with Hertzian Waves.—At a meeting of the French Physical Society, on November 17th, M. J. Blondin referred to some recent experimental researches by M. A. Turpain. A resonator was placed successively (1) perpendicular to the direction of the wires, (2) coincident with the plane of the wires, and (3) coincident with the plane of symmetry of the wires. It was found that the relative wave-lengths in the three positions were equal. The maximum amplitudes of position (1) coincided with the nodes of positions (2) and (3) (which coincided with one another), and inversely. The fields concentrated by a single wire, and the ordinary Hertz field with two wires gave the same system of arcs and nodes. If the field was concentrated by two wires issuing from terminal plates near to the same exciting plates, the field thus constituted did not give any system of arcs and nodes. It was the interference field of the two wires. M. Turpain then dealt with the action of the resonator. He enunciated the principle of the laws leading to the study of the complete resonator, and indicated that a resonator which has a gap independent of the micrometer resonates with greater facility. In a gap resonator the gap took the place of the micrometer in a complete resonator. The propagation of oscillations in dielectrics constituted the last part of M. Turpain's researches. He found that the wave lengths of the oscillations which excited the resonator in the position (2) were the same in air as in any dielectric other than air. For oscillations exciting the resonator in position (1) the relation between the wave length in air and the wave length in a dielectrie was equal to the square root of the specific inductive capacity of the dielectric.

The Brussels Underground Telephone System.—A short article in *L'Electricien*, from the pen of M. E. Piérard, describes the underground telephone network which is being put down in Brussels. All the telephone lines within a mean radius of about two miles from the new 15,000-subscriber exchange in the Rue de la Paille (situated a few hundred yards from the present exchange) are being placed underground. Before deciding this, however, delegates were sent to various countries, especially to the United States, to study the state of telephony there, particularly with regard to underground work. The cable contract has been awarded to Messrs. Felten and Guilleaume and Messrs. Siemens and Halske, and the contract for conduits to Messrs. Hargot, of Liège. The cables are of the air-space type, so well known now, and the most interesting part of the work is the conduits, of which there will be about 20 miles, only a few miles being at present finished. Each cable will be drawn into a glazed stoneware tube and buried in cement. A trench 5ft. deep and about 3ft. wide is made, and the bottom of this is levelled and covered with a bed of cement 4in. thick. The cement employed is slow setting, and a mixture of carbon, lime, and potter's clay, containing less than 2 per cent. of magnesia, and being manufactured at least three months before it is used. On this bed the pipes are laid in 18in. lengths, their internal diameter being 3¾in. The joints are oblique to the length of the pipes, and their truth is ensured by first inserting a wooden mandrel. The mortar used for jointing the ducts is a mixture of 1 cwt. of cement to 10 gallons of sand. The pipes are placed side by side, the joints being alternate, and the whole is carefully embedded in cement mortar and covered in all round with a thickness of 4in. of cement. Manholes are placed at all the bends and at distances not exceeding 165 yards apart in the straight runs. These manholes are built of Boom bricks on a bed of cement 6in. thick, and their internal measurement is a minimum of 6ft. long, 3ft. 3in. wide, and 5ft. 7in. high. They are closed by a double cast-iron cover resting on a framework of the same metal, the inside cover fitting tight to keep out the water.

High-Voltage Low Candle-Power Incandescent Lamps.—With regard to the statement recently made by an eminent consulting engineer, that it was impossible to obtain good high-voltage lamps of a smaller size than 16 c.p., Mr. Sydney Baynes, electrical engineer to the St. Pancras Vestry, writes that he does not agree with this view; but in any case he considers this objection to the employment of higher pressures to be of little or no moment. In the prevailing practice in gas lighting, he says, there are few, if any, 5 c.p. burners in use, and even 2½ft. or 8 c.p. burners are hard to find, although, on the other hand, 2ft. or 3 c.p. burners can be obtained. The consensus of opinion, he thinks, is in favour of burners ranging from 5ft. or 15 c.p. upwards. Moreover, when it is determined to change from gas to electricity, in nine cases out of ten the first consideration is improved lighting. In actual practice Mr. Baynes finds that 5 c.p. lamps are used chiefly for artistic effects in drawing-rooms, &c., and that there is no difficulty in installing these, if necessary, in groups of two in series, an arrangement often found where 110 volts is the standard pressure His own experience with 5 c.p. lamps is small beyond a laboratory test or two, and as there are so few on his circuits, he has had no complaints. "The comparatively small number" of 8 c.p. lamps in use answer admirably, he says. In conclusion he gives the following list of the lamps recently applied for by some 1,200 consumers:—

Arcs.

8 lamps of	2,000 c.p.	10 lamps of	500 c.p.
1 „	750 „	14 „	300 „

Incandescents.

3 lamps of	250 c.p.	99 lamps of	25 c.p.
132 „	200 „	37,623 „	16 „
12 „	150 „	40 „	12 „
93 „	100 „	64 „	10 „
295 „	50 „	5,665 „	8 „
1,149 „	32 „	266 „	5 „

MEETINGS OF SCIENTIFIC AND ENGINEERING SOCIETIES, &c.

MONDAY, December 4th.

ROYAL INSTITUTION.

5 p.m. General Monthly Meeting.

TUESDAY, December 5th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Paper to be further discussed: "The Waterloo and City Railway, and its Electrical Equipment." By Messrs. Dalrymple-Hay and Jenkin. Paper to be read, time permitting: "Combined Refuse Destructors and Power Plants." By C. Newton-Russell.

NORTHERN SOCIETY OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary Meeting, at the Grand Hotel, Aytoun-street, Manchester. Paper to be read: "Methods of Suppressing Arcs in Switches, Fuses, &c." By E. K. Scott.

WEDNESDAY, December 6th.

INSTITUTION OF ELECTRICAL ENGINEERS.

7 for 7.30 p.m. Annual Dinner, in the Grand Hall of the Hotel Cecil, Strand, W.C.

THURSDAY, December 7th.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary General Meeting. Adjourned discussion on Messrs. Holliday and Crompton's Papers.

RÖNTGEN SOCIETY.

8 p.m. Ordinary General Meeting at 20, Hanover-square. Paper to be read: "Observations on Practical X-Ray Work, with Exhibition of Apparatus and Stereoscopic Skiagrams," by M. Davidson; also Mr. J. Moore will show with a fluorescent screen a case of "Bullet in the Brain."

FRIDAY, December 8th.

INSTITUTION OF CIVIL ENGINEERS.

2.30 p.m. Students' Visit to the Works of the Baker-street-Waterloo Railway in course of construction. Meet at the works, near Charing Cross railway bridge.

PHYSICAL SOCIETY.

5 p.m. Meeting in the Physical Laboratory of the City and Guilds Technical College, Leonard-street, Finsbury. Agenda: (1) "Cylindrical Lenses," by Prof. S. P. Thompson, F.R.S.; (2) "Exact Formulæ for Lenses," by T. H. Blakesley; (3) "On an Organic Compound of Great Double-Refraction," by Prof. S. P Thompson, F.R.S.

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THE DOUBLE-CURRENT GENERATORS AND POLYPHASE APPARATUS OF THE CHICAGO EDISON COMPANY.

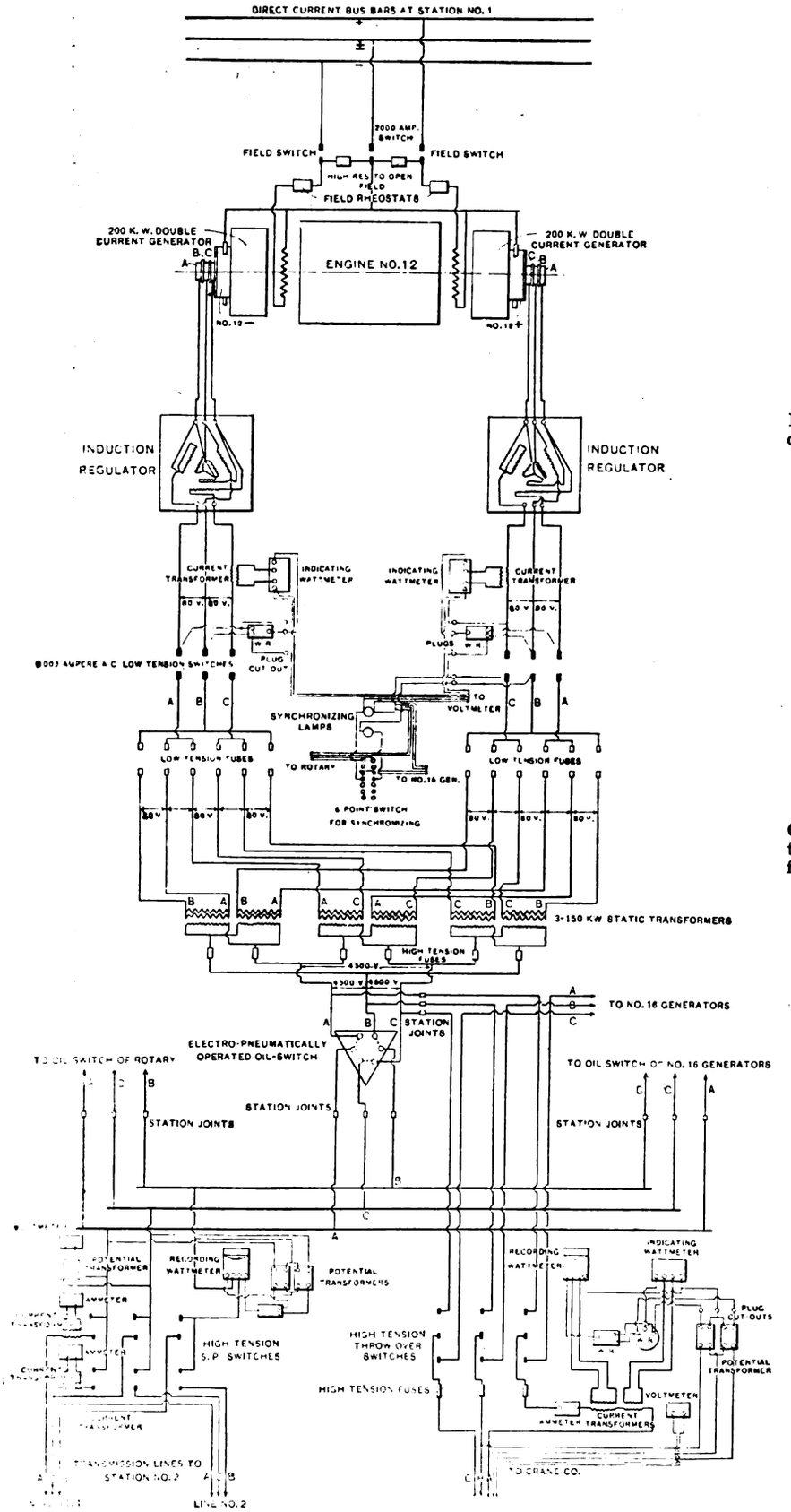

FIG. 1.—THE CIRCUITS FROM THE DIRECT-CURRENT BUS BARS TO THE HIGH-TENSION TRANSMISSION LINES.

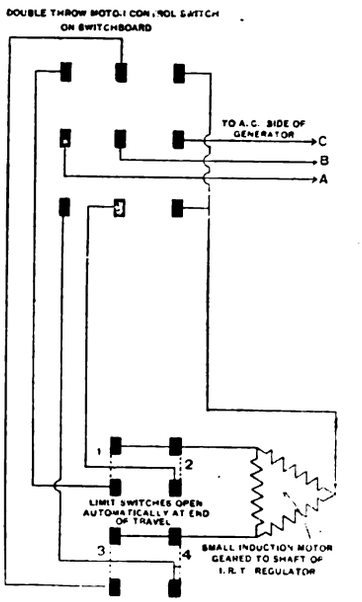
DOUBLE THROW MOTOR CONTROL SWITCH ON SWITCHBOARD
TO A.C. SIDE OF GENERATOR
C
B
A
LIMIT SWITCHES OPEN AUTOMATICALLY AT END OF TRAVEL
SMALL INDUCTION MOTOR GEARED TO SHAFT OF I.R.T. REGULATOR

FIG. 2.—The Circuits of the Controlling Motor of an Induction Regulator, showing the Method of Reversal and the Arrangement of the Limit Switches.

FIG. 3.—One of the Induction Regulators, showing the Hand Gear, the Small Controlling Motor, with its Reversing Switch, the Flexible Leads to the Movable Secondary, and the Damper for controlling the Air Blast.

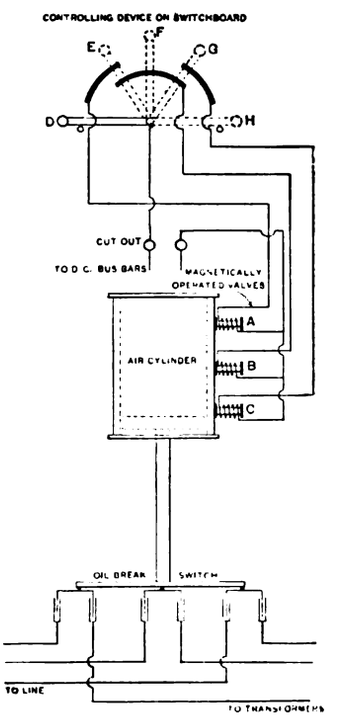

FIG. 4.—The Circuits of the Controlling Device of an Electro-pneumatic Switch, showing the Method of Operating the Valve Magnets and Interlocking them.

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THE DOUBLE-CURRENT GENERATORS AND POLYPHASE APPARATUS OF THE CHICAGO EDISON COMPANY.*

BY HOMER E. NIBBZ.

When the Edison lighting companies found that the low tension of their direct-current systems of distribution limited the area which one station could supply, and required for larger areas a number of stations with a poorer economy than that of the equivalent single-generating plant, they accepted as a valuable ally their erstwhile enemy—the alternating-current system. The rapid development of polyphase apparatus, and particularly of rotary converters, opened up a line of possibilities in central station consolidation and electrical co-operation that live engineers were quick to grasp, when it had been demonstrated by a plucky few how great were the advantages of transmission and distribution by this new system. Among the first to advocate, and the pioneer to adopt the system of transmitting alternating three-phase currents at a high potential to a sub-station, changing the power through step-down transformers and rotary converters and distributing it by means of a three-wire direct-current network, was the Chicago Edison Co., whose installation is the subject of this article.

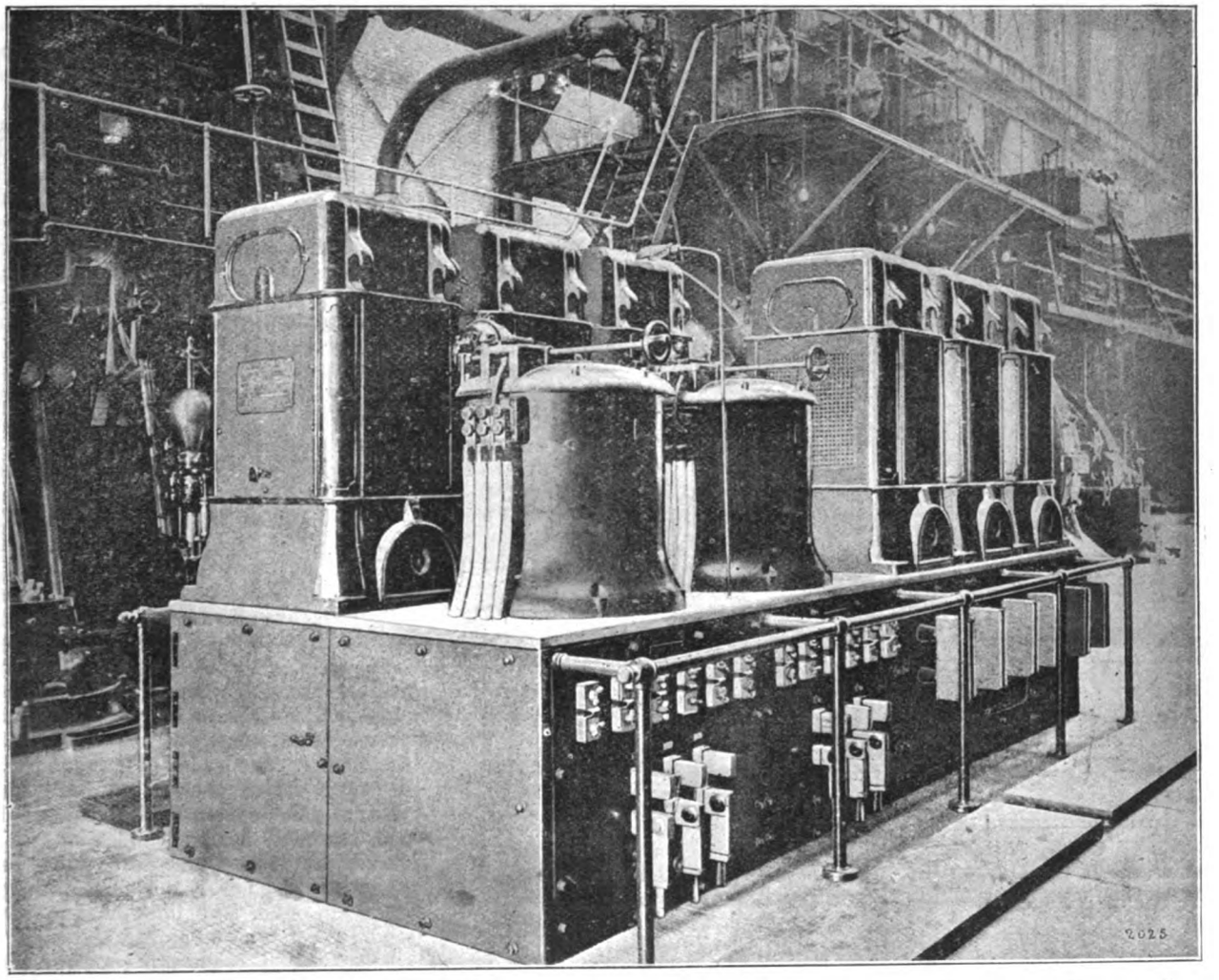

FIG. 5.—THE INDUCTION REGULATORS AND STEP-UP TRANSFORMERS FOR TWO DOUBLE-CURRENT GENERATING UNITS IN THE HARRISON STREET STATION OF THE CHICAGO EDISON COMPANY.

Early in 1893 the possibility of such an installation was first seriously discussed and considered by the electrical engineer of the company, but it was then too early to put his ideas into execution, because the manufacturers had not yet developed suitable apparatus; and it was not until the spring of 1897 that the long-cherished and strongly-advocated plans were realised by the installation in the Harrison-street station of a 250 kilowatt converse rotary converter—that is, a machine absorbing direct and delivering alternating power. This rotary is driven by direct current taken from the + and − 'bus-bars of the switchboard, though it was originally designed as a double-current belt-driven generator, the first of its kind ever built. From three collector rings at the end of the machine opposite the commutator three-phase currents are taken and conducted to air-blast transformers which raise the pressure to 4,500 volts for transmission over 8½ miles of cable to a sub-station located at 27th-street and Wabash-avenue, where, by means of step-down transformers, the voltage is reduced and the power is transformed by means of two 100-kilowatt rotary converters into direct current feeding into the three wire network of that district.

The success of this installation was so pronounced that it was immediately decided to enlarge it the following year. It then became expedient to build a double-current generator, so that the same unit could be used either on the direct-current down-town system or the three-phase transmission line independently or simultaneously. As the peak of the load on the 27th-street station occurred later in the day than that in the down-town district, the plan of building double-current generators was especially desirable, because by utilising their capacity to carry at different times of day the peak

* From the *American Electrician*.

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load of both districts it obviated the necessity for separate machines for each peak which would be required if two classes of generators were used. As a result, the first double-current direct-coupled dynamos ever used for direct-current and alternating-current lighting systems were manufactured and installed during the summer of 1898. A 600-H.P. engine already in use and direct connected to two 200-kilowatt direct-current dynamos was provided with an extended sub base and outboard bearings, and a new armature and fields were put on to provide the necessary frequency, and collecting and commutating devices. During the present year an additional unit of the same size has been installed.

This in brief is a history ot the installation, a description of which can be but general, as the details of the work are many.

In the plant at Harrison-street and the river there are two units, each consisting of a 600-H.P. Southwark vertical triple-expansion condensing engine direct connected to 200-kilowatt dynamos built by the General Electric Co., one at each end of the shaft. Each dynamo consists of a special single-wound armature, the coils of which terminate in a large commutator about 5ft. in diameter and of ample cross section to carry the entire output of the dynamo in direct current. The brushes are of carbon, of the radial type, and are shifted and adjusted by means of a handwheel, as is customary on large machines.

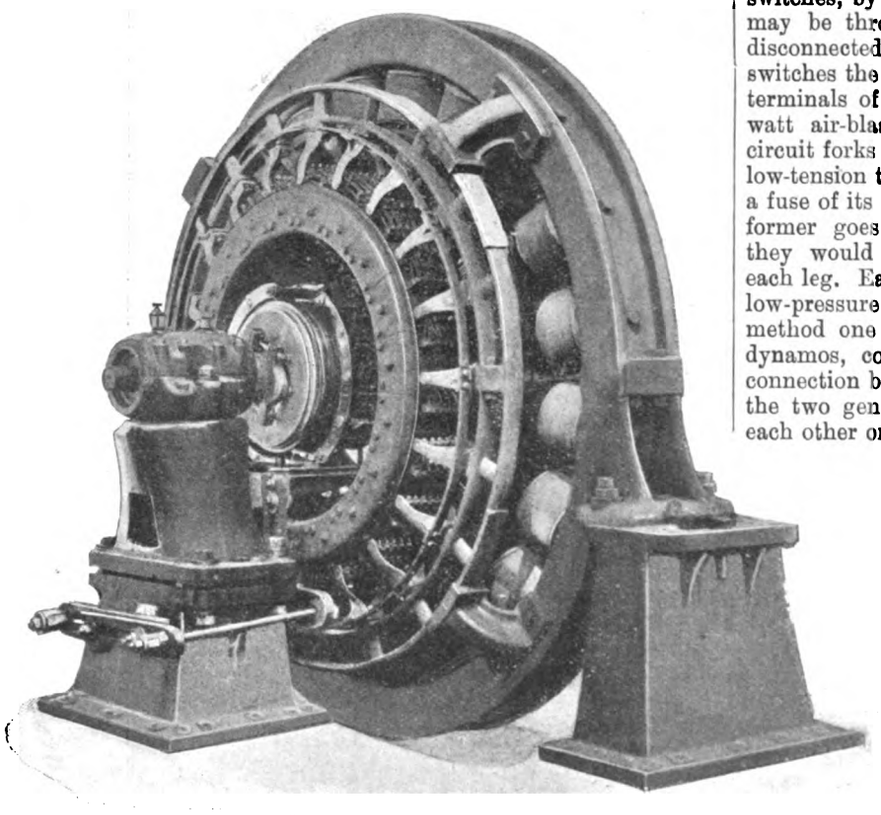

FIG. 6.—ONE OF THE DOUBLE-CURRENT GENERATORS, ERECTED IN THE SHOPS FOR TESTING, SHOWING THE COLLECTOR RINGS SUNK WITHIN THE COMMUNICATOR SPIDER.

The direct-current sides of these generators are connected in series to form a three-wire unit, supplying current through a standard direct-current low-tension panel on the switchboard in the gallery to the three-wire 'bus-bars which furnish the bulk of the current for the downtown net-work. Connected also to the armature windings are leads terminating in three heavy collecting rings, of smaller diameter than the commutator and located practically within it, the commutator spider being cup-shaped and overhanging the collector rings. Bearing on each ring are 12 tangential copper brushes, which carry off three-phase currents at about 80 volts pressure. There are 20 poles to each dynamo, and the speed being 150 revolutions per minute, they give a frequency of 25 cycles, which is considered the best for transmission and power work.

The complete circuits from the direct-current 'bus-bars to the high-tension transmission lines are shown in Fig. 1. From the collector rings of each dynamo, as this figure shows, the three phase currents are conducted through six 750,000-c.m. asbestos-covered cables to an induction regulator in order to give a control of the alternating-current pressure without varying the field strength, which must necessarily be adjusted to give the proper direct-current voltages. By means of the regulators the voltage may be raised 7½ per cent. or lowered 7½ per cent., giving a total range of 15 per cent. of the initial voltage. Each regulator is of 15 kilowatt capacity, and is air-cooled by forced draught. As is well known, these regulators, which are of the General Electric Co.'s I. R. T. type, have no moving contacts, but are adjusted by moving an iron core which varies the inductive effect of a shunt winding upon a series coil. This core may be moved by hand, but for convenience in operating from a distance there is installed a small three-phase induction motor to drive the core by a worm-gear, and this is controlled from the switchboard, as described below.

From the regulator, the current passes to three single-pole switches, by means of which the two machines on one engine may be thrown together on the alternating-current end or disconnected from each other or from the line. From the switches the current passes to six fuse block, which form the terminals of the low-pressure windings of the three 150-kilowatt air-blast transformers. Each leg of the three-phase circuit forks to two fuse blocks, thus giving each of the three low-tension transformer windings, which are delta connected, a fuse of its own at each of its terminals, so that if one transformer goes out the other two will remain working, as they would not if there were only three fuses, one in each leg. Each transformer is provided with two independent low-pressure windings, which magnetise the core. By this method one set of transformers can be used for the two dynamos, comprising one unit, without making electrical connection between the windings of the two generators. As the two generators are electrically connected in series with each other on their direct-current sides, any electrical connection on their alternating-current sides would of course become a very complicated short-circuit.

There are two high-pressure windings in each transformer, which can be connected either in multiple or in series, giving a potential of 4,500 or 9,000 volts. At present 4,500 volts pressure is used. The high-pressure leads of these transformers terminate in six high-pressure fuse blocks of a special design, known as the expulsion-type fuse blocks. The leads are brought through the panel board encased in hard rubber bushings, the current being carried from them through flexible connections to two hinged terminals which are pulled apart by springs. The fuse of stamped metal passes through two lignum vitæ blocks, provided with air chamber and vent hole on one side, and is fastened at each end to these hinged terminals. The fuse being in a state of tension, is pulled apart before it quite reaches the melting point, and is withdrawn from the air chamber, so that only a very small amount of the metal is volatilised, and the violence of the disruption under high voltage and heavy load is therefore greatly reduced.

The six transformers and four induction regulators of the four dynamos constituting the two units stand on a platform in the middle of the floor space, between the two generator units. A view of this platform and apparatus is given in Fig. 5. There are two regulators and three transformers for each unit. Under the platform, and enclosed by sides of marbles, is a large air chamber in which all the electrical connections between transformers, regulators, and fuse panels are made. Air is forced into this chamber by a blower, driven by a direct-current motor, whose speed is controlled by a speed regulator, so that the proper volume and pressure of air may be maintained in the chamber. The transformers

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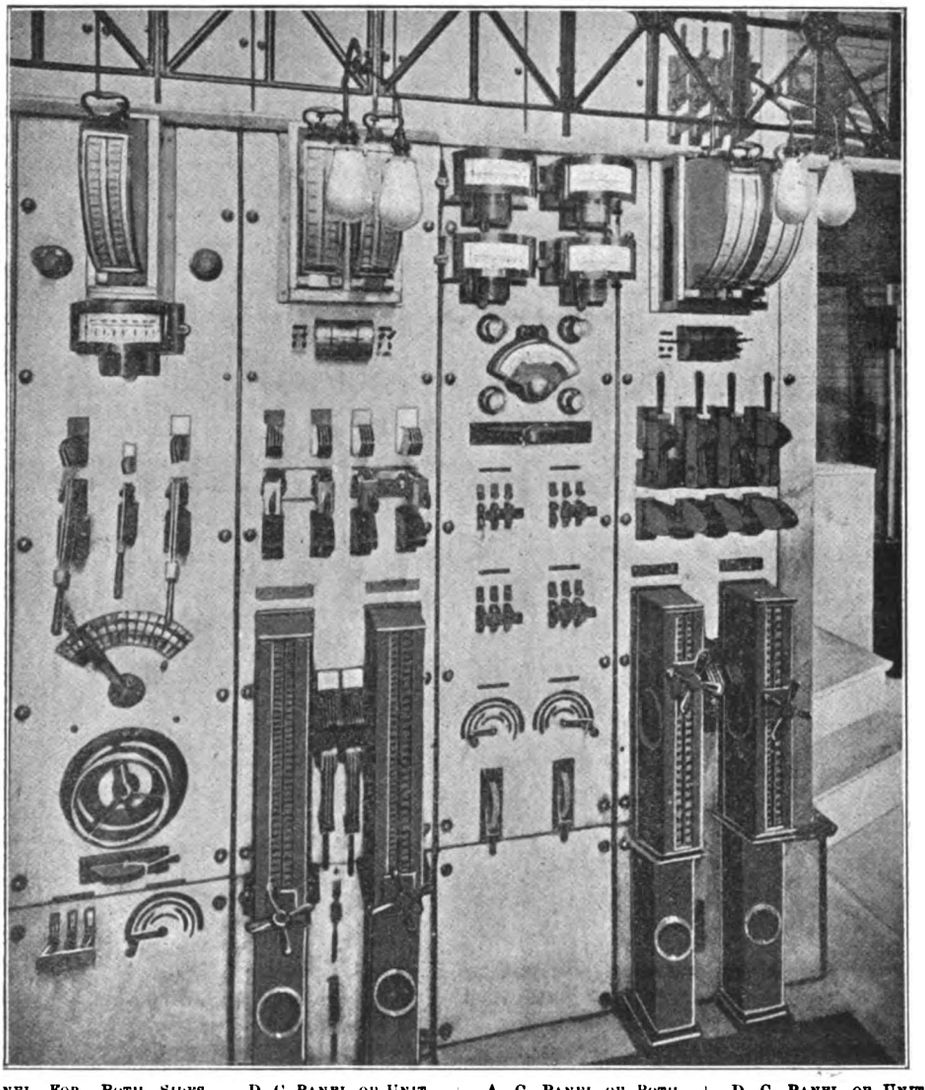
are provided with dampers which regulate the amount of air passing through them individually, and may be adjusted according to the division of the load between them. On the sides of the chamber, mounted directly on the marble, are the high-pressure expulsion-type fuse blocks described above and the low-pressure fuses and switches, the former being away from and the latter facing the units to which they belong.

From the high-pressure fuses a three-conductor cable conveys the current to a three-pole switch of special type placed under the gallery, on which is located the transmission line switchboard. The switch consists of three cylindrical vessels filled with oil, in each of which one lead of the three-phase circuit is broken. The terminals and connections are this type, one for each generating unit and one for the rotary converter.

The most interesting and important part of the entire installation is the regulating board, located in the switchboard gallery, a view of which is reproduced in Fig. 7. The direct-current panel for each unit is of the standard type used for three-wire direct-current central station work. The fields are 'bus-excited, and the necessary regulation of the field strength is done by resistances controlled by parallel clip switches on the direct-current panels. Immediately between the panels controlling the direct-current side of the double-current generators is a single panel containing all the alternating-current regulating and controlling devices for



Panel For Both Sides of Rotary.	D. C. Panel of Unit No. 12.	A. C. Panel of Both Units.	D. C. Panel of Unit No. 16.
D. c ammeter.	Pilot lamps.	4 a. c. ammeters.	The equipment of this panel is similar to that two sections to the left.
Synchronising lamps.	Ammeters.	Synchronising lamps.	
A. c. ammeter.	Potential indicators for paralleling.	A. c. voltmeter.	
Switch around starting box. Field switch. Switch to starting box.	Main positive and negative switches to two sets of 'bus bars.	Voltmeter switch.	This panel controls the d. c. end of the two generators comprising unit No. 16.
Starting box.	Parallel-clip field rheostats.	Switches to 4 I. R. T. regulators.	
Field rheostat.	Main switches to neutral.	Controllers of oil-break switches.	The a. c. controlling apparatus of the same machines is immediately adjacent to the left
Synchronising switch.	Field switches.	Synchronising switches.	
Switch of I. R. T. regulator.		Left-hand side of panel for No. 1; right-hand side for No. 16.	
Controller of oil.			
Break switch.			

Fig. 7.—The Section of the Main Switchboard Controlling both the Direct-current and the Alternating-current Sides of the Rotary Converter and of the Two Double-current Three-wire Generating Units.

arranged so that there are four breaks in series on each pole, each break being about 4in. in length, which ensures safe opening of circuit under any degree of load. The switch is operated pneumatically—the valves being controlled electrically from the operating panel—and can be locked open or closed by means of the special switch described below controlling them. Fig. 8 gives a view of the three switches of the two units or four three-phase generators. At the top of the panel are four indicating wattmeters, showing the output in watts of each generator. Below these are the phase lamps—two for each unit—which show when the units are in synchronism and ready to be thrown in multiple. Between the two sets of phase lamps is an alternating-current voltmeter, and below it a double-pole multiple point switch, by

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means of which the voltmeter may be connected to any one of the generators. Below the voltmeter and switch are two three-pole double-throw knife switches—one for each generator—each of which controls the small three-phase motor mentioned above mounted on the induction regulator for raising or lowering the pressure. Below these are two multiple point switches—one for each unit—and connected to the phase lamps for that unit. There are also two special contact switches for operating the electro-pneumatic high-pressure oil switches. On the bottom of the panel are four single-pole knife switches, with high resistances connected across their terminals, for opening the field circuit of each generator.

The controlling apparatus of the electro-pneumatic switches is shown diagrammatically in Fig. 4. The direct current enters the apparatus from the direct-current 'bus-bars and passes under control of the hand switch in the upper part of the figure to one or more of the magnets, A, B, C, on the cylinder. In the position D, in which the switch is shown open, there is no circuit through any of the magnets. When the switch is rotated to the right it strikes a segment carrying current to magnet A, which works an auxiliary air valve which operates the main valve, hunting between generators. The phase lamps are connected through the double-pole multiple point switches above mentioned to one phase of the generator leads. Each unit has its own phase lamps and its own switch, by means of which it may be connected to the other unit or the converse rotary converter, without touching any other part of the panel than that containing the apparatus controlling that unit. By means of the multiple point switch below the voltmeter that instrument may also be connected in parallel with one of the phase lamps so that the needle will indicate simultaneously with the lamps when the generators are in step.

The three-pole double-throw knife switch for controlling the motor, which rotates by means of a worm-gear the movable part in the induction regulator, is connected so that by throwing the switch up the motor will run in a certain direction and raise the pressure. By throwing the switch down the motor will be reversed and the pressure lowered. The circuits of this switch and the motor are shown in Fig. 2. The three-phase current enters through the wires A, B, C to the hinges of the throw-over switch. Leg C goes right through to the small induction motor whether the switch is up or down. Legs A and B go through other switches located on the machine and numbered

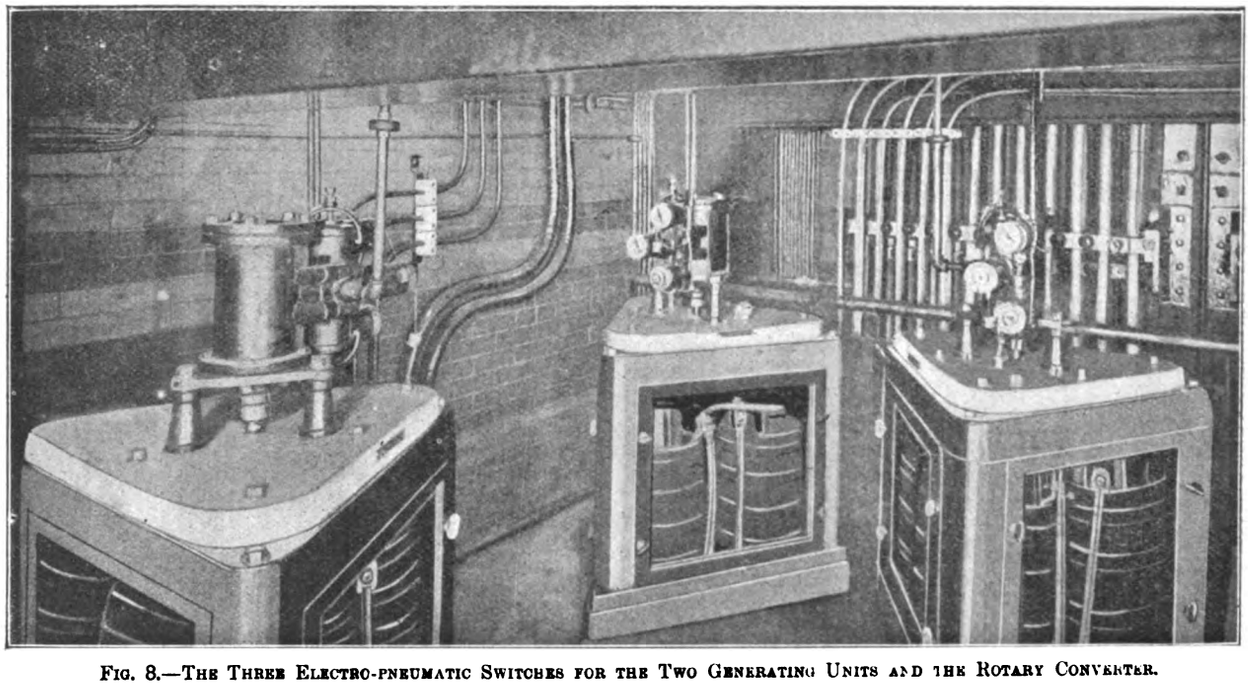

Fig. 8.—The Three Electro-pneumatic Switches for the Two Generating Units and the Rotary Converter.

admitting compressed air to the upper end of the cylinder and opening the lower end to the atmosphere. The piston is by this means forced down, closing the switches attached to its cross head. A further movement to the right brings the switch arm in contact with a segment closing the circuit through magnet B, which is a mechanical latch holding either valve A or C open, except when B is energised. A further movement to the right operates magnet C, admitting air below the piston and forcing it up, thereby opening the main oil break switch.

All the various functions of operation and regulation of these generators can be accomplished by the regular switchboard attendant from this panel on the gallery, and the entire installation is thus under his control, enabling it to be handled quickly, conveniently, and economically. There are no leads to the alternating-current panel carrying heavy currents or high pressures. The heavy current leads run directly from the generators to the transformer stand, and are very short. The indicating wattmeters are connected by means of small secondary wires to series transformers inserted in one leg of the leads from each generator. On another panel are four alternate-current ammeters connected to these same wires, which show the number of amperes generated, whether energy or wattless current, and indicate any cross current or

respectively in the diagram 1, 2, 3, and 4. These are limit switches, which prevent the small induction motor from turning the regulator too far in case the switchboard attendant tries to raise or lower the voltage beyond the capabilities of the regulator. In case he leaves his switch in the upper position, switches 1 and 3 are opened automatically when the regulator reaches its highest boosting position, thus stopping the small induction motor; but it is obvious that this does not cut it out of circuit when the switchboard attendant throws the switch over to the downward position when circuit of legs A and B is made through switches 2 and 4. These, however, open when the regulator is depressing the voltage by its maximum amount, to prevent the motor from running too far in that direction. The extent of the arc through which the movable part of the induction regulator may be turned is thus limited automatically. The convenience of this method of regulation of pressure is most marked, and can be best appreciated after an attempt at hand regulation with the aid of an assistant on the floor. The two double-current units and the 250 kilowatts converse rotary, which is controlled similarly by devices on the panel adjacent to that for the large units, may be operated in multiple and transmit a total of 1,050 kilowatts for power purposes.

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The principal purpose of this installation is to furnish current for the sub-station at 27th-street and Wabash-avenue, to be distributed from that point by means of rotary converters to the three-wire network of that district. The line for the transmission of the three-phase current from the Harrison-street station to the 27th-street station consists of two three-conductor cables, laid in ducts the entire distance of 8½ miles. These cables are each No. 500 B. & S. gauge, with paper insulation, designed for 20,000 volts pressure, and are encased in lead sheathing covered with jute. At each end of the line each cable terminates in three single-pole quick-break knife switches of special design, by means of which either cable may be disconnected from the line at will. These are mounted on a marble board with barriers of slate placed between them, and are opened by a pole hook in the hands of the operator. On the board at the transmitting end is a wattmeter which records the entire electrical energy transmitted, and a voltmeter which indicates directly in volts the pressure on the transmission line, as well as two ammeters, one on each transmission cable. The circuits of this board are shown in the lower right-hand corner of Fig. 1.

At the receiving end of the line are the necessary apparatus and appliances for reducing the pressure, changing the current to direct and distributing it over the feeders of the three-wire network. This installation cannot be described in detail in the space of this article, but in general consists of the following: A high-tension switchboard, with switches and fuses for each set of transformers; three sets of three 150 kilowatt air-blast transformers; five induction regulators; two 100 kilowatt 125-volt rotary converters; two 200-kilowatt 125-volt rotary converters; one 250-kilowatt 250-volt rotary converters; with the necessary low-tension switchboard for regulating and controlling both alternating-current and direct-current sides of the rotaries.

There has just been installed a 4,000-ampere-hour storage battery at an eight hour rate in this station to carry part of the peak load and to furnish higher voltage current for some of the long feeders in remote sections of the districts.

Another important function of the double-current generators is the furnishing of three-phase current for power purposes in large factories. A line has been installed to the factory of the Crane Co., the well-known makers of valves, in which are operated three-phase induction motors aggregating 200 H.P. The current is brought into the building at a pressure of 220 volts from a set of three 75-kilowatt transformers, which are mounted in a special transformer house built between two poles just outside the building, the line, carrying 4,500 volts, being brought on poles from the station. Lightning arresters are placed on each side of the circuit. There is a special switchboard in the station, from which the line receives the high-pressure current, but the arrangement of its details in the circuit is represented in the general diagram, Fig. 1. As will be seen from the latter figure, a tap is made on the transformer side of the oil switch of each of the double-current units, and three lead-covered cables are carried to the Crane Co.'s board. One set of leads thus brought in is connected to the top and the other to the bottom terminals of three single-pole, double-throw, quick-break knife switches, the line being connected to the middle points, so that by throwing the switches, up or down the line may be thrown on either generator unit independently of whether either or both units are working singly or in parallel on the 'bus-bars and transmission line.

The double-current machines in this station give an excellent opportunity for comparison with direct-current machines, since they stand immediately adjacent to three-wire sets of exactly the same output and exactly the same speed in revolutions per minute. In fact, the first double-current unit is driven by an engine which originally drove direct-current machines and is a duplicate of other engines standing next to it and still driving such generators. The differences in appearance are as follows: A double-current machine necessarily has 20 poles to obtain the proper frequency, instead of the six poles on the direct-current machine, and in order to avoid crowding these poles the diameters of the yoke ring, the armature and the commutator have been increased and the machine has been shortened axially somewhat to compensate for this increased diameter. The narrower pole face necessarily reduces the number of slots and commutator segments per pole which can be used, which number in the double-current machines is 21, about one-quarter of that in the older dynamos. This increases considerably the voltage generated per commutator segment, but proper commutation has been attained by using carbon brushes.

It will be seen that a great flexibility of operation is obtained by means of the apparatus above described. Each double-current generating unit can be used simultaneously to furnish current for the direct-current system, three-phase current for the transmission line and for the power line—either alone or in multiple with the other machines—and to the extent of its capacity on either the direct-current or alternating-current side. The converse rotary may furnish current for the transmission line and one generator unit furnish current for the power line, independently of each other, or they may be run in multiple, or one generator unit may furnish current for both transmission and power line, or the second generator unit may be run in multiple with the converse rotary on the transmission line, independently of the generator unit on the power line, or all three may be run in multiple on the transmission and power lines, each generator furnishing direct-current at the same time to the three-wire 'bus bars. Thus the company is able to run its dynamos and engines at the point of greatest efficiency all the time, and secure the best economy in operation with a smaller number of units, a more uniform system of apparatus, and less investment in machinery. The field thus opened up is capable of vast extensions, and the realm of double-current generators for light and power business is almost limitless.

THE COPENHAGEN "AUTOMATIC" TELEPHONE CALL-BOXES.

In December, 1898, the Automatic Telephone Co., of Copenhagen, began erecting telephones on the "penny-in-the-slot" principle. At the present date there are about 465 instruments connected to the telephone exchange, and this number is being gradually increased. These telephones are placed in nearly all public buildings and theatres, and also in a number of houses where people live in flats. The test of about a year's use has shown that these instruments are thoroughly reliable. The inventors are Mr. L. M. Ericsson, of Stockholm, and the manager of the Danish company, Mr. Sophus Ritter. Compared with the call-box instruments employed in this country, the chief advantages of this system are:—

1. The exchange can only be called up after a coin (10 öre, about 1¼d.) has been dropped in; this prevents a deal of unnecessary trouble at the exchange.

2. In case the exchange cannot connect through, the coin is recovered by pressing a button.

3. Ringing off is avoided, as this is performed automatically by replacing the receiver on the hook.

4. By special arrangements for receiving extra coins, telegrams can be forwarded through the exchange.

Fig. 1 shows arrangement for receiving the coin. This is dropped in at A_1, and passes through the flat tube R_1 into the receptacle B_1. S_1 and S_2 are two forks, pivoted on O_1 and O_2 and insulated from one another. When a coin is resting in B_1 it connects S_1 and S_2, thus completing the circuit through the magnets I to the exchange (*see* Fig. 2), and the latter can now be rung up in the usual way.

After receiving the caller's demand and making the engaged test, the operator at the exchange answers either "Connected" or "Engaged." In the first event the caller pushes the button k_1, and the coin drops through the passage R_2, strikes the

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gong K, and falls into B_2. The operator at the exchange hears the coin strike against the gong, and only then connects through. If the reply "Engaged" has been received, the button k_2 is pressed and the coin is returned through the passage R_3 into the box B_3 placed on the outside of the telephone, whence the caller can recover it.

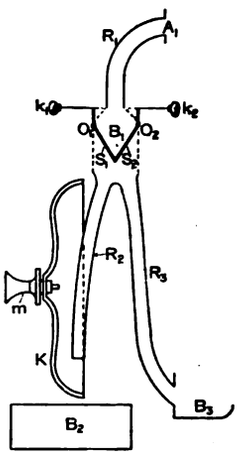

FIG. 1.

The connections are shown in Fig. 2. When not in use the receiver hangs on the hook N, and contact is made between a_2 and a_3. The one pole of the magnets I is in direct connection with the line L_1, while the other line, L_2, is broken between S_1 and S_2. After a coin has been dropped in,

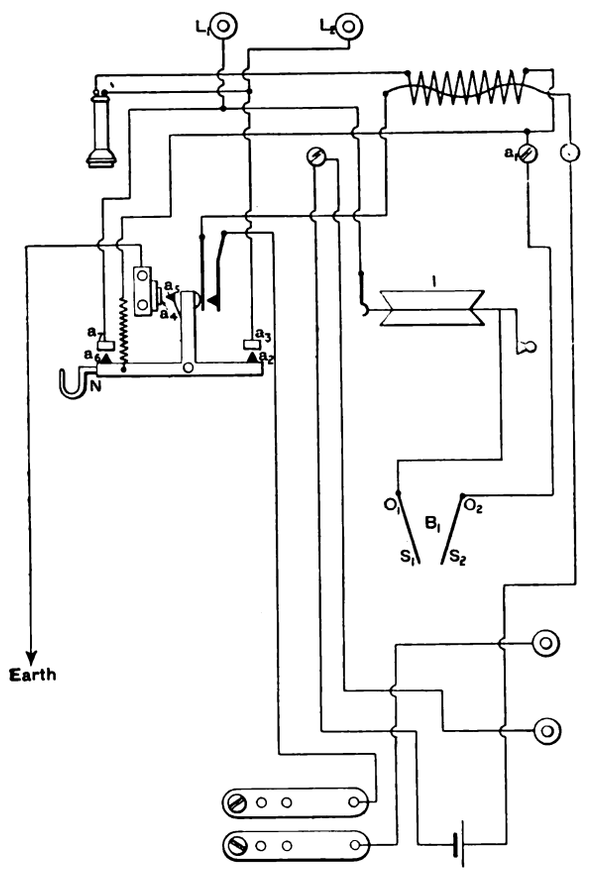

FIG. 2.

the circuit through the magnets is completed through $O_1 S_1$, the coin, $S_2 O_2 a_1 N a_2$, and a_3 to line L_2, and the exchange can be called in the usual way. On taking the receiver off the hook N the circuit is broken between a_2 and a_3, and contact is made between a_6 and a_7, and the connections are the same as in a usual telephone.

When the receiver is replaced on the hook the line L_2 is connected through a_4 and a_5 to earth, and the clearing signal is given automatically at the exchange: this is arranged on the "ringing through" principle.

Telegrams are telephoned to the operator at the exchange, and he telephones the amount to be paid. The necessary coins

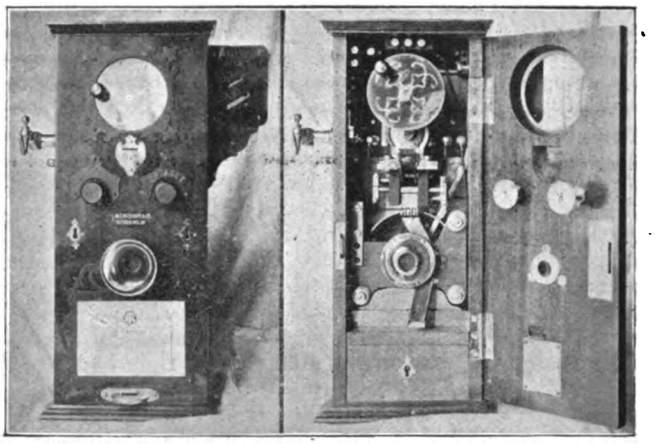

FIG. 3.—EXTERIOR AND INTERIOR VIEWS OF APPARATUS.

are then dropped through two slots at the right-hand top corner of the instrument: on their way they strike against gongs, by means of which the operator can control the amount paid in.

FIG. 4.—GENERAL VIEW OF APPARATUS IN POSITION.

The apparatus is mounted in oak cases, and on the outside of these are illustrated instructions for the public.

Figs. 3 and 4 show external and internal views of the instruments.

Wireless Telegraphy in Hawaii.—Wireless telegraphic communication is to be established between five of the Hawaiian islands by a company of Americans, who will use the Marconi system. Mr. Frederick J. Cross, of an engineering firm of Honolulu, has been in the city lately and closed a contract for the American company in Hawaii. Although many engineers regarded the connection of the five islands by cable as impracticable because of coral reefs, the American company had about decided to attempt it, as the needs of telegraphic communication had grown most urgent. On hearing of Mr. Marconi's achievements, Mr. Cross was sent to the United States to examine the workings of the system. He found that the Marconi system would cost much less and be more practicable in many ways than a cable. A regular telegraph business will be done by the company installing the wireless system. The distances over which communication will be established will vary from eight to sixty-one miles.

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SOME NOTES ON THE ELECTRO-DEPOSITION OF ZINC UNDER PRESSURE.

BY SHERARD COWPER-COLES.

A series of experiments was undertaken to ascertain whether the adhesion of electro-deposited zinc to iron and steel could be increased by depositing under hydraulic pressure. It was also thought that the physical properties of the deposit might be improved. With this object in view, a pressure cylinder was constructed, as shown in Figs. 1 and 2; the lead lining A was used as an anode in some cases, and in other cases a circular zinc anode was placed round the object to be zinced, which was suspended on the hook marked B, the positive connection being made by means of the terminal C. The solution was not circulated during the experiments, pressure being applied by means of a hand pump.

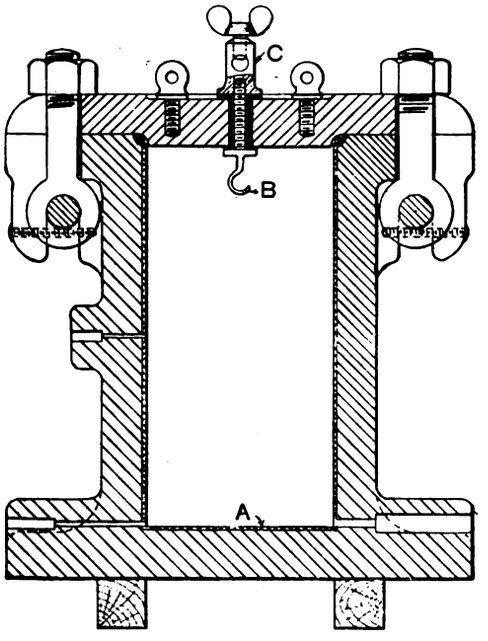

FIG. 1.—Elevation.

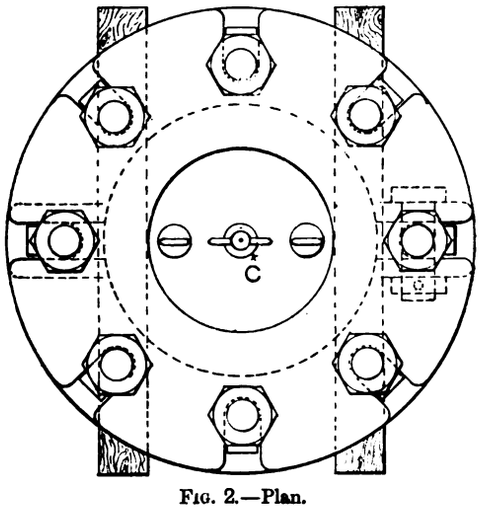

FIG. 2.—Plan.

A number of mild steel plates were prepared, and zinc deposited at current densities varying from 15 to 75 amperes per square foot. At the higher current densities there was a tendency for the zinc to tree and nodule at the edges of the plate. The plates in a great number of cases had round spots upon them which appeared to be uncoated, probably due to gas bubbles clinging to the surface.

On several occasions it was observed that a loud sharp cracking noise occurred during deposition: when the electric current was stopped no cracking noise took place, but as soon as the current had been flowing for a few minutes the noise was again heard distinctly. The zinc deposits obtained had the same appearance as those which were obtained under pressure when no cracking noise was heard, and the cracking noise was only heard when current densities of above 50 amperes per square foot were employed.

Figs. 3, 4, and 5 show deposits obtained under a pressure of one ton to the inch at current densities of 17, 50, and 100 amperes per square foot. The zinc obtained at 50 amperes per square foot was a beautifully smooth, close-grained deposit. The electrolyte contained 35oz. of crystallised zinc sulphate to the gallon of water, and $\frac{1}{10}$oz. free sulphuric acid to the gallon, and a small quantity of zinc dust was added to prevent the solution becoming too acid. The anode was of zinc.

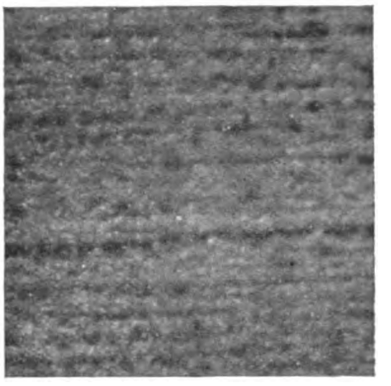

FIG. 3.—17 amperes per sq. ft.

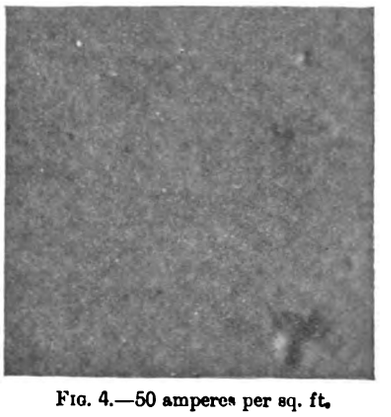

FIG. 4.—50 amperes per sq. ft.

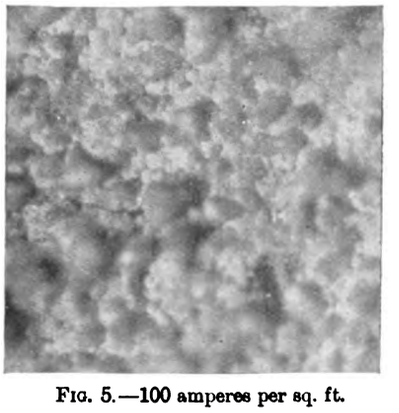

FIG. 5.—100 amperes per sq. ft.

The following table shows the actual as compared to the theoretical weight obtained under a pressure of one ton from a neutral solution containing 35oz. of zinc sulphate to the gallon of water:—

No. of experiment.	Time. Minutes.	Area of plate. Sq. in.	Current density. Amperes per sq. ft.	Actual weight of deposit in grammes.	Theoretical weight of deposit in grammes.	Actual weight of deposit. Oz. per sq. ft.
1	60	17·5	15	3·2	2·80	0·346
2	60	13·0	20	1·56	2·80	0·606
3	60	10·5	25	0·84	2·80	0·404
4	60	7·5	35	0·40	2·80	0·268
5	60	36·0	45	4·50	13·64	0·630
6	60	28·8	55	4·50	13·44	0·780
7	60	24·0	65	6·36	13·44	1·334
8	60	24·0	75	5·60	15·16	1·178

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AN ELECTRIC TRAMWAY-OMNIBUS.

Messrs. Siemens and Halske have recently brought out what they term a "tramway-omnibus," which is designed to run equally well as a tramcar on tram-lines or as an electric omnibus on ordinary roads. In an article describing it in the *Elektrotechnische Zeitschrift* it is pointed out by Herr Siebert that it is particularly suitable for employment in large towns such as London, through the centre of which the heavy traffic does not permit of tramways, while this centre is fed by tram-lines from the suburbs. This vehicle, which is now in use in Berlin, commences its journey on a tram-line fed from overhead in the usual way, and then the collecting bar which takes the place of the trolley in all Messrs. Siemens and Halske's systems is made use of. Besides propelling the car, it charges the cells as in the so-called "mixed" overhead and accumulator systems in Hanover and other towns. The wheels, of course, exactly fit the gauge of the tram-line, and the guide wheels seen in front are let down so that the vehicle does not run off the rails. In the middle part of its journey the car is running on asphalte or good paving, and at the end there are again an overhead wire and rails. In this manner considerable gain is attained over running all the way on ordinary roads, for in the outer parts of the town—just where the

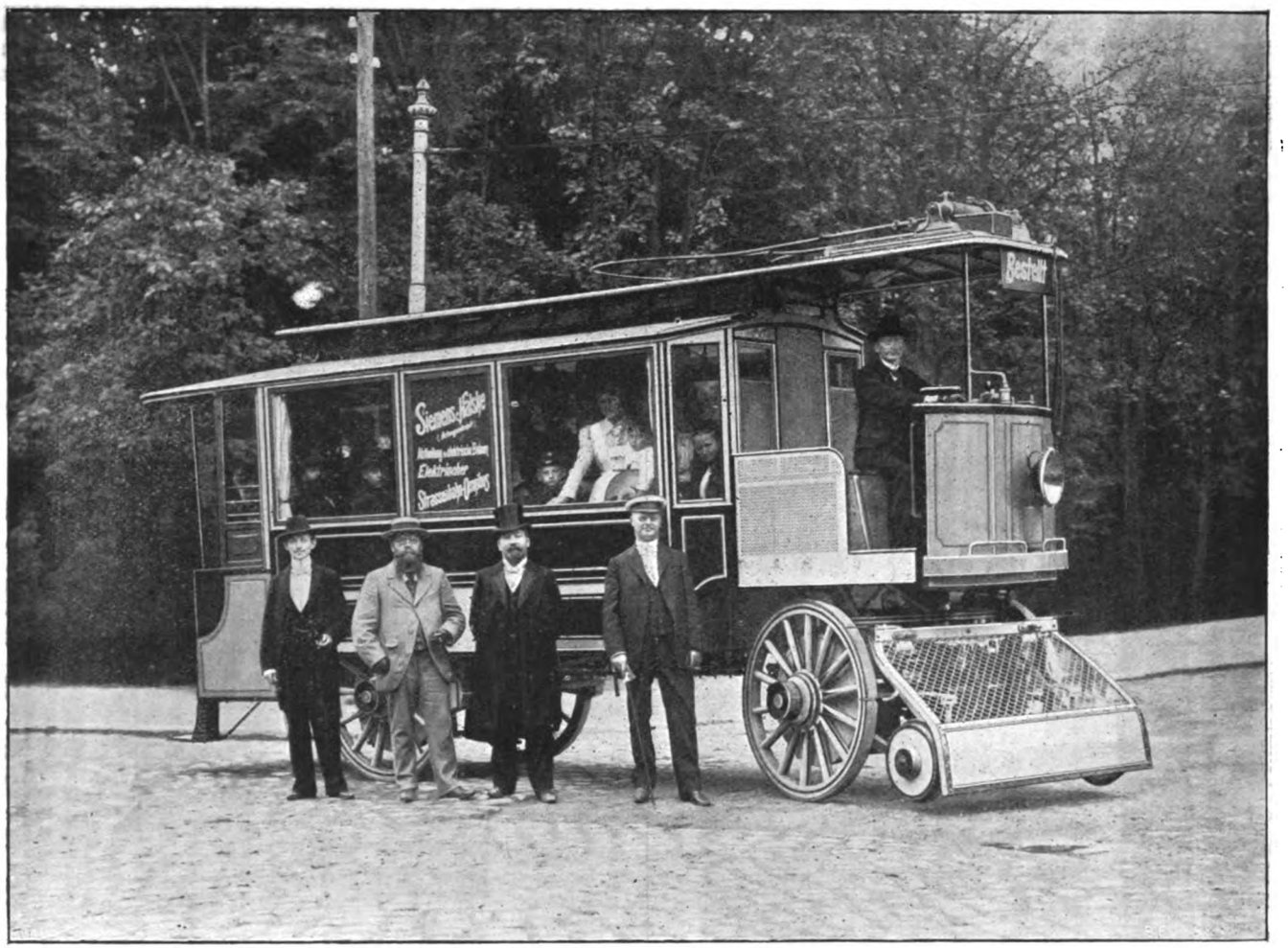

FIG. 1.—GENERAL VIEW OF SIEMENS & HALSKE "TRAMWAY-OMNIBUS."

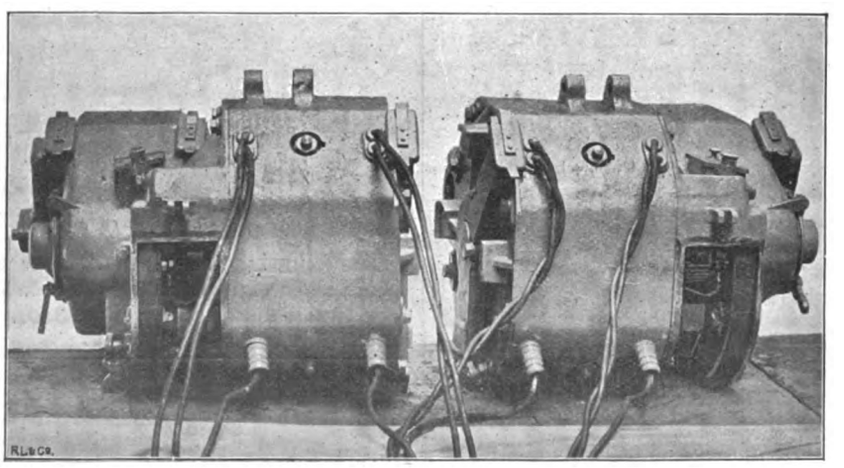

FIG. 2.—MOTORS OF THE "TRAMWAY-OMNIBUS."

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rails are—the roads are of course much worse than in the centre of the town. In the centre it is estimated that the tractive resistance is only about one and a half to twice as much as on rails. Another advantage is that the time necessary for charging at the end of the journey may be diminished very considerably, so that the number of cars in use at the same time is increased.

Fig. 1 shows the general appearance of the omnibus, which follows more or less the lines of the ordinary German type of horse omnibus. The front wheels have a diameter of 3ft. 3in., and the rear wheels 3ft. 7in. The gauge of the tram-lines is standard, and the distance between the wheels is 0 4in. less. All the wheels run in roller bearings. When in use, the guide wheels are pressed down by strong flat springs, so that they cannot get out of the groove in the rails, and this arrangement has proved satisfactory up to a speed of 18½ miles per hour. When running on the ordinary road the guide wheels are lifted up about 4in. above the surface. On straight portions of track it is found that the hind wheels have no inclination to leave the rails, and it is only on the sharpest curves that they leave the rails by a distance of about 3in. or 4in. As is seen in the illustration, the body of the 'bus is supported on long flat springs instead of being mounted on a truck. The omnibus is designed to seat 15 passengers, and there is standing room for six on the rear platform. Steering is accomplished by turning the whole of the front frame. A disadvantage to this system is that it needs the exercise of a considerable amount of power on the part of the driver, and in order to diminish this, balls are placed between the crown of the moving framework and the corresponding fixed surface on the car body, so that the friction is a rolling instead of a rubbing one. This makes so much difference, that while the omnibus is running it can be steered by means of a handwheel of only 12in. diameter (without intermediate gearing) and with one hand, although the front axle has to support a weight of about 3½ tons. It is recommended, however, that in future vehicles of this class should be geared down between the handwheel and the turning framework, in order to enable the driver to move it while the omnibus is standing still. An automatic locking gear is not used, as this of course would be *de trop* when the 'bus was running on the tram-lines. A mechanical brake works on the hind wheels, and in front of them are placed sand boxes. This is deemed sufficient, as the electric short-circuiting and back-current brake is usually employed, and acts on all four wheels. It is worked from the same handle as the controller.

Each wheel has its separate motor, rated at 4 H.P. at 300 volts and 550 revolutions. The four motors are connected in parallel. They can exert an aggregate tractive effort of two tons on the circumference of the wheels. Simple single-reduction gearing is employed, 1 : 7·5 for the front wheels and 1 : 8 for the back wheels. Fig. 2 is a view of two of the motors. In order to keep down the size of the controller as much as possible, a magnetic blow-out is employed. It may be noted that as the rails are used for a return, and as the spokes of the wheels are wooden, it was necessary to have a special conductor between the nave and felloe. When the collecting bar is not in use, it is automatically disconnected from the battery as it is pul'ed away from the trolley wire. In this way, if a telephone wire falls on it, the battery is not short-circuited. There is also a resistance in series with the lamps when the current collector is up, which is also automatically switched out when the bar is lowered, and the lamps fed from the battery only. The battery consists of 200 cells from the Hagen Co., in ebonite boxes. Its capacity will suffice to drive the car 3·7 miles as an omnibus. The cells are partly placed on the front platform under the driver's seat and partly under the passengers' seats inside. The battery weighs 1½ tons, and the whole omnibus, without passengers, 6½ tons. The weight is so arranged as to rest equally on all four wheels. The makers intend to reduce the weight somewhat in future vehicles.

PHYSICAL SOCIETY.

Ordinary general meeting, held Nov. 24, 1899, Prof. S. Carey Foster, F.R.S., Vice-President, in the chair. A Paper

"On the Conductivities of Certain Heterogeneous Media for a Steady Flux Having a Potential"

was read by Dr. C. H. LEES.

Two formulæ had already been proposed to express the conductivity of a mixture in terms of the conductivities of its constituent. In the first formula the conductivity was represented as the sum of a number of terms each one of which was the product of the conductivity of any constituent and the fractional part of the mixture which was made up of that constituent. In the second formula the resistivity of a mixture was expressed in the same way with respect to the resistivities and percentages of its constituents. In general the first of these suppositions gave results which were above the experimental values, while the second gave results which were below. If we suppose that the mixture is made up of a series of columns of the separate parts stretching normally between two equipotential surfaces, then the conductivity would be accurately represented by the first formula. If, however, we assume that the constituents are arranged in parallel layers, then the second formula would apply. In the present Paper the author attacked the problem two-dimensionally, and investigated the relation which holds between the conductivities when the constituents are arranged in the mixture alternately like the squares on a draught-board. Dealing first with two components, it is, he says, easily shown that the problem reduces itself to finding the form of the equipotential curves and of the stream lines in a square which is divided by a diagonal into two parts of different material. By means of a conformal representation Dr. Lees referred the square under consideration to a kite-shaped quadrilateral with two opposite angles right angles and the other two so determined by the conductivities of the constituents as to give straight equipotential lines in the two portions of the figure which represent the two materials and which are separated the one from the other by the axis of symmetry. The general relation which exists between the vector co-ordinates in the two systems had been proved by Love to consist of elliptic functions, but near the angular points of the figures a close approximation could be obtained by the use of a simple expotential expression. Taking the known solution to the problem in the case of the kite-shaped quadrilateral, it was easy to calculate the result for the square under consideration. This led to the conclusion that the conductivity of the square is the geometric mean of the conductivities of the constituents. Allowing the medium to become fine-grained and introducing new materials, it followed at once that the logarithm of the conductivity of a mixture was equal to the sum of a number of terms, each one of which was the product of the logarithm of the conductivity of any constituent and the fractional part of the mixture which was made up of that constituent. By a superposition of fluxes the author showed that the above law holds for flows in four directions, and he therefore considered that with the assumed structure the formula represents the conductivity for any flux.

Dr. LEES then read a second Paper

"On the Thermal Conductivities of Mixtures and their Constituents."

In this Paper the three formulæ considered in the preceding communication were applied to the known experimental results upon the conductivities of mixtures of liquids. The author found that the least satisfactory formula was the first one, whereas the least unsatisfactory was the logarithmic one.

Mr. APPLEYARD said that it was frequently of importance to be able to determine the resistance of a mixture of gutta-percha from the known resistances of component parts. He had attempted without success to do this by means of the old formulæ, and he would be interested to see whether Dr. Lees' logarithmic formula gave better results. In electrical work Mr. Appleyard pointed out that the nature of the contacts affected the conductivity, the resistance of a sheet of rubber being different when measured between metal plates and mercury sheets.

Mr. CAMPBELL said that the difference between the calculated and observed results might be due to the thermo-electric properties of the materials. Lord Rayleigh had observed that the high resistivity of alloys might be due to a back E.M.F. produced by the contact of dissimilar metals. Mr. Campbell said that he had measured the resistances of ferro-nickels both with direct and alternating currents, and found them the same in the two cases.

Dr. LEES, in reply, said that all his experimental work on conductivity had been carried out with mercury contacts.

The Society then adjourned until Dec. 8th, when, by the invitation of Prof. S. P. Thompson, the meeting will be held in the Physical Laboratory of the Finsbury Technical College.

BOOKS RECEIVED.

(Copies of any of the undermentioned works can be had from *The Electrician* office post free, on receipt of published price.)

"The Mechanical World Pocket Diary and Year Book for 1900." (Manchester: Emmott and Co.) 6d. net.

"Kalender für Elektrotechniker for 1900." Edited by F. Uppenborn. (Leipzig: R. Oldenbourg.) 5 marks.

Another Californian Transmission Plant.—The Truckee River General Electric Co. has completed its plans for a generating plant on the Truckee river, to transmit power for use in the celebrated Comstock mines, some 80 miles distant. The first installation, says the *Electrical World* of New York, will consist of two 750-kw. generators driven by turbines, to be operated either under 85ft. or 110ft. head, to be decided later. The transmission voltage will be 20,000 and the current will be distributed in the mines at 2,200 volts.

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ELECTRICITY WORKS ACCOUNTS.

Oldham Municipal Electric Supply Works.

The first of our tables this week embodies the accounts of the fifth year of working of the Oldham municipal electric supply undertaking. The figures given clearly indicate highly satisfactory results, and show that the concern continues to maintain the excellent position which has already characterised it.

Up to March 25th last the borrowed capital amounted to a total of £52,000, raised at rates varying from 2¾ per cent. to 3¼ per cent., while of this total amount £2,400 had been repaid out of the sinking fund. The total expenditure on capital account was represented by £57,110, or at the moderate rate of £51·6 per kilowatt of generating capacity of plant installed in the station.

The following table shows the progress which has been made :—

Year ended Mar. 25.	No. of consumers.	Equiv. lamp connections 8 c.p.	Max. supply demanded.	Plant capacity. KW.	Output. Unsold.	Total revenue per unit.	Total costs per unit.	W'rking profit. Total.	W'rking profit. % to mean cap.
1895	55	6,910	135	190	68,998	...	...	...	...
1896	113	11,830	250	432	147,432	6·26d.	2·10d.	£2,270	7·97%
1897	163	15,763	300	432	227,982	5·86d.	2·76d.	2,946	8·28%
1898	213	21,626	413	657	322,203	4·40d.	1·79d.	3,492	7·88%
1899	323	28,471	542	1,107	456,170	3·55d.	1·68d.	3,561	6·71%

It may be noticed that last year there were 110 new consumers, with the equivalent of 6,845 8-c.p. additional lamps. The year's output marks an advance of from 322,203 to 456,170 units sold, or no less than 41·6 per cent., and was productive of a total revenue of £6,756, representing the low average of 3·55d. per unit.

A further excellent reduction in the aggregate costs has been effected, and at 1·68d. per unit they are quite 0·8d. below what might fairly have been expected from the average 1897 results of stations of similar output to Oldham.

Among the generating costs the item of repairs and maintenance represents a fair average. The three remaining items, but especially the item of "oil, waste, water, and stores," are well below the average at the output, although the fuel charge at this, as at many another station in 1898, has gone up. Management and property charges have fallen, and now stand at the excellent figure of 0·44d. per unit.

In consequence of the material reduction in the price charged, and therefore in the total revenue, the percentage of the working profit to the capital has not been quite maintained, and the result for the year was a balance of £3,561, representing 6·71 per cent. of the mean capital. Out of this profit, together with the balance from the preceding year of £1,351, the interest charge of £1,397 has been met, while £1,280 was put aside to the sinking fund and £1,351 to the depreciation fund, leaving a balance for next year of £885.

It may be mentioned that of the year's capital expenditure of £8,050 the proportion spent at the station on buildings and plant was £4,493, while £3,557 represents the expenditure on street mains, meters and indicators. The maximum demand on the station during the period dealt with in our table was 542 kilowatts, and occurred on February 24, 1899; while the greatest quantity supplied in 24 hours was on December 17, 1898, being 3,198 units, as against a corresponding amount of 2,307 units in 1897-8. From September 25, 1898, large consumers have had the option of being charged either under the maximum demand system or according to the following scale—viz., for the first 1,000 units per quarter 4d. per unit, for the second 1,000 units 3½d. per unit, and so on, the fifth thousand units and all in excess of 5,000 being charged at 2d. per unit.

Leeds Municipal Electric Supply Works.

Our second table embodies the results of the working during 1898 and the opening three months of this year of the Leeds undertaking. The table gives, separately, analyses of the accounts for the period from January 1 to September 30, 1898, up to which date the undertaking was worked by the Yorkshire House-to-House Electricity Co. (Limited), and for the half-year extending from October 1, 1898, to March 25, 1899, during which period and since the concern has been under the control of the Corporation.

Owing to the fact that the results of working during the two periods are quite incomparable, there is little point in attempting an examination of the progress made in the matter of costs, but attention may be directed to the good advance in the lamp connections, which have increased from the equivalent of 65,828 to 78,380 8-c.p., lamps or nearly 20 per cent. in a period of six months. It is also interesting to note that, as the result of the six months' working to March 25th last, the gross profit amounted to £14,103, representing 6·14 per cent. of the mean capital over the period. £4,241 represents the amount placed to the credit of the capital account from revenue, and £6,256 the interest charges. The balance of £3,606 has been carried to the credit of the capital suspense account.

Wakefield Municipal Electric Supply Works.

The station at Wakefield, a near neighbour of that of Oldham in the north, but differing in the important respect of being on the alternating-current system, was started in November, 1897. This undertaking has therefore only completed one year of working, and, considering this fact, the results obtained are by no means unsatisfactory.

The total capital borrowed up to March 31st last was £25,000, raised at 3 per cent. £1,130 of this stock has been purchased at £1,145 by the sinking fund. The total expenditure was £28,657, representing £67·6 per kilowatt of generating capacity of plant. At 3·58d. per unit the costs are very fair at the output. All the items of the generating costs are quite satisfactory, while the item of repairs and maintenance is less than half what might have been expected were not the station a new one.

The item of management property charges is the only item which might be selected for criticism as being a trifle high, but for a concern in its first year the figure of 1·196d. is by no means abnormal.

The working profit made was £788, representing 2·75 per cent. of the capital expenditure at the end of the year. £600 was paid as interest, and £454 was placed to the sinking fund, resulting in a deficit of £267.

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared :—

Aberdeen (Municipal)	Jan. 6, 1899	Kingston-upon-Hull (Mun.)	June 9, 1899
Ayr (Municipal)	Sept. 22, ,,	Kingston-on-Thames (Mun.)	April 21, ,,
Bedford (Municipal)	May 19, ,,	Lancaster (Municipal)	Oct. 21, 1898
Belfast (Municipal)	Sept. 15, ,,	Leeds (Company)	Mar. 3, 1899
Birmingham (Company)	Sept. 15, ,,	Leicester (Municipal)	Jan. 20, ,,
Blackpool (Municipal)	Sept. 29, ,,	Leyton (Municipal)	Sept. 8, ,,
Bournemouth (Company)	April 28, ,,	Liverpool (Municipal)	June 9, ,,
Bolton (Municipal)	Nov. 24, ,,	Manchester (Municipal)	Aug. 11, ,,
Bradford (Municipal)	April 14, ,,	Newcastle and District (Co.)	Oct. 6, ,,
Brighton (Municipal)	May 12, ,,	Newcastle-upon-Tyne (Co.)	April 14, ,,
Bristol (Municipal)	July 14, ,,	Northampton (Company)	Oct. 20, ,,
Burnley (Municipal)	Aug. 25, ,,	Norwich (Company)	Nov. 17, ,,
Burton-upon-Trent (Mun.)	April 21, ,,	Notting Hill (Company)	Mar. 17, ,,
Bury (Municipal)	Sept. 22, ,,	Nottingham (Municipal)	July 21, ,,
Cambridge (Company)	Mar. 10, ,,	Oldham (Municipal)	Nov. 18, 1898
Cardiff (Municipal)	Jan. 6, ,,	Oxford (Company)	May 19, 1899
Charing Cross (Company)	Mar. 17, ,,	Pontypool (Company)	May 5, ,,
Chelsea (Company)	Mar. 31, ,,	Portsmouth (Municipal)	July 14, ,,
Cheltenham (Municipal)	Nov. 10, ,,	Preston (Company)	Sept. 29, ,,
Chester (Municipal)	June 23, ,,	Reading (Company)	Oct. 13, ,,
City of London (Company)	May 12, ,,	Richmond (Company)	Oct. 13, ,,
Clerkenwell (Company)	Aug. 18, ,,	Scarborough (Company)	Nov. 3, ,,
Derby (Municipal)	Dec. 9, 1898	St. James' & Pall Mall (Co.)	Feb. 24, ,,
Dewsbury (Municipal)	Nov. 24, 1899	St. Pancras (Vestry)	May 30, ,,
Dover (Company)	June 2, ,,	Sheffield (Company)	Dec. 16, 1898
Dundee (Municipal)	Nov. 4, 1898	Shoreditch (Vestry)	Oct. 27, 1899
Eastbourne (Company)	July 22, ,,	Southampton (Municipal)	Nov. 10, ,,
Edinburgh (Municipal)	Nov. 17, 1899	Southport (Municipal)	July 7, ,,
Exeter (Municipal)	Aug. 5, 1898	South Shields (Municipal)	July 7, ,,
Glasgow (Municipal)	Sept. 1, 1899	Stafford (Municipal)	Oct. 21, 1898
Guildford (Company)	May 5, ,,	Sunderland (Municipal)	July 28, 1899
Halifax (Municipal)	July 21, ,,	Taunton (Municipal)	June 16, ,,
Hammersmith (Vestry)	May 26, ,,	Tunbridge Wells (Mun.)	Sept. 1, ,,
Hampstead (Vestry)	Aug. 25, ,,	Walsall (Municipal)	June 23, ,,
Hanley (Municipal)	April 28, ,,	Wandsworth (Company)	Aug. 18, ,,
Harrogate (Municipal)	Oct. 20, ,,	Westminster (Company)	Feb. 24, ,,
Harrow (Company)	June 16, ,,	Whitehaven (Municipal)	July 28, ,,
Hast'gs & St. Leonards (Co.)	April 29, 1893	Windsor (Company)	Dec. 30, 1898
H'use-to-H'use Co. (K'ns'gt'n)	Mar. 31, 1899	Wolverhampton (Municipal)	June 30, 1899
Hove (Company)	Mar. 10, ,,	Woolwich (Company)	Jan. 18, ,,
Huddersfield (Municipal)	Oct. 6, ,,	Worcester (Municipal)	April 7, ,,
Islington (Vestry)	Oct. 27, ,,	Yarmouth (Municipal)	Nov. 3, ,,
Kens'gton & Knightsbr' (Co.)	Mar. 5, ,,		

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	OLDHAM.		LEEDS.		WAKEFIELD.
Undertaking Worked by	Oldham Corporation.		Leeds Corporation.		Wakefield Corpn.
Date of Commencement of Supply	March 20, 1894.		May, 1893.		November, 1897.
System of Supply	Three-wire continuous current.		Alternate-current transformers.		Alt.-curr. trans. sub-sta. feeding 3-wire network.
Chief Engineer	S. Wilmott Newington.		Harold Dickinson.		J. K. Brydges.
YEAR ENDED	MAR. 25, **1898.**	MAR. 25, **1899.**	SEPT. 30, **1898.**[a]	MAR. 25, **1899.**[j]	MAR. 31, **1899.**
QUANTITIES—					
Units generated	396,744[a]	589,633	—	—	123,270
„ SOLD (TOTAL)	322,203	456,170	695,718	1,001,540[j]	104,557
„ sold to consumers	305,859	437,690	—	1,001,290[j]	89,252
„ sold for public lighting, &c.	16,444	18,480	—	250[j]	15,305
„ used on works	11,222	15,543	19,305	20,985[j]	5,365
UNITS SOLD per 8 c.p. LAMP CAPACITY	15·7	13·2	—	—	7·39
Maximum supply demanded	413 kilowatts	542 kilowatts	2,091 kilowatts	2,509 kilowatts	152·4 kilowatts
Number of public lamps	22 arc	26 arc	1 arc	1 arc	10 arc
Number of consumers	213	323	750	1,000	149
Connections to mains in 8-c.p. lamps	21,626	28,471	65,328	78,380	11,300
CAPACITY OF PLANT IN 8-c.p. LAMPS	20,500	34,600	75,000	75,000	13,250
CAPACITY OF PLANT IN KILOWATTS	657	1,107	2,400	2,400	424
CAPITAL—	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kw. capacity.
AUTHORISED (TOTAL)	£52,000 / £79·2	£52,000 / £47·0	£200,000 / £83·4	— / —	£25,000 / £59·0
Share	— / —	— / —	200,000 / 83·4	— / —	— / —
Loan (including Debenture charges)	52,000 / 79·2	52,000 / 47·0	nil / —	— / —	25,000 / 59·0
RECEIVED (TOTAL)	46,650 / 71·0	52,000 / 47·0	169,244 / 70·3	£4,241 / £1·77	25,000 / 59·0
Share	— / —	— / —	169,244 / 70·6	— / —	— / —
Loan (including Debenture charges)	46,650 / 71·0	52,000 / 47·0	nil / —	— / —	25,000 / 59·0
AUTHORISED, NOT RECEIVED (TOTAL)	5,350 / 8·15	nil / —	30,756 / 12·8	— / —	nil / —
Share (unissued)	— / —	— / —	12,130 / 5·06	— / —	— / —
Share (uncalled)	— / —	— / —	18,626 / 7·76	— / —	— / —
Loan (including Debentures)	5,350 / 8·15	nil / —	nil / —	— / —	nil / —
REPAID (TOTAL)	2,000 / 3·04	2,400 / 2·17	— / —	4,241 / 1·77	1,130 / 266
RESERVE OR SINKING FUND	1,062 / 1·62	2,034 / 1·84	8,000 / 3·33	— / —	8 / 0·019
DEPRECIATION FUND	2,836 / 4·32	4,275 / 3·86	9,212[b] / 3·84	— / —	— / —
EXPENDED (TOTAL)	49,060[b] / 74·7	57,110[b] / 51·3	226,633 / 94·4	232,516 / 96·8	28,657 / 67·6
Lands and buildings	— / —	— / —	— / —	74,174 / 30 9	8,992 / 21·2
Plant	— / —	— / —	— / —	89,048 / 37·1	12,859 / 30·3
Mains	— / —	— / —	— / —	65,542 / 27·3	5,441 / 12·8
Miscellaneous	— / —	— / —	— / —	3,752 / 1·56	1,366 / 3·22
BALANCE OF CAPITAL ACCOUNT	−2,410[c] / −3·67	−5,110 / −4·62	−57,389[c] / −23·9	−228,275[c] / 95·1	−3,657[a] / −8·63
REVENUE—	Total. / Per unit sold	Total. / Per unit sold	Total. / Per unit sold	Total. / Per unit sold	Total. / Per unit sold
TOTAL	£5,899 / 4·396d.	£6,756 / 3·553d.	£13,901 / 4·799d.	£18,281 / 4·384d.	£2,349 / 5·398d.
Revenue from supply	5,461 / 4·070d.	6,351 / 3·340d.	12,720 / 4·390d.	17,182 / 4·120d.	2,108 / 4·842d.
„ meters, &c.	154 / 0·115d.	212 / 0·112d.		832 / 0·199d.	78 / 0·179d.
„ public lighting	206 / 0·153d.	193 / 0·102d.	— / —	— / —	140 / 0·322d.
„ sale of lamps, &c.	73 / 0·058d.	— / —	— / —	16 / 0·004d.	16 / 0·037d.
„ miscellaneous sources	— / —	— / —	1,181[d] / 0·407d.	251[i] / 0·060d.	7 / 0·016d.
EXPENDITURE—					
TOTAL COSTS	£2,406 / 1·792d.	£3,194 / 1·680d.	£4,933 / 1·718d.	£4,178 / 1·002d.	£1,561 / 3·594d.
WORKS COSTS	1,685 / 1·255d.	2,356 / 1·239d.	3,335 / 1·151d.	2,494 / 0·598d.	1,040 / 2·387d.
Generation of Electricity	*1,486 / 1·107d.*	*2,159 / 1·136d.*	— / —	*2,259 / 0·542d.*	*859 / 1·972d.*
Fuel (including cartage, &c.)	619 / 0·461d.	1,103 / 0·580d.	703 / 0·243d.	780 / 0·187d.	232 / 0·533d.
Oil, waste, water, stores	64 / 0·048d.	60 / 0·032d.	162 / 0·056d.	284 / 0·068d.	57 / 0·131d.
Wages at station	520 / 0·387d.	601 / 0·316d.	1,855[e] / 0·640d.	853 / 0·205d.	516 / 1·184d.
Repairs & maintenance at Station	283 / 0·211d.	396 / 0·208d.	615[e] / 0·212d.	342 / 0·082d.	54 / 0·124d.
Distribution of Electricity	*199 / 0·148d.*	*197 / 0·104d.*		*235 / 0·056d.*	*72 / 0·165d.*
Wages, &c.	15 / 0·011d.	17 / 0·009d.	—[f] / —	100 / 0·024d.	14 / 0·032d.
Repairs, renewals of mains, &c.	185 / 0·138d.	180 / 0·095d.		135 / 0·032d.	58 / 0·133d.
Public Lighting	— / —	— / —	— / —	— / —	*109 / 0·250d.*
Attendance	— / —	— / —	— / —	— / —	98 / 0·225d.
Renewals	— / —	— / —	— / —	— / —	11 / 0·025d.
MANAGEMENT CHARGES, &c.	721 / 0·537d.	838 / 0·441d.	1,948 / 0 569d.	1,684 / 0·404d.	521 / 1·196d.
Royalties	— / —	— / —	— / —	— / —	— / —
Rent, rates, taxes	*244 / 0·182d.*	*277 / 0·146d.*	*176 / 0·061d.*	*322 / 0·077d.*	*41 / 0·094d.*
Management	*477 / 0·355d.*	*561 / 0·295d.*	*1,473 / 0·508d.*	*1,362 / 0·327d.*	*480 / 1·102d.*
Salaries	331 / 0·247d.	339 / 0·178d.		1,045[m] / 0·251d.	200 / 0·459d.
Stationery, &c.	31 / 0·023d.	43 / 0·023 l.	1,472[g] / 0·503d.	114 / 0·027d.	17 / 0·039d.
Establishment charges	54 / 0·040d.	133 / 0·070d.		93 / 0·022d.	55 / 0·129d.
Law charges, &c.	61[d] / 0·045d.	46[f] / 0·024d.		110 / 0·026d.	207[b] / 0·476d.
FINANCIAL RESULTS—	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'd.
WORKING PROFIT FOR YEAR	£3,492 / 7·88%	£3,561 / 6·71%	£8,918 / 4·60%	£14,103 / 6·14%	£788 / 2·75%[d]
Carried to Depreciation Fund	2,793 / 6·30%	1,351 / 2·54%	2,612 / 1·35%	— / —	— / —
Carried to Res. or Sinking Fund	905 / 2·04%	1,280 / 2·41%	— / —	4,241 / —	454 / 1·58%[d]
Net int. on loans (incl. Deb. charges)	1,236 / 2·79%	1,397 / 2·63%	3,105[h] / 1·60%	6,256 / 2·72%	600 / 2·09%[d]
BALANCE FROM LAST ACCOUNT	2,793 / 6·30%	1,351 / 2·54%	1,329 / 0·686%	— / —	— / —
Do. AVAILABLE for DISTRIBUTION, &c	1,351 / 3 05%	885 / 1·67%	10,740 / 5·51%	3,606[k] / 3·42%	— / —
Deficit	— / —	— / —	— / —	— / —	*267 / 0·932%*[d]
ORDINARY DIVIDEND PAID	— / —	— / —	6¾% / —	— / —	— / —
% of TOTAL COSTS to GROSS REVENUE	40·8%	47·3%	35·8%	22·9%	66·5%
Expenditure per kilowatt capacity	£3. 13s. 3d.	£2. 17s. 8d.	£2. 1s. 6d.	£1. 14s. 10d.	£3. 13s. 7d.
REVENUE PER KILOWATT CAPACITY	£8. 19s. 10d.	£6. 2s. 0d.	£5. 15s. 10d.	£7. 12s. 5d.	£5. 10s. 10d.
Expenditure per 8-c.p. lamp capacity	2s. 4d.	1s. 10d.	1s. 4d.	1s. 1½d.	2s. 4½d.
REVENUE PER 8-C.P. CAPACITY	5s. 9d.	3s. 10½d.	3s. 8½d.	4s. 10½d.	3s. 6½d.
REVENUE PER 8-C.P. CONNECTED	5s. 5½d.	4s. 9d.	4s. 3d.	4s. 8d.	4s. 2d.
Price charged for lighting, per unit	4½d. to 3½d.[e]	4d. to 2d.[e]	5d. to 4½d.[i]	4½d. to 5d.[n]	6d. to 3d.[e]
„ for power, per unit			2d. less 5%	2d. less 5%	3d. [ann.
„ for public lighting	3d. per unit	2½d. per unit	—	4d. per unit	£12. 10s. per arc per

OLDHAM.—REMARKS—*a* Of which 9,202 units were expended in batteries and 51,591 in the feeders. *b* Details of expenditure not available. *c* Over-expended. *d* Includes auditing £10, and insurance £28. *e* Maximum demand

LEEDS.—REMARKS—*a* This analysis is of the accounts for the nine months working under the administration of the Yorkshire House-to-House Electricity Co., Ltd., from Jan. 1, 1898, to Sept. 30, 1898. *b* Being amount allowed for depreciation on sale of the undertaking to Corporation. *c* Over-expended. *d* Includes £1,149 rents receivable. *e* Includes the distribution charges. *f* Not separately rendered in the accounts. *g* Includes £375 directors' remuneration, and £95 to insurance. *h* To *credit* of net revenue account, £3,663 being interest *received and due* from the Leeds Corporation. *i* With discounts.

WAKEFIELD.—REMARKS—*a* Over-expended. *b* Includes "temporary plant" £172, and insurance £35. *c* Maximum demand system on 1-hour scale. *d* Per cent.

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PROF. THOMPSON'S PRESIDENTIAL ADDRESS.

The inaugural address of the President of such an important society as the Institution of Electrical Engineers is likely to have a great influence on the profession, and the more so when the reader of the address, besides being President of the representative body of British electrical engineers, is one of the most eminent and popular teachers of applied electricity. A presidential address to a scientific or engineering society is as a rule either a review of the state of progress of the science or industry in which that association is interested, or else it is devoted to a special subject which the President has made peculiarly his own. As recent examples of the latter kind of presidential address we may cite that of the late Dr. JOHN HOPKINSON, in 1890, on "Magnetism"; Prof. CROOKES' interesting discourse, in 1891, on "Electricity in Transitu: from Plenum to Vacuum"; and Prof. AYRTON'S 1892 address on "Electrotechnics." Such addresses are more in the nature of Papers, and are sometimes distinctly polemical in nature, whereas it is exceptional for those in the category of reviews to enter into controversial matters. In this respect Prof. THOMPSON'S address is a brilliant exception, but not exactly one to be followed. In tone, it is true, Prof. THOMPSON was far from being dogmatic. He gave expression to his own opinions, and he gave the reasons which he had for forming them. Yet he should not forget that a large proportion of his hearers and readers are among the younger members of the profession, and, as students, may be inclined to take the Professor's utterances as doctrine when delivered with all the pomp and ceremony of a presidential address. Had the opinions been delivered only in the form of a Paper, the impression created would have been considerably modified by the expression of opposite views from other leaders of thought in matters electrical. We have on previous occasions alluded to the too great tendency to fashion in electrical engineering practice, and it would be a matter for regret if some of the views expressed by Prof. THOMPSON on questions in which the most eminent of our electrical engineers differ should be adopted by their younger colleagues as solid foundations on which to build their future mode of thought and action.

We called attention in our last issue to some of the points raised in the first part of the address. In the region of sub-

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marine telegraphy Prof. THOMPSON advocates a method for increasing speeds which he has for long championed, although the practical suggestions for carrying it out have not been received with any enthusiasm by those most interested commercially and by their expert advisers. The Professor's slighting reference to telephony may discourage many of his hearers from devoting themselves to this branch of the electrical profession. He next advocates the universal adoption of a system of house wiring which supply station engineers and the Board of Trade have, save in a few exceptional cases, taboced. Although the cheapening of house wiring is much to be desired, many other things have to be considered. An indiscriminate earthing of one pole of a supply network might lead to many results, some foreseen and others unforeseen. It would necessitate a great alteration in present practice. Instead of earthing one main at the station, and carefully insulating it in all other places, it would be necessary in a large system to earth the feeding points in order to prevent too large differences of potential between the various bare portions of the uninsulated main and the neighbouring gas and water pipes. The Board of Trade limit for traction would not suffice in this case, where the uninsulated main would be led into every house. The work of testing would be greatly increased and rendered more difficult. In the houses it would be necessary for the supply undertaker and also the fire offices not only to specify but also to measure the maximum fall of potential in the installation. Testing the network for insulation resistance and the discovery of faults would also give still greater trouble than at present. We do not wish to say that such a system might not eventually be adopted, but it would entail so much alteration in existing practice that many men with equal and greater experience than Prof. THOMPSON in the distribution of electrical energy take sides against him in the matter. The difference of opinion as to the new alternating *v.* continuous-current controversy which Prof. THOMPSON'S address may initiate is as great if not greater than that on the bare return wire question. We referred in our last issue to the crucial point which renders alternating currents, except under exceptional conditions, less efficient than continuous currents for distribution purposes on lighting networks. However more efficient two and three-phase current may be for the transmission of electricity wholesale, the daylight losses involved when alternating current is retailed to consumers have always to be reckoned with and are an important item when electrical energy has to be generated by the consumption of fuel, whether at the pit's mouth or 100 miles away. Neither in this matter nor in the matter of heavy railways should we follow blindly the lead of Switzerland, where the local conditions are entirely different. We can certainly gain much by studying the developments in other countries, but it is necessary in considering the application of the same methods here to study first the conditions which have given rise to these developments. In traction work more is to be learnt from America than from Switzerland, especially in those parts where water-power is not abundant, and where electricity has to be generated from coal as in this country.

We need not dwell here on Prof. THOMPSON and Mr. MILES WALKER'S surface-contact system, as it has been reviewed in our columns on previous occasions. Needless to say, we wish it every success, and that it may live to be combined with a three-phase system and fulfil the dearest hopes of its inventors. Nor is it necessary to say that we cordially share Prof. THOMPSON'S enthusiasm with regard to the Volta centenary and his satisfaction in the establishment of our National Physical Laboratory. The growth of the Institution itself also affords ground for congratulation; and the excellence to which *Science Abstracts* has attained, as well as the initiation this year of what we hope will be only the first of many meetings away from the metropolis, should render the society still more popular, for it has greatly increased its utility to individual members. The time has certainly arrived when the Institution of Electrical Engineers should have a home of its own, and we would call our readers' attention to Prof. THOMPSON'S remarks as to the building fund.

One portion of the President's address remains to be mentioned—that relating to the financing of electrical companies. There have certainly been numerous examples of over-capitalisation and worse sins during recent years in the promotion of companies for the exploitation of electrical inventions or for carrying on electrical industries, but we think that Prof. THOMPSON is too pessimistic. True, he owns that electric traction has "largely escaped this curse," but we cannot but think that he puts the case too strongly when he asserts that "it is almost impossible" for an inventor "to find a middle course between a purely private affair and an over-capitalised swindle." Those company promoters who are guilty of such sharp practices will do well to remember that attention has been directed to their evil ways by the man who now occupies the most honoured position in the electrical profession.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

Charge and Mass of Cathode Particles.—Since the discovery of the Zeeman effect, the ratio e/m of the charge of a cathode particle to its mass has assumed a great theoretical importance. S. Simon has therefore endeavoured to obtain as accurate a value as possible for this ratio. He used Kaufmann's method of transmitting a beam of cathode rays through a magnetising coil. The chief matter of importance was the task of determining accurately the variation of the magnetic field along the path of the beam, and this was done by means of a specially-designed magnetometer. It was important that this field should be as uniform as possible, and that the remainder of the path should be uninfluenced by magnetic forces. For this object the position of the anode and cathode were so chosen that the resultant magnetic effect outside the coil was zero. Three independent measurements were made with different positions of the electrodes. The first and third measurements resulted in a difference of 0·43 per cent., and the first and second in a difference of only 0·1 per cent. The final value for the ratio was $1{\cdot}865 \times 10^7$ C.G.S. units. Kauffmann's corrected value was $1{\cdot}77 \times 10^7$.

[S. SIMON, *Wied. Ann.* No. 11, 1899.]

Moving Bodies in an Electric Field.—If a sphere rotates uniformly in a medium of different conductivity and in an electric field, and the conductivity of the medium is negligible in comparison with that of the sphere, a couple acts upon the sphere tending to stop its motion. If the conductivities are reversed, the couple tends to accelerate the motion. A. Heydweiller has repeated the experiments of Quincke, Arnò, Threlfall, and others made in this connection. He finds that the phenomena in air are complicated by its dielectric conductivity. This conductivity depends upon the field intensity on the one hand and upon the density on the other hand, increasing with increasing field intensity and with decreasing density. A maximum is reached at a pressure of about 0·005mm. of mercury. The conductivity may, according to these conditions, be greater or less than that of a glass sphere or plate suspended in it, and the rotations or oscillations observed will vary accordingly. The author makes an important application to the motion of celestial bodies, which may be regarded as conducting spheres suspended in a non-

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conducting medium strained by a feeble electrostatic field. He shows that if the earth's potential was 10^7 as at present, or somewhat higher, say 10^{10} electrostatic units, for 100 billion years, the field thus created would account for the stoppage of the moon's rotation without having to call in a supposed tidal action.

[A. Heydweiller, *Wied. Ann.* No. 11, 1899.]

Atomic Weight of Radium.—Demarçay's work on the spectrum of radium brought out the fact that as the proportion of the radio-active constituent in the barium chloride becomes greater, certain spectrum lines increase in brightness. The other conditions being equal, this gives a definite and valuable indication that the radio-active substance has a distinct existence apart from all known elements. Following up this hint, Sklodowska Curie has endeavoured to determine the atomic weight of radium, or at least to get some information as to its order of magnitude. For that purpose she subjected to fractional distillation a mass of purified radiant barium chloride, obtained from half a ton of uranium residues supplied by the Austrian Government. She further treated the chloride by fractional precipitation in alcohol. The highly active substance obtained was used for determining the atomic weight by means of the silver nitrate reaction. The values thus obtained varied from 140 to 145·8, as against the atomic weight of inactive barium 137·7 found at the same time. This of course leaves the atomic weight of "radium" indeterminate, but it is clear that radium is not allotropic barium, since no allotropic forms of an element have different atomic weights. And further, whatever be the atomic weight of radium, it must be greater than that of barium.

[S. Curie, *Comptes Rendus*, Nov. 13, 1899.]

Curves of Periodic Processes.—R. Franke describes an improved Joubert device for tracing alternate-current curves and the curves of other periodical physical processes. For tracing such curves two fundamentally different methods are adopted. One consists in photographing or otherwise tracing the curve in its entirety. The other, first employed by Joubert in 1881, picks out a certain phase by a suitable contact maker, and obtains a constant galvanometer deflection or other indication connected with it, tracing the full curve by successive points thus obtained. The author has devised a contact maker by which the duration of the contact can be very accurately regulated, two brushes being employed, with an adjustable distance between them. The galvanometer deflection obtained is optically registered on a drum revolving with the screw which picks out the phase. Thus the curve is traced with any slowness required, and a tracing device is added by means of which the operator can draw a pencil line following the optical trace. In another arrangement, suitable for demonstrations, a mirror is substituted for the drum and the curve is projected on a screen. The author claims that by means of his tracer the curve of a dynamo can be obtained in about three minutes. He has endeavoured to construct an apparatus which should answer ordinary workshop requirements, and describes a great variety of applications.

[R. Franke, *Elektrotchn. Zschr.*, Nov. 16, 1899.]

Frictional Electrification.—Continuing his researches on the mechanism of frictional electrification, C. Christiansen has studied the difference of potential of jets of mercury and of zinc amalgam or other amalgam falling side by side through dry or moist oxygen. A mercury jet was surrounded by 12 jets of the amalgam containing very little of the foreign metal—say 0·1 per cent. The rate of efflux of the amalgam jet was about 2m. per second, and as the unbroken mercury jet was 18mm. long, the amalgam opposite the end of the mercury jet had been exposed to the oxygen for about 0 01 second at the point of measurement. As long as the oxygen was somewhat moist, the normal difference of potential of 0·88 volt was indicated between the amalgam and the mercury. But when the moisture was gradually reduced the difference of potential steadily decreased, and finally was reversed in sign at a point where the vapour pressure was about 0 5mm. This indicates that the amalgam forms a hydrate in moist air and an oxide in dry air. Magnesium amalgam shows a higher difference of potential, both positive and negative. Cadmium amalgam shows about the same as zinc, and lead amalgam less. The negative values of the differences of potential are very indefinite, as it is extremely difficult to employ absolutely dry oxygen.

[C. Christiansen, *Wied. Ann.* No. 11, 1899.]

Measurement of Variable Discharges.—In addition to the stationary continuous-current discharge and the symmetrical alternate current, attention has recently been directed to the periodically varying discharge produced from continuous currents by the interposition of an interrupter. An elucidation of the detailed process of discharge in this case is very desirable, on account of the characteristic relations existing between the current and potential on the one hand and the effective expenditure of energy on the other. The existing measuring instruments and methods are inadequate for dealing with such measurements, as has been shown by the many obscurities still attaching to the action of the Wehnelt interrupter. Instruments containing iron do not give indications independent of the frequency, while those free from iron, like most dynamometers and hot-wire instruments, usually are governed by the square of the quantity to be measured. C. Heinke points out that satisfactory results may be arrived at by measuring potential and current simutaneously with galvanometric and "efficiency" instruments, thus splitting them up into a constant term and a periodically variable term. The latter may be replaced by an equivalent sine wave. The total work of the "wave-current" is best measured calorimetrically, by converting the whole energy expended into heat.

[C. Heinke, *Wied. Ann.* No. 11, 1899.]

TRANSMISSION PROBLEMS FOR MODERN CENTRAL STATION SUPPLY.—THE USE OF DOUBLE-CURRENT MACHINES.

BY EUSTACE THOMAS, B.SC.

The engineer who proceeds to lay out a central station for a wide area of supply is confronted with a number of systems, from which he has to choose that which will best suit the local conditions; and it may be of interest to review the direction which opinion appears to be taking in this matter at the present day.

There is one point perhaps on which all are agreed—namely, that it is preferable where possible to concentrate the generating plant in one station and to employ large units, the number of such units being reduced to the minimum consistent with meeting all variations of load.

For traction work there appears to be practical unanimity in the selection of direct-current supply at a voltage not less than 500. Where possible the current is generated directly at approximately this voltage, and fed to the line through low-tension feeders. In large plants, however, even where the station is in a central position, the cost of such feeders may become so great that considerable saving can be effected by the employment of multi-phase transmission, and conversion to direct current in sub-stations employing rotary converters. It may be said, that the essential element of success for such systems is that the amount of power required from each sub-station shall be sufficiently large, in order that large transforming units may be employed, and that the expense of attendance may be relatively small.

There are, however, a number of cases where the main portion of the supply can well be obtained from direct-current machines located in the central station, but where, at the same time, advantage can be obtained by multi-phase transmission to certain outlying districts. Here it would be useful to combine in the one station plant capable of furnishing both direct and alternating currents.

Turning to the case of a town supply to private consumers, single-phase systems have been adopted in a large number of cases, but are now losing favour. It may be said that one

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important reason for this is the appreciation by the public of the advantages to be obtained from the use of electric motors, and the desire on the part of the station engineer to make the most of this feeling. The single-phase motor has not yet convinced anyone of its adaptability for all purposes for which power is required, and hence we find that some very large systems which have been laid out for single-phase working are being changed over rapidly for direct current supply.

On the Continent and in America multi-phase distribution has been employed to a large extent, although in this country it has not been adopted except in comparatively unimportant cases. Yet long experience has proved that a multi-phase motor will adapt itself to almost all conditions which have to be met in practice, while at the same time lighting problems have presented no difficulty.

It is interesting in this connection to refer to the system which has been laid down by Signor Semenza in Milan.* He has adopted three-phase distribution throughout, a considerable number of sub-stations, containing static transformers, being used to feed into the network. By this means it is possible to employ comparatively low voltages. Signor Semenza has assured himself that he is able to obtain low-voltage lamps having far greater efficiencies than those which are produced for say 200 volts, with considerable ultimate advantage to the consumer and therefore to the station.

With all this, however, there is no question that the direct-current motor is the most flexible in its adaptability to all the conditions which occur in practice, and hence the tendency is most strongly marked towards the employment of distribution on a three-wire system by direct currents, at a voltage which every day approaches more closely to the limit of 500. Hence, for lighting also, the tendency in this country is to arrive at a system which is directly similar to that to which traction practice has reduced itself, and the station conditions become similar to those which hold in the case of traction.

It frequently happens that it is advantageous to generate direct current for local supply and three-phase current for transmission to districts at a distance from the station. The requirements can be met by the employment in the same station of both direct-current and alternating-current generators, but the number of units required must necessarily be increased, together with the proportion of spare, and each unit will further be reduced in size. All this will involve a reduction in the economy of working. Where such systems have been employed, motor-generators, or rotary converters, have commonly been installed, to afford a connection between the two classes of machinery. These, however, are of the nature of transforming devices only, and, while expensive, add nothing to the ultimate capacity of the station.

There are a number of cases where what are known as double-current generators can be employed. These consist essentially of direct current machines, from the windings of which connections are taken to a suitable number of collector rings mounted on the shaft at the same end as that occupied by the commutator. It is in the writer's knowledge that several of the more progressive engineers in this country have been considering the use of such machines, and now that they have had an extended practical application in the case of Chicago, which has shown them to be successful in practice, it may be assumed that they will come frequently under consideration in the future.

It has been found that such machines can deliver their full output either on the direct-current or the alternating-current side, or that they can yield part of their output as alternating current and part as direct current. Their regulation is practically the same as that of direct-current machines. The voltage on the alternating-current side bears a practically constant relation to that on the direct-current side, and its variation does not affect satisfactory regulation of the rotaries in the sub-stations by sub-station attendants. At the same time it is well to point out that such machines have certain limitations, and that consequently one would not make all machines in the station of this character. For modern direct-current machines the armature reaction is commonly made larger than is consistent with good regulation as alternating-current generators, and such armature reaction serves in some cases a useful purpose. Also, to obtain a suitable frequency, the number of poles would commonly exceed that usual with direct-current machines. These two conditions are consistent with one another, but they tend somewhat to a reduction of the efficiency of working. With the high-speed engines which have reached such perfection in this country, the difficulties are reduced to a very small amount, or are practically eliminated; but in general it may be said, that comparatively large units, and a low frequency such as 25 cycles per second, are conditions most suited to the use of double-current generators. Fortunately, it is just such a frequency which has been found most advantageous for rotary converter working.

Double-current machines, then, may commonly be employed as intermediaries in stations where both direct-current and alternating-current plant is installed, and would in such cases obviate the employment of running transformers. They will also find application in cases where the bulk of the requirements is for current of one class only, the other class being conveniently obtained from double-current generators.

A third case has arisen which possesses very attractive features. It has sometimes been proposed to equip a comparatively long line electrically, on which only one or two trains will be running at a time. In such cases double-current machines might be installed in the generating station, with rotary converters at suitable positions along the line. When a train was in the neighbourhood of the generating station it would take current almost entirely from the direct-current end of the machine. When, however, it was close to any one of the sub-stations, the power would be derived from the alternating end of the machine. Thus the same generator would automatically adapt itself for both systems of distribution, and the plant would be of the simplest and most economical character possible.

* See *The Electrician*, Vol. XLII. pp. 255, 361, and 413.

THE INDUCTANCE OF A PORTION OF AN ELECTRIC CIRCUIT.

BY H. N. ALLEN, B.SC.

(*Concluded from page 109.*)

The graphical solution of the problem is shown in Fig. 4. The maximum electromotive force at the terminals E is resolved into two components at right angles to one another, C_1L_1p the maximum value of the electromotive force required to overcome the effects of inductance in the main circuit being in advance of E; while C_1R_1, which overcomes the resistance, lags behind it. E can also be resolved into the two

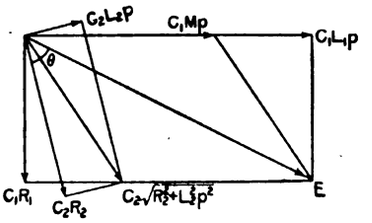

FIG. 4.

components, C_1Mp, which overcomes the back electromotive force in the voltmeter circuit due to mutual induction, and $C_2\sqrt{R_2^2+p^2L_2^2}$, which overcomes the impedance of the voltmeter circuit. The first of these is in step with C_1L_1p, the second can be resolved into the two components, C_2L_2p and C_2R_2. The current C_2 is in step with the latter.

If $M = 0$ (voltmeter connection BFC Fig. 2),

$$C_2 = \frac{E}{\sqrt{R_2^2+L_2p^2}},$$

and E the maximum potential difference between the voltmeter terminals can be determined by measuring the other quantities in the equation.

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If, on the other hand, $M = L_1$ (voltmeter connection BEC Fig. 2),

$$C_2 = \frac{ER_1}{\sqrt{(R_1^2 + p^2L^2)(R_2^2 + p^2L_2^2)}} = \frac{C_1R_1}{\sqrt{R_2^2 + p^2L_2^2}}.$$

This is the value which would be obtained with no mutual induction, if the inductance of the main circuit were zero, and the value of E is not obtained from the observation of C_2.

If an electrostatic voltmeter of capacity F is made use of, the resistance of the connections being R_2, an alternating current with instantaneous value c_2 will flow in the voltmeter circuit.

$$c_2 = C_2 \sin(pt + \psi),$$

where $$C_2 = \frac{E\sqrt{R_1^2 + (L_1p - Mp)^2}}{\sqrt{(R_1^2 + p^2L^2)\left(R_2^2 + \frac{1}{p^2F^2}\right)}},$$

and $$\sin\psi = \frac{\frac{R_1^2 + L_1^2p^2 - ML_1p^2}{Fp} - R_2ML_1p^2}{\sqrt{(R_1^2 + p^2L_1^2)(R_2^2 + p^2L_2^2)[R_1^2 + (L_1 - M)^2p^2]}}.$$

The current may either lag or lead with respect to the electromotive force E, though in practice, when R_2 and M are generally small, it will lead.

Fig. 5 shows the graphical solution of the problem: it is similar to that for an electrodynamic instrument. The electromotive force E is resolved into C_1Mp, which overcomes the back electromotive force due to mutual induction, and $C_2\sqrt{R_2^2 + \frac{1}{p^2F^2}}$, which overcomes the impedance of the voltmeter circuit. This last is resolved into the two components C_2R_2 and $V = \frac{C_2}{pF}$, the former being 90deg. in advance of the other. The first is the maximum electromotive force required to overcome the resistance of the connecting wires, the second

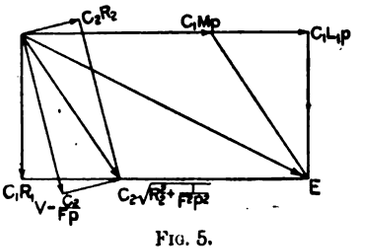

Fig. 5.

the maximum difference of potential between the terminals of the instrument. Here again the current C_2 is in step with the component C_2R_2.

If $M = 0$, $$C_2 = \frac{E}{\sqrt{R_2^2 + \frac{1}{p^2F^2}}}.$$

The denominator is the impedance of the voltmeter circuit and this is the well-known expression, "current equals electromotive force divided by impedance."

If $M = L_1$, $$C_2 = \frac{ER_1}{\sqrt{(R_1^2 + p^2L_1^2)(R_2^2 + p^2L_2^2)}} = \frac{C_1R_1}{\sqrt{(R_2^2 + p_2L_2^2)}},$$

this, again, is the value which would be obtained if the inductance of the main circuit were zero and there were no mutual induction.

The problem with a hot-wire instrument is the same as that with an electrodynamic one, so that, unless M can be made equal to zero, neither of the forms of voltmeter considered will correctly measure the virtual volts between the terminals.

These theoretical considerations were verified in a series of experiments which were originally undertaken to find the inductance of different portions of an armature conductor on a dynamo or motor. A more or less rectangular coil of one turn was used, which had been employed in some other experiments. This is marked ABC in Fig. 6. The two longer sides were straight and parallel, while the shorter ones curved upwards, so as to clear the spindle of the armature core D of a small Immisch motor on which the coil was placed. When the core was put in position, between the poles faces of the motor, with the coil in the median or horizontal plane, the magnetic flux would pass down into the lower pole face, go round through the field-magnet limbs and yokes on either side, and back into the core through the upper pole face, and in the reverse direction when the direction of the current was reversed. This greatly increased the inductance of the coil. An alternating current of 167 amperes was sent through ABC, and voltages were measured with a reflecting electrodynamometer, the fixed and moving coils of which were placed in series. The frequency was 213 alternations per second, and at this frequency the impedance of the instrument differed very little from the resistance. The apparent inductance of the coil—that is, the inductance calculated by means of the equation $C = \frac{E}{\sqrt{R^2 + p^2L^2}}$ from the observed voltage between A and C, was found to depend upon the condition of the field magnets, being only a little larger than when the core was removed from the field if the field coils were short-circuited. The voltmeter wires were arranged in three different ways.

I. One of the voltmeter wires was attached to C and led round, keeping as close as possible to the conductor, past B to A. There it was twisted with the other insulated voltmeter wire, which was attached to A, and both were led off together to the voltmeter.

II. The two wires from A and C were twisted together, and led direct to the voltmeter.

III. The wire from C was brought over to A, and round past B and C to A again, keeping as close as possible to the main conductor.

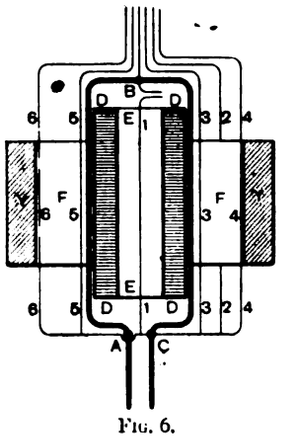

Fig. 6.

Horizontal section through the motor, with the experimental coil in position. D is the section of the armature core; B, the hole through it; A B C, the experimental coil; F, the lower field magnet limbs; Y, the sections of the yokes; 1, 2, 3, 4, 5, 6, voltmeter wires going by different paths from C to B.

Each of the above arrangements was used to take readings with the coil on the core outside the field, with the core in the short-circuited field, and with the field circuit open. The following table gives the volts observed in each of these cases:—

Table I.

	Core out of field.	Closed field.	Open field.
I. Mutual induction opposing	0·113	0·118	0·117
II. No mutual induction	0·217	0·239	0·350
III. Mutual induction assisting	0·340	0·378	0·602

In each of the vertical columns the volts in I. are less than those in II., while those in III. are greater. In II. there is no mutual induction between the main and the voltmeter circuits, while in I. the mutual induction introduces an electromotive force which opposes the current flowing in the voltmeter circuit, and in III. one in the same direction as the current. The resistance of the coil being 0·000568 ohms, 0·095 volts will be required to send the current through the resistance. The volts in line I. are in all three cases only a little larger than this, and there is very little difference between the

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three readings. The mutual inductance is not much smaller than the inductance of the main circuit.

In the next table the component of the observed volts which differs in phase from the main current by 90deg., and which may be looked on as overcoming the apparent reactance of the coil, is recorded.

Table II.

—	Core out of field.	Closed field.	Open field.
I. Mutual induction opposing..	0·057	0 065	0·064
II. No mutual induction	0·192	0·218	0·337
III. Mutual induction assisting...	0·327	0·366	0·593
Difference between I. and II.....	0·135	0·153	0·273
Difference between II. and III....	0·135	0·148	0·256

It will be noticed in each of the vertical columns that the difference between I. and II. is nearly equal to that between II. and III. In the first line the three numbers are nearly equal, which shows that the number of tubes passing between the main circuit and the voltmeter circuit is nearly the same in all three cases, and is small. The tubes which pass outside the voltmeter circuit produce, in cutting the wire, an electromotive force with an advance of 90deg. on the current in the main circuit and opposing that component of the potential difference between the terminals which overcomes the reactance of ABC. In III. the same electromotive force acts, but in the opposite direction. The numbers in line II. may be taken as a measure of the total flux through the main circuit when the current is a maximum, those in line I. of the portion of this flux included between the main circuit and the voltmeter wire, while the difference between I. and and II., or that between II. and III, measures the portion of the flux which lies outside the voltmeter wire and cuts it as the current dies away to zero. The differences between these numbers in the last two columns are due in part to the fact that in calculating them losses in the iron, and in the case of the second column in the copper, of the field are left out of consideration.

Since in Fig. 6 the point B is exactly midway between A and C, the inductance of BC must be half that of ABC. One of the voltmeter wires was connected to the point C in the main circuit, and the virtual difference of potential between B and C was determined, with the voltmeter wires in several different positions. In Fig. 6 the wire marked 1 passes from C, through the central axial hole in the armature coil, to B, where it is twisted with the other voltmeter wire, which is connected to this point in the main circuit. The observed voltage in this case was practically half what was obtained by connecting the two wires to A and C. The same was true when the wire was led outside the field-magnets from C to B, as in 2, and there twisted with the other one. In neither of these cases was the voltmeter wire cut by tubes of induction when the current varied, and though the inductance of the voltmeter circuit was increased by linking it with an iron circuit, it appears from the result of the experiment that even thus the total reactance was small as compared with the resistance. When the wire was passed through the space between the field-magnet limbs, the volts were reduced to a very low value if the wire went through on the side CB, as in 3 and 4, and were greatly increased if it went through on the side AB, as in 5 and 6. The following are the observed numbers, the current being 167 amperes and the frequency 213 alternations per second. The field circuit of the motor was left open, so as to make the voltage as large as possible.

Table III.

Position of voltmeter wires.	Volts.
1. Wire from C through central hole to B	0·187
2. Wire from C outside the field to B	0·187
3. Wire from C along CB to B close to main conductor...	0·077
4. ,, ,, ,, yoke	0 087
5. Wire from C along AB to B close to main conductor...	0·305
6. ,, ,, ,, yoke	0·232
7. Wires from A and C twisted together	0·371

0·064 volt would be required to send the current through the ohmic resistance of the conductor, and the value obtained in the third observation is only a little larger than this. Half the number obtained in the seventh observation is 0·185, and this agrees very well with observations 1 and 2. In the fourth and sixth observations, where the voltmeter wire is close to the yoke, fewer induction tubes lie outside the voltmeter wire, when the current is a maximum, than in the third and fifth, in which it lies near the conductor. As the electromotive force due to mutual induction is in five and six assisting the voltmeter current, the observed volts in five are larger, while, since in three and four this electromotive force is in the opposite direction, and lowers the voltmeter reading, the observed volts in three are smaller than those in four.

The results obtained may be summed up as follows:—It is possible for the effect of mutual induction between the main and voltmeter circuits to nearly neutralise the effect of the inductance of the main circuit, so that the volts recorded are only a little more than those required to send the current through the resistance. The very worst arrangement of the voltmeter wires in determining the impedance of a portion of a loop is that in which they are led along the conductor to a meeting point, and then twisted together, and so to the instrument. In some cases mutual induction can be avoided, but more often the impedance of a portion of a looped circuit cannot be determined by means of an alternating-current voltmeter.

PROF. SILVANUS P. THOMPSON'S PRESIDENTIAL ADDRESS TO THE INSTITUTION OF ELECTRICAL ENGINEERS.

(Concluded from page 150.)

In the United States heavy railways have been to a very limited extent operated by electric locomotives. Some built for the Baltimore and Ohio railroad, weighing about 90 tons, are employed to draw ordinary trains over a short line around part of the city of Baltimore. They work with continuous currents from overhead trolley lines.

There can be little doubt, however, that to Switzerland rather than to America we must look when desiring guidance as to the future development of this problem. All necessary data now exist for the exact working out of the necessary equipment of any given line, actual or projected. No experiments are needed to enable the constructor to proceed, so soon as it shall have been determined which kind of current is to be used. Already it has been found, in the designing of the Central London line, that continuous-current methods, however suitable for light and short railways, and for tramways where frequent stoppages occur, fail when the current has to be supplied from a distance of several miles, alternating currents being brought in because of their greater economy in transmission. The extraordinary thing is that, this having been so far grasped, the whole of the rest of the equipment was not designed to match with three-phase motors, instead of introducing the complication of rotatory converters to work continuous-current motors. Time alone can show how the mixed system adopted will work in practice. To me the choice of the mixed system appears of doubtful wisdom. Perhaps the distinguished engineers who are understood to be spending £30,000 on experiments for the Metropolitan Railway to enable them to recommend the best system for our inner circle underground line will shortly be able to report whether a simple three-phase system throughout is, or is not, more economical than either a continuous-current system throughout or than a mixed system with converters. If they do not settle this question, which is to-day the one important question in electric railway work not yet settled, we must regard the expenditure as pure waste.

Returning to the question of electric tramways, the problem of the hour is the equipment of busy city thoroughfares where for obvious reasons overhead wires are inadmissible. To all the three possible methods that dispense with overhead construction—viz, by accumulators carried on the car, by use of slot conduits in the road, and by use of surface contacts objections are not wanting. Accumulators are found too heavy and too short-lived to be satisfactory. Conduit constructions are objected to as too costly, and as interfering too much with the roadway; while to surface-contacts there is brought the terrible indictment—worse than any against the conduit—that nobody has had experience of them. You are aware that in this question of surface-contact systems of tramways I am an interested party, and cannot be expected, even in a presidential address, to speak dispassionately. Yet you have never expected your President to banish from his inaugural address the topics to which he has devoted his thoughts, his energies, his time, or his resources. And with the examples before me of other presidents who have spoken of their own work, I take the liberty of speaking of mine. A Paper dealing with some aspects of surface-contact working was read by me at the Bristol meeting of the British Association, and in January last you listened here to a Paper on some other points by

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Mr. Miles Walker, my former assistant, and partner in this matter. We have, indeed, worked out several different systems, of which the earlier only have yet been publicly described. We are at work on modified plans, the result of our experience gained on our short experimental line at Willesden; and before long we expect to demonstrate the advances we have in hand. Meantime we are not alone in the field. Since the time when the late Dr. Hopkinson proposed his original plan, many others, including Mr. Wynne, Mr. Holroyd Smith, Mr. Esmond, and Messrs. Johnson and Lundell, have suggested various new methods. Three years ago Dr. Hopkinson wrote of one of these methods that he "would not hesitate to approve its adoption in any town in which overhead conductors were inadmissible;" adding that he had "not the least doubt that it would work thoroughly, effectively, and safely." A good deal has happened since then, and much experience has been gained. But there remain not only in London, but in many provincial cities, crowded thoroughfares where overhead construction is absolutely out of the the question, and where a slot-conduit would be almost equally objectionable. It is some years since Mr. J. Love equipped slot-conduit lines in Washington and Chicago. It is now most significant that in three great capitals—New York, Berlin, and Paris—the electric tramways are being largely extended without overhead wires. New York and Berlin are putting down slot-conduits; New York most expensively, as if the object were to put as much cast iron as possible into the roads; and the conduit at every 15ft. is furnished with pairs of hand-holes, the covers of which interfere with the surface quite as much as any surface-contact system, to say nothing of the interference of the central slot or of trouble about drainage. In Paris, on the other hand, where a tentative surface-contact system has for about a couple of years been tried with moderate success, no fewer than 63 kilometres—about 48 miles—are now being equipped by Mr. Diatto on his surface-contact plan which has been in successful operation on a small scale at Tours. Surely, then, if a method of surface contact can be shown which is at once simple, safe, and not too expensive, there is every reason to urge on engineers and municipal authorities its adoption. Thanks to the criticisms—some of them passed in this place—with respect to possible difficulties likely to arise from the use of underground coils, from mercury switches, and from surface leakage around the contact studs, improvements have been worked out which largely, if not wholly, remove the fears that have been expressed on these grounds. As contrasted with the conduit, a surface-contact system has the advantages of much lower prime cost, of less interference with the roadway, and of not requiring any drainage arrangements. On long lines that run out into the country it can be operated with the same cars that carry trolley-poles for use in the suburban part of the track. Those cities and towns which, like London, Birmingham, and Cambridge, have waited before erecting overhead lines, will have justified their waiting attitude when they can point to examples of the successful surface-contact roads at Monaco, at Tours, and lastly at Paris.

Time forbids me to dwell further upon this topic; it precludes me likewise from entering upon a number of other topics of great interest, such as the development of the single-phase motor; the establishment of electric time-services by synchronised dials throughout buildings, blocks of offices, or whole municipalities; the use of prepayment meters; the recent developments of electrometallurgy; the revolution in chemical manufactures by the use of electric methods; the use of aluminium wires in place of copper wires as conductors; and, last but not least, seeing that Atlantic liners can now signal their presence when 50 miles from port, the progress of telegraphy without communicating wires. In all these many directions there may be noted pronounced tendencies toward development along distinct lines of progress, and some of these topics will doubtless form the subjects of discussion at our meetings during the session now beginning. I venture also to express the hope that the question of the distribution of electric energy on the large scale may be brought before our members for discussion. Nothing can be more helpful to the industry generally, just at present, than the free discussion of a topic which is likely again to engage the attention of Parliament, and which ought to be discussed from the standpoint, not of restricted parochial or municipal interests, but of its bearing on the wider interests of national and public economics and of the industry at large.

In commemoration of the centenary of the discovery of the pile by Alessandro Volta in 1799, the city of Como, his birthplace, has this year held high festival. Beyond contest this discovery of a means of generating chemically a steady electric current constitutes the starting-point of the entire modern development of the science of electricity. Though that modern development turns upon the subsequent discoveries and inventions of others—the discovery of the magnetic properties of the current by Oersted, the invention of the soft-iron electromagnet by Sturgeon, the discovery by Faraday of the fundamental principles underlying the dynamo and the transformer, together with many others of lesser moment—it still remains to be true that to the genius of Volta we owe the initial impulse. His memorable letter of June, 1800, to Sir Joseph Banks, first describing the pile, marks the opening of a new epoch in the history of civilisation. Without that discovery, we should now possess, neither telegraph nor telephone, neither electric light nor electric power, and electrotyping and electroplating would not exist. Commerce, diplomacy, warfare, and journalism would have remained in a totally different stage of development from that in which they are to-day. In brief, we should—with the modifying circumstances of the steam engine existing for power and the gas-jet for light—be still living in the stage of civilisation of the eighteenth century.

The Volta centenary was commemorated at Como by the erection of an exhibition and the holding of a series of celebrations. Unfortunately, the exhibition was destroyed on July 9th by a calamitous fire, in which not only a fine collection of modern electrical machinery was destroyed, but a number of Volta's original manuscripts and a considerable part of his historical apparatus perished. Happily the original pile and numerous other relics were saved, and are now enshrined in the Civic Museum of Como. Nothing daunted, the citizens of Como reconstructed their exhibition, which was reopened in 42 days. Amongst the Como celebrations were held two Congresses: one a Congress of Telegraphists, in June; the other a Congress of Electricians, in September. No invitation to send delegates to the former was received by this Institution, and neither it nor the British Post Office was officially represented. Four English telegraphists, none of them members of this Institution, were reported as having been present. This Congress, having been convened by the Italian Minister of Posts and Telegraphs, and being attended by official delegates of various European Administrations, many of them telegraph engineers of the highest distinction in their various countries, it is extraordinary, to say the least, that the English Postmaster-General was not represented on the occasion. The Congress of Electricians was organised by the co-operation of the Physical Society of Italy, of which Professor Roiti of Florence is President, and of the Italian Association of Electrical Engineers, which has branches in Milan, Turin, Genoa, Rome, Naples, and Palermo, and of which Professor the Hon. Giuseppe Colombo is President.

At this congress, at which distinguished electricians from France, Germany, Holland, Switzerland, and Finland were present, this Institution was represented by Prof. Ayrton, past President, and by myself. The Italian physicists and electrical engineers attended in great force. The proceedings of the congress were carried on with great vivacity, and many matters of the highest scientific and technical importance were discussed in its various sessions. After the sittings were concluded, two days were devoted to visits to the large generating stations at Paderno and at Vizzola: the former taking power from the river Adda (which flows out of the Lago di Como), and supplying electric current for transmission at high voltage to the city of Milan; the latter, not yet quite completed, taking water from the river Ticino, which drains the Lago Maggiore, and distributing its currents to the industrial towns of Gallarate, Legnano, and Somma Lombardo, within a radius of some 25 miles. Alike from the point of view of electrical and hydraulic engineers these stations are of the highest interest, presenting as they do special features different from those of almost all other kindred enterprises. Our Italian brethren may well be proud of the engineers who have found the solutions for these special problems of construction, and carried those solutions to practical success.

This year is also marked by the establishment, with a Government grant, of the National Physical Laboratory for the standardising and certification of scientific instruments, and for physical research on well-defined lines. Though thus commenced on a modest scale, the circumstance marks an event of national importance.

I cannot forbear to direct your attention to another matter of public interest, and one which exercises an influence on all attempts at developing new enterprises. It is only too notorious that the whole question of financial development of new inventions is in this country in a most unsatisfactory state. The promotion of joint-stock companies under the Limited Liability Acts has become a public scandal. In the eighties a heavy blow was given to the real progress of electric lighting by the reckless promotion of bubble companies with inflated capital, causing the loss of millions of money upon foolish and worthless schemes. In the year 1882 no less a total than £23,000,000 of nominal capital was registered in electrical company schemes alone. In the nineties a similar reckless speculation has been witnessed over bicycles and automobiles. Happily electric traction has largely escaped this curse; and it will be an evil day for any of the newer developments of electrical engineering if a like craze should overtake them. There is something amiss in our economic machinery when such scandals can recur. Nothing is more familiar to those who have to deal with new inventions, or to those who as consulting engineers have to advise and report upon them, than the ever-recurring difficulty of getting them financed on a sound basis. Suppose that there is an invention of a thoroughly sound character, properly protected by patents, but requiring time and money to establish itself commercially. Suppose that there is required a capital of from £10,000 to £25,000 to put it upon a commercial basis. In the present

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state of public finance in this country the inventor finds himself in this difficulty. He must either raise the necessary capital privately by personal effort amongst his own friends, or he must put it into the hands of a promoter who will want to bring it out with a capital of at least £100,000. In other words, it is almost impossible to find a middle course between a purely private affair and an over-capitalised swindle. We have, unfortunately, in this country no organisation corresponding to the industrial banks of Germany, to the enlightened management of which the financing of sound schemes on a moderate scale can be entrusted. Much more might be said on this topic. It is one which affects not our industry alone, but it affects ours perhaps more than any other industry, because the glamour which is attached in the public mind to everything and anything electrical is made use of by the unscrupulous financier to the detriment of honest promotion.

I have already alluded to the sums of money which have been invested in this country in the supply of electricity for lighting and power, and in electric traction. According to Mr. Garcke's invaluable "Manual of Electrical Undertakings," from which I derive my figures, the aggregate subscribed capital in shares and debentures at the present date stands as follows :—

Telegraphs	£31,284,957
Telephones	7,729,626
Electric supply (companies)	9,265,793
,, ,, (municipalities)	8,531,167
Electric traction	20,808,959
Electric manufacturing	16,799,152
Electrochemical and miscellaneous concerns	8,558,065
Total	£105,997,716

This hundred millions of subscribed capital is much less, it is true, than that represented by the total capital invested in railways or in many other domains of British industry. But it is this electrical industry and the scientific and professional elements associated with it which our Institution represents to-day. Competing as we have to do not only in foreign and colonial markets, but even in our own home markets, with the manufacturers and engineers of other countries, it behoves us to do all we can to make our Institution of use to our members of all grades, and particularly to our younger members. One great duty which we owe to them is to furnish them with the latest information as to the progress of electrical development, the development not only of industrial undertakings, of new machinery, of new materials, and of new inventions, but also of pure science, upon which all technical developments are in truth based. From the very first of our existence—1872—we have always issued, in our *Journal of Proceedings*, abstracts and extracts of scientific and technical papers published at home or abroad. Two years ago we joined with our colleagues of the Physical Society in bringing out in the monthly numbers of *Science Abstracts* a far more complete digest of electrical progress than we were previously in a position to produce. To carry on this publication both we and the Physical Society have had to devote considerable sums; and indeed, one of the reasons why we had a year ago to raise the fees paid by our students was avowedly to meet the financial burden which we had thus assumed for the purpose of disseminating knowledge. I venture to think that every penny thus spent has been a most wise outlay, and one of which we are already beginning to reap the fruits. Our members all over the country and in distant lands are thus kept informed month by month of the progress of the science, and they increasingly appreciate their connection with the Institution. I know of no means better calculated to keep our younger men abreast of the times than by putting into the hands of every one of them this admirable compilation.

But the needs of our Institution do not end with the effort to keep our members informed of the progress of science. We have other demands upon our funds of a very pressing character. The benevolent fund established a few years years ago upon an independent basis has, though small, been available for helping necessitous members. In this connection every member of the Institution will rejoice to learn of a great and generous offer which has just been made to us. One of our honorary members, Mr. Henry Wilde, a name memorable as that of the pioneer in the sixties of the early forms of dynamo machine, both continuous and alternating, and of their application to lighting, to deposition of copper, and to the transmission of power, has offered to the Institution, and the council has accepted, a sum of £1,500 for the purpose of constituting a benevolent fund. I need only mention this to secure your cordial acknowledgment of the great generosity of Mr. Wilde, whom two years ago we elected an honorary member in recognition of his claims on the electrical community.

From the very beginning we have been accorded by our generous hosts, the Institution of Civil Engineers, the privilege and advantage of holding our meetings in this hall. If some of us feel that with the rapid growth of our own body the time is coming when we ought to be taking active steps toward providing ourselves with a home of our own, it is not because we are not deeply grateful for that privilege. Nay, rather the circumstance that our growth compels us to contemplate this step is a perpetual reminder of the courteous generosity which has itself been no small factor in promoting our welfare and our increase. The founding of our building fund six years ago was due largely to the foresight and fostering care of our then treasurer and Vice-President, Sir David Salomons. At his instigation we have annually set aside such sums as we could spare from our surplus income, and our nucleus of a building fund stands this autumn at £5,000 so accumulated. The council has for some months been quietly prosecuting inquiries for a suitable site; and it has recently decided to issue a circular drawing attention to the building fund, and suggesting to members of all grades the expediency of subscribing for the next few years an annual contribution thereto. If by this means we can treble or quadruple our present fund, we shall be ready at least to begin to build when a suitable site shall have been found. And it is most earnestly to be hoped that the generous example of Mr. Wilde will stimulate others of our wealthy members to rival his gift by valuable donations to the building fund.

Finally, I would speak of the growth of the Institution itself. From a total membership of 110 in 1872 we have increased, as the accompanying table shows, to a total of 3,254 at midsummer, 1899, and the statistics show clearly that the rate of increase is itself increasing. In the establishment of the new class of associate member we think we have secured a new element of strength. With the growth of total membership has come a new movement for the grouping of our provincial members in local branches. The council has appointed a committee to organise these; and already preparations are on foot for constituting two local centres in the North, and another in Ireland; while our South African members have already constituted themselves informally into a local branch, holding meetings in Cape Town, which will shortly be officially recognised under our new articles of association. All these are signs of active progress The novel departure made last summer, when the council sanctioned the suggestion of an official visit to Switzerland, has already borne fruit in many ways. The Swiss tour brought together many of those who, though active members of the profession, cannot often attend the ordinary meetings in London. It not only enabled us to see what Swiss engineers are doing; it brought us into the most pleasant personal touch with our able and courteous Swiss *confrères*, and it procured for us an invitation to pay a similar visit to Germany at a date in the near future. But, best of all, it has, I think, enabled some of us to realise more fully than we did before the value of our connection with our own Institution of Electrical Engineers; it has taught us what the power and usefulness of our Institution may be; and it has knit us together and inspired us to do what we can to promote its prosperity and the prosperity of the great industry which it represents. In this spirit, and with the note of progress sounding in our ears, let us carry on the work of the session now opened.

THE COST OF STEAM RAISING.*

BY JOHN HOLLIDAY, ASSOC.M.INST.C.E.

(Concluded from page 162.)

We have now to consider the other items already mentioned, which go to make up the full cost of steam raising. The most important of these is working expenses, and in this labour is the heaviest. Under normal conditions seven boilers are under steam—viz., Nos. 1, 2, and 3 fired with breeze, and four of the other six fired with Welsh coal. As the boilers are worked continuously, the firemen are divided into three shifts, of which the two day shifts work three spells of three hours each between 6 o'clock a.m. and 10 p.m., and the night shift one spell of eight hours; thus for two hours in the day both sets of the day men are in the house together, and in this time some of the necessary cleaning, &c., is done. There are generally three men per shift, the two leading men taking three and four boilers each, and the third man assisting each of them as required. Taking the amount burned in 24 hours as 15 tons of breeze and 18 tons of the Welsh coal, the total amount fired per day is 33 tons by the nine men, or an average of 3·67 tons per man per day, not an excessive quantity when compared with the new Board of Trade rule for ships, which allows one stoker for every 4½ tons burned per day; but the low quality of the fuel used on the Perret furnaces adds greatly to the labour of firing them, each of the six having to be cleaned out once in three hours or oftener. The firemen are paid at an average rate of 23s. per week, those working at night getting a shilling extra whilst doing so; they are under the charge of a foreman, who, however, has other duties to perform, so that a portion only of his time is charged against the boilers. A charge at the rate of £150 per annum is also made for the time

* Paper read before the Institution of Electrical Engineers, November 23rd. Slightly abridged.

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which the engineer-in-charge devotes to this portion of his work. A boy is also employed for a portion of the day in the boiler house in sweeping the tops of the boilers, &c. The expense of weighing the coal, and any incidentals connected with its receipt over and above the price paid for it per ton delivered, is included in the working expenses; these being the same per ton for all qualities of fuels, constitute a heavier expense per 1,000 gallons of water evaporated by the inferior as compared with the better-class fuels.

During 16 hours, between six o'clock a.m. and ten o'clock p.m., which constitute the only light portion of the week's work, two boilers are kept under easy steam, the fires in the others being cleaned quite out in the morning and started again at night. The firing during Sunday is done by three men, working two of them five hours and one six hours, for which they are allowed time and a half; whilst a second fireman works two or three hours in the evening as required, in order to re-start the boilers that have been at rest during the day.

Flue sweeping and boiler cleaning is the item next in importance. The boilers using the inferior fuel are very thoroughly cleaned out at the end of each 11 or 12 weeks' run, during which time they have generally steamed from 1,600 to 1,700 hours each and have deposited in their flues a very large amount of dust, which, but for the forced draught, would require to be removed much more frequently; as it is, there is certainly a falling off in the amount of water evaporated both per boiler and per pound of fuel burned, but not to such an extent as would justify the shutting down and cleaning of these three boilers five times a year instead of four, as at present. This cleaning is performed, not by the firemen, but by some of the general labourers attached to the concern; two men are able thoroughly to sweep and clean one boiler in four days, and in addition to their regular wages they are paid a gratuity of 12s. per boiler. In addition to the actual cleaning and removal of dust, some expense is incurred in taking out fire bars, disconnecting air pipes, cleaning bars, &c., all of which are carefully overhauled at each periodic cleaning.

The natural draught boilers, fired with better-class coal, run for about the same length of time between cleanings as the forced draught ones, but as there are generally two of these idle, each boiler is cleaned only from three to four times a year; two men can finish a boiler in two days, and in addition to their wages of 5½d. per hour they earn between them the gratuity of 12s. for the job. Each cleaner is provided with a suit of overalls, which seldom serves for more than four boilers at the most. The expenses of cleaning out one of the natural draught boilers is far less than that of one of the forced draught boilers fired with inferior fuel.

The removal of refuse—viz., clinkers and ashes taken from the furnaces in the ordinary way of firing, and the dust removed from the flues during sooting out—amounts to a considerable sum during the year: the bulk of it is removed from the premises by a contractor at a fixed rate per load, but since an intermediate handling is necessary, the removal of an average week's refuse from the forced draught boilers during work costs about £2, and the amount removed from the flues at each cleaning about 11s. 6d. per boiler; whilst that from the natural draught boilers is removed for 16s. 6d. per week whilst in full work, and 4s. 6d. per boiler cleaned. The feed heaters being common to both groups of boilers, the cost of cleaning them and the feed pumps is taken according to the quantity of water evaporated in each group. The water used is taken from the town main through meters, the cost being fourpence per thousand gallons; and as it is very pure, there is no expense incurred in treating it except for the addition of a small quantity of soda ash, which is necessary to prevent corrosion.

The cost of illumination is divided amongst the boilers according to the number of boiler hours worked; gas and electric light are both used—the annual cost is about £50. In the same way also the cost of the steam used to drive the boiler feed pumps is divided according to the quantity pumped, but in the case of the forced draught boiler a further charge has to be made for the steam used by the fan engine in producing the forced draught. The quantity of fuel to be charged against feeding the boilers is, however, very small, as a very large portion of the heat in the exhaust steam is recovered by passing the exhaust into the low-pressure main by which the feed water is heated. Some experiments have shown that by utilising the exhaust steam from the feed pumps to heat the feed water an economy of 1¼ per cent. in fuel can be realised. There are two quadruple-acting steam feed pumps, each capable of delivering one gallon per revolution, which also act as water meters, for which purpose they are fitted with counters which are read daily, whilst the pumps are calibrated periodically against a tank of known capacity to ensure correctness in the results; it is generally found that they deliver about 5 per cent. less than their full charge. A certain quantity of stores are of course used, such as shovels, firing-tools, barrows, soap, oil, waste, which in the course of a year amount to an appreciable sum.

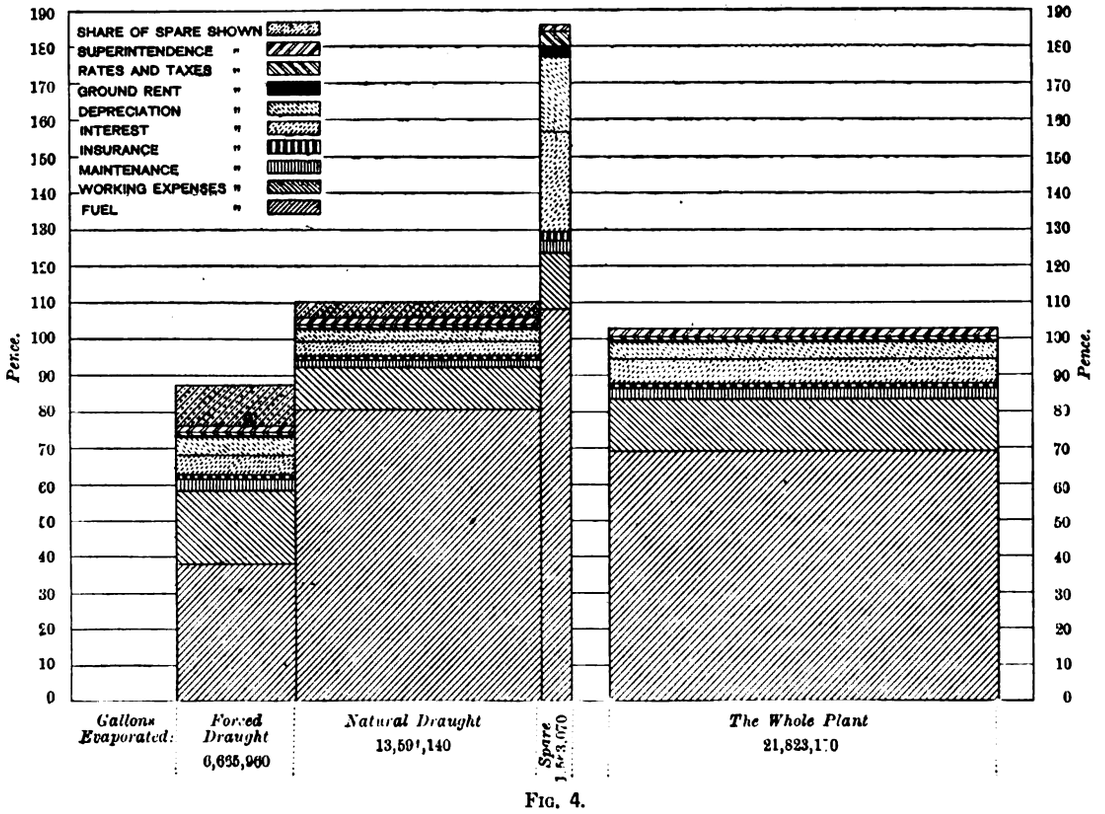

FIG. 4.

The maintenance charges are somewhat more difficult to set out precisely for any given period than are the working expenses, as these vary from time to time, and a year is quite too short a period to ensure every item being fairly treated; some parts will come out too high or too low, as repairs of any considerable extent happen to fall within or without the period under consideration. The figures given are those ascertained for the year 1895, and include somewhat heavy repairs to the pumps and heavy items for renewals of non-conducting coverings of tops of boilers and steam mains; but in order to avoid errors the costs have been compared with those of previous years, and though the details differ, the totals agree very closely. The figures for maintenance are considerably less than they were expected to be when the investigation was taken up, but as the work was mostly done by the company's own workmen, only charges for labour and material are included. Had the work been done by

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Table IV.—*Spare Boilers, Nos. 10, 11, 12, and 13.*

Boiler.		Fuel.			Feed water.		Cost of fuel.	Working expenses.																					
Date.	Time.	Coal.	Price per ton.		Refuse.	Evaporated.	Per hour per boiler		Wages.			Fu'lweigh'g &distributn			Removal of refuse.			Light.			Water.			Stores.			Total.		
1895.	Boil'r hrs	Tons.	s.	d.	Tons.	Gallons.	Gallons.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
January ...	...	...	...		...	...	...	...			...			...			...			...			...			...			...	
February...	53	23	13	0	2·3	33 600	63·4	16	5	0	0	10	9	0	1	11	0	4	7	0	3	7	0	11	3	0	0	9	1	12	10
March	87	23	13	0	2·1	30,912	35·5	14	19	0	0	18	2	0	1	11	0	4	2	0	3	0	0	10	3	0	6	9	2	4	3
April	34	10	13	0	1·0	13,440	39·5	6	10	0	0	7	1	0	1	2	0	2	0	0	1	7	0	4	6	0	0	10	0	17	2
May	188	58	13	0	5·3	77,052	41·5	37	14	0	1	19	2	0	6	5	0	10	8	0	7	0	1	6	0	0	3	8	4	12	11
June	265	65	13	0	6·0	87,360	33·0	42	5	0	2	15	3	0	4	6	0	12	0	0	4	0	1	9	1	0	4	7	5	9	5
July.....	251	67	13	1	6·1	90,048	35·9	43	14	6	2	12	4	0	7	5	0	12	2	0	3	10	1	10	0	0	3	3	5	9	0
August ...	683	188	13	0	17·3	252,672	37·0	123	4	0	7	2	5	0	19	5	1	14	8	0	11	10	4	4	3	0	2	6	14	15	1
September.	1,203	327	13	0	30·1	439,488	36·5	212	11	0	12	10	8	0	19	3	3	0	1	1	1	8	7	6	6	0	12	2	25	10	4
October ...	1,115	288	13	0	26·5	387,072	34·7	187	16	4	11	12	4	1	10	4	2	13	0	0	18	8	6	9	0	1	7	11	24	11	3
November..	446	112	13	0¾	10·3	150,528	33·7	73	0	2	4	12	11	4	18	5	1	0	8	0	11	3	2	10	2	0	14	7	14	8	0
December...	...	...	...		...	...	...	...			...			...			...			...			...			...			...	
Averages & totals	4,325	1,163	13	0⅛	107·0	1,563,072	36·1	756	9	0	45	1	1	9	10	9	10	14	0	4	6	5	26	1	0	3	17	0	99	10	3

Table V.—*Costs of Steam Raising.*

	Forced draught boilers. Water evaporated, 6,665,960 gallons.								Natural draught boilers. Water evaporated, 18,594,140 gallons.								Spare boilers. Water evaporated, 1,563,070 gallons.								All boilers. Water evaporated, 21,823,170 gallons.							
	—			Costs per annum.				Costs per 1,000 galls.	—			Costs per annum.				Costs per 1,000 galls.	—			Costs per annum.				Costs per 1,000 galls.	Costs per annum.				Costs per 1,000 galls.	
	£	s.	d.	£	s.	d.	%	s.	d.	£	s.	d.	£	s.	d.	%	s.	d.	£	s.	d.	£	s.	d.	%	s.	d.	£	s.	d.	%	s.	d.
Fuel bill	...			1,051	6	0	43·23	3	1·84	...			4,557	19	6	73·05	6	8·47	...			706	10	0	58·10	9	0·46	6,315	15	6	67·81	5	9·43
Other working expenses—																																
Wages of stokers, &c.	277	7	6	...			...		...	288	12	6	...			...		...	45	1	1	...			...		...	...			...		...
Fuel receipt	23	8	2	...			...		...	38	19	4	...			...		...	9	10	9	...			...		...	...			...		...
Removal of refuse	120	6	0	...			...		...	79	6	0	...			...		...	10	14	0	...			...		...	...			...		...
Water	119	8	6	...			...		...	226	7	8	...			...		...	26	1	0	...			...		...	...			...		...
Light	16	6	10	...			...		...	27	7	2	...			...		...	4	6	8	...			...		...	...			...		...
Stores	16	19	2	573	11	2	23·58	1	8·65	13	11	6	674	4	2	10·79	0	11·90	3	17	0	99	10	3	8·18	1	3·28	1,347	5	7	14·44	1	2·82
Maintenance—																																
Boilers and mountings	24	16	1	...			...		...	23	14	0	...			...		...	...			...			...		...	...			...		...
Furnaces and brickwork	21	7	0	...			...		...	36	7	6	...			...		...	...			...			...		...	...			...		...
Feed water heaters	4	9	11	...			...		...	8	9	8	...			...		...	...			...			...		...	...			...		...
Feed pumps	10	2	3	...			...		...	19	3	0	...			...		...	...			...			...		...	...			...		...
Fan and engine	3	7	9	...			...		...	...			...			...		...	...			...			...		...	...			...		...
Steam and feed mains	7	11	0	...			...		...	14	10	0	...			...		...	...			...			...		...	...			...		...
Non-conducting coverings	13	4	9	...			...		...	27	16	0	...			...		...	...			...			...		...	...			...		...
Sundries	4	1	0	83	19	9	3·66	0	3·20	7	14	11	137	5	1	2·20	0	2·42	...			39	15	9	2·52	0	3·84	227	0	7	2·76	0	2·82
Insurance—																																
Boiler (explosion)	7	17	6	...			...		...	15	15	0	...			...		...	11	10	0	...			...		...	...			...		...
Boiler house & contents (fire)	4	19	4	12	16	10	0·53	0	0·46	9	18	8	25	13	8	0·41	0	0·46	1	8	0	12	18	0	1·06	0	1·99	51	8	6	0·55	0	0·56
Interest on— [machinery																																
First cost of boilers and	113	0	0	...			...		...	149	0	0	...			...		...	100	0	0	...			...		...	...			...		...
First cost of boiler house &	52	10	0	165	10	0	6·89	0	5·95	95	0	0	214	0	0	3·91	0	4·31	75	0	0	175	0	0	14·39	2	2·87	581	10	0	6·27	0	6·43
Depreciation— [chimney																																
Boilers and machinery	113	0	0	...			...		...	149	0	0	...			...		...	100	0	0	...			...		...	...			...		...
Boiler house and contents	23	5	0	139	5	0	5·73	0	5·02	47	10	0	195	10	0	3·15	0	3·47	37	10	0	137	10	0	11·31	1	9·11	473	5	0	5·08	0	5·20
Ground rent	...			12	10	0	0·51	0	0·44	...			24	0	0	0·38	0	0·42	...			16	10	0	1·36	0	2·53	53	0	0	0·57	0	0·58
Rates and taxes	...			20	0	0	0·82	0	0·72	...			38	0	0	0·61	0	0·67	...			26	13	0	2·19	0	4·09	84	13	0	0·91	0	0·92
Superintendence	...			45	15	0	1·88	0	1·64	...			93	8	9	1·50	0	1·54	...			10	16	3	0·89	0	1·63	150	0	0	1·61	0	2·04
Share of cost of spare	...			322	14	11	13·27	0	11·62	...			249	4	6	4·00	0	4·46	...			...			...			...			...		
Totals	...			2,432	8	8	100·00	7	3·54	...			6,240	5	8	100·00	9	2·12	...			1,216	3	3	100·00	15	5·8	9,316	18	2	100 00	8	6·80

an outside firm, the figures must have been much higher, and the average cost of maintenance would probably have been 5 per cent. of the total, instead of less than 3 per cent. as they stand in Table IV.

The fixed charges include the insurance of the boilers against explosions at £2. 12s. 6d. per boiler per annum and it is worthy of remark what a very small proportion the cost of this excellent safeguard bears to the total cost of the steam made. In calculating the interest on the first cost of the plant and buildings it was found impossible to ascertain the actual figures, so a careful estimate was prepared on the basis of present prices, on which the interest has been taken at 5 per cent. per annum. Depreciation of boilers and machinery has been taken at 5 per cent. per annum, and of buildings, including chimneys, at 2½ per cent.; ground rent, rates, and taxes having been approximated to local conditions as far as possible, and superintendences in proportion to the amount of the steam made.

The question of spare plant is one of extreme difficulty, and the practice varies with each different case. In the case under notice it has been found that a spare plant of one boiler to every three in work is sufficient for all emergencies. This, of course, is based on the maximum and not on the average output of steam, consequently the spare plant has been comparatively very little used, but, as it exists, it has had to be kept in order, and as it is a recognised fact that a boiler idle may deteriorate as fast as one in work, it has been kept in complete working order, and worked occasionally. Of course, the cost of steam produced by these independent boilers is much greater in almost every way than that made in the main boiler house, as the statement in Table V. will show. The extra expenses of making this steam, over and above those of that made in each of the two groups in the main boiler house, have, in order to determine the full cost of the steam made in each, to be added to the ascertained expenses of those groups. It is, in the first place, difficult to decide what share of the expenses of the spare plant should be debited to each group of boilers in the main house; but, since the forced draught boilers were always worked when possible to their full fuel capacity, and had no self-contained spare as did the natural draught boilers, it has been considered right, in spite of their much smaller output of steam, to charge half of the extra cost of the spare to them, and the other half to the natural draught boilers.

The figures charged in Table V. as share of spare against the forced and natural draught boilers respectively have been determined thus: The quantity of water evaporated by the spare boilers is 1,563,000 gallons, at a cost of 15s. 5·8d. per 1,000 gallons; the difference in the cost of evaporating one-half of this—viz., 781,500 gallons at 15s. 5·8d. – and the same quantity at 7s. 3 3d., the cost of the steam made in the forced draught boilers, amounts to £322. 14s. 11d., or 11·62d. per 1,000 gallons on the quantity evaporated in the forced draught boilers. Similarly the difference in the cost of evaporating 781,500

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gallons at 15s. 5·8d, and the same quantity at provisionally 9s. 2·75d., amounts to £249. 4s. 6d., or 4·4d. per 1,000 gallons on the quantity evaporated in the natural draught boilers. Even if this distribution of the extra cost of the steam made by the spare boilers be heavier than it should be on the forced draught boilers, the figures will, all the same, show that a too large spare plant may prove an expensive luxury, quite apart from the fact that, unless kept in good working order and tried from time to time, it may fail in more ways than one when most required.

The author regrets that circumstances have compelled him to confine his observations to a type of boilers not so universal as was the case a few years ago, and which work at a pressure much below that now commonly used; but he ventures to hope that the figures may be of some use as a basis of comparison, and may perhaps elicit a more complete return from a thoroughly up-to-date plant. In conclusion, the author would express his thanks to the officials of the company who have allowed him to use the figures, but who have expressed the wish that their names should not be made public.

CORRESPONDENCE.

FOREIGN COMPETITION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: My attention has been called to a letter from the British Insulated Wire Co. on the subject of the Dublin United Tramways cable contract, which appeared in your issue of November 17th. This letter is not only a libel on Mr. Parshall, the consulting engineer of the Tramways Co., but it is an aspersion on the character of the directors, imputing, as it does, that they failed in their duty to their shareholders.

As chairman of the Dublin United Tramways Co. I took an active part in the settlement of all the contracts for the electrical conversion of the tramways, and I am perfectly familiar with the conditions under which the cable contract was awarded. The specifications and conditions on which the British Insulated Wire Co. and the National Conduit and Cable Co. tendered were identical, and the tender of the latter company was accepted because the price was lower and the guarantees better than in the offer of the British Insulated Wire Co., while any subsequent variations from the conditions in the original tender were made in the interest of the Tramways Co.

As the conditions included an indemnity against infringement of patents, the Tramways Co. were not interested in the results of the suit for infringement brought by the British Insulated Wire Co. and referred to in their letter. The success of the plaintiffs in this action was, I may mention, limited to a small portion of cable landed in Dublin before September 2, 1898, the date when their patent expired.

It is not true, as stated in the letter of the British Insulated Wire Co., that "the Tramways Co. loaned to the National Conduit and Cable Co. the services of their engineer (Mr. Parshall) to supervise the drawing in and jointing, so that this work, although carried out at the contractors' expense, had not been effected by him as provided for in the original specification." This work was, in fact, effected by highly skilled men under the supervision and direction of a representative of the National Conduit and Cable Co., who remained all the time in Dublin in special charge of this part of the work. Mr. Parshall and his representatives gave the same supervision and inspection to this as to every other part of the works, to see that they were done in an efficient and proper manner. The conduit and cable system now laid down in Dublin has completely justified our selection of contractors, who have performed their work efficiently and well, and from whom we got no delay in the opening of our traffic by electrical working.

I am astonished that a responsible body like the British Insulated Wire Co. should have been betrayed into publishing such reckless charges, especially as they have quite recent evidence of Mr. Parshall's impartiality, knowing that on his advice I accepted a tender from them, subject to guarantees, for cables amounting to over £10,000.

The general tendency in this country to municipalise tramways has tended to retard electrical development, as municipal bodies move slowly and only a very limited field was open for private enterprise. Under other conditions prevailing in America enormous strides have been made in this industry, and huge manufactures have sprung up to meet the demand, the extent of which is hardly realised in Great Britain. America has, in consequence, got a long way ahead in the manufacture of plant required for electrical installations. If British manufacturers are to make up the leeway, they will be more likely to succeed by learning from the larger experience in this business of their competitors across the Atlantic than by imputing unworthy conduct to honourable men, as a reason for their failure to obtain a contract in competition with American manufacturers.—Yours, &c.,

Dublin, Nov. 22. WM. M. MURPHY.

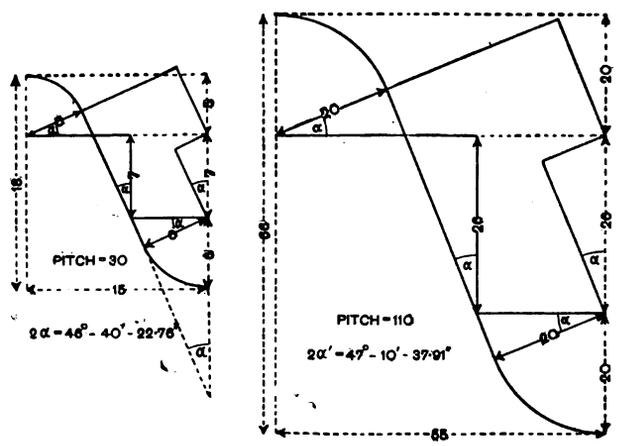
[Although dated November 22nd, the above letter was delivered by hand November 24th, after our issue of that date had been published.—ED. *E.*]

THE B.A. SMALL-SCREW GAUGE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I would venture to suggest that the difficulty with regard to manufacture of correct gauges for the British Association screws may not be one altogether of American *versus* British skill. The B.A. report of 1883-1884 stated that the Thury system of threads had an angle of 47½deg. The committee then practically adopted the Thury system, with the exception that the roundings at the tops and bottoms of the threads were to be in each case $\frac{2}{11}$ths of the pitch instead of being respectively $\frac{1}{6}$th and $\frac{1}{6}$th of the pitch, as laid down by Prof. Thury; this the committee said would maintain the angle of the threads the same—namely, 47½deg.

Now, if I have read the report of B.A. committee aright, firstly, the angle of the Thury thread is not 47½deg.; and, secondly, the alteration made by the B.A. committee neither maintains the angle the same as in the Thury system nor does it make the angle 47½deg.



If the threads be laid out as in the accompanying diagrams, the following equations can be obtained for the Thury thread:—

$$11 \sec \alpha + 7 \tan \alpha = 15,$$
$$15 \cos \alpha - 7 \sin \alpha = 11,$$

and from these $\alpha°$ can be shown to be 23° 20′ 11·38″. The angle between the threads is consequently 46° 40′ 22·76″.

For the B.A. thread we get the following:—

$$40 \sec \alpha + 26 \tan \alpha = 55,$$
$$55 \cos \alpha - 26 \sin \alpha = 40.$$

From these equations $\alpha°$ works out to be 23° 35′ 18·955″, and the angle between the threads becomes therefore 47° 10′ 37·91″.

Perhaps these differences have had something to do with the difficulties of the gauge manufacturers.—Yours, &c.,

Kingston, Jamaica, Nov. 5. BLACK MAN.

REVIVAL OF LAPSED PATENTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The *London Gazette* dated November 24, 1899, contains an advertisement of an intended application to Parliament by the Uralite Co. for an Act to reinstate or

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confirm Patent No. 5,254 (1895) granted to Imschenetzky for the "manufacture of fireproof and insulating compounds," which has been allowed to lapse owing to failure of the owners to pay the renewal fee thereon. As applications for private Acts of Parliament for dealing with such cases are not very frequent, a few facts in connection with them may interest your readers.

By Section 17 (2) of the Patents Act, 1883, patents lapse if the renewal fees are not paid within the prescribed time, but by (3) and (4) of the same section monthly extensions of time up to three months are granted on payment of suitable fines and if a reasonable excuse can be given. Previous to January 1, 1884 (when the Patent Act of 1883 came into operation), the only mode of reviving lapsed patents was by an application to Parliament, and mere inadvertence of the patentee constituted sufficient ground for the application. The above-mentioned extension of three months now covers such a ground, and there must be some solid reason for asking for the interference of Parliament. Since 1884 some of the successful grounds of application for reinstatement have included the following: (*a*) Serious and continual illness of the patentee, (*b*) original intention of the patentee to come within the International Convention, and in consequence the antedating of his patent allowed and fee taken as paid on the right date, (*c*) felonious and fraudulent conduct of patent agent. Unsuccessful grounds include (*a*) oversight on the part of the secretary of the company, (*b*) non-receipt of the patent agent's notice of fees due by the assignee.

The details of procedure to obtain a special Act are sundry, but the Standing Orders of the House must be complied with. Advertisement of intended application must be inserted in November, and the Royal assent is usually given, if at all, towards the middle of the following year. In consequence of the advertisements, fees to the House, and printer's bills, &c., obtaining an Act of Parliament for reinstatement is an expensive matter, costing roughly from £400 to £500.

We would add that Section 17 (4B.) provides that in an action for infringement of a patent committed after the failure to pay the tax within the prescribed time and before the enlargement thereof (by Act of Parliament), the court trying the case, if it shall think fit, may refuse to award or give any damages in respect of such infringements. If the patent is a very valuable one, a certain way to avoid all risk of failure to comply with the Act is to pay up at once the whole of the duties for the full term of the patent.—Yours, &c.,

J. C. CHAPMAN AND CO.,
Chartered Patent Agents.

London, Nov. 30.

DR. STIENS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I was glad to see Mr. Robertson's article on "Electrical Eyes" in your current issue, and also your leader on "Dr." Stiens, the self-styled inventor thereof. I had very much the same experience as Mr. Robertson when—some months ago—I called on Mr. Stiens with reference to his "inventions" in wireless telephony. He had absolutely nothing to show, and his "explanations" were utter balderdash.—Yours, &c.,

W. PERREN MAYCOCK, M.I.E.E.

Croydon, Nov. 28.

PUBLIC LIGHTING SYSTEMS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In an editorial on public lighting systems (*The Electrician*, October 20th) I notice that the enclosed arc lamp is referred to in a very disparaging way. In view of the opinions therein expressed, the status of the enclosed arc in public lighting systems in this country may be of interest. In an article in the *Electrical World and Engineer*, November 4th (clipping enclosed), I have presented a few enclosed arc lamp statistics, which speak for themselves. Trusting that the same will be of interest to you, yours, &c.,

L. B. MARKS.

New York, Nov. 14.

[Mr. Marks' article gives statistics of the number of enclosed and open arc lamps connected to the mains of 86 central stations in the United States. The total number of enclosed arc lamps in these stations in 1899 is given as 20,848, and the number of open arc lamps as 16,010. In the latter figure, however, it appears that the open arc series service in Brooklyn and the open arc series municipal service in San Francisco are not included. An estimate is also made that there are now in use in the United States about 150,000 enclosed arc lamps, of which more than half have been installed within the past two years, and that approximately 55,000 such lamps are in use in Great Britain and the Continent of Europe. Statistics such as these from comparatively few American stations, and apparently relating as much to private as to public arc lighting, are hardly relevant criticisms of the technical points raised in our article.—ED. *E.*]

ELECTRIC WIRING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Prof. Silvanus Thompson in his presidential address refers to the question of electric wiring and the importance of keeping down its first cost. You also refer to the matter in this week's issue of your paper. Prof. Thompson is of opinion that this reduction in cost is to be effected by adopting an uninsulated return wire.

As I patented a system on these lines some seven years ago, and have continuously adopted it in all installations which I have carried out since then, the publication of the experience gained during this period may perhaps be of advantage at the present time. The system was first introduced by me in the lighting of Hollycombe for Mr. J. C. Hawkshaw in 1892, after having obtained the sanction of Mr. Tarrant, inspector of the Sun Fire Office. The installation was at first only for some 250 lights, but has since been extended to over 600. Mr. Tarrant himself made an exhaustive inspection, and subsequently expressed his approval in the strongest manner. Fortified by this opinion, I have never had any objection raised by any insurance company, although some 200 houses have now been wired by this system. At Fort William also, where some 5,000 to 6,000 lamps have been wired by the same method, the result has been entirely satisfactory.

Major Cardew, when inspector to the Board of Trade, made an examination, and after taking sundry tests also gave his approval and passed the arrangements adopted. I was curious at the time to know what form these tests would take; and Major Cardew explained to me that the question concerning which he wished to satisfy himself related to the possible existence of a difference of pressure between the earthed electric conductor and other neighbouring earths, such as gas or water pipes; which difference of pressure, if present, might cause trouble from electrolysis. On testing, however, no such effect could be detected to any appreciable extent, and all objection on this score was removed.

I think, therefore, that, having been found satisfactory and passed by the Board of Trade and the insurance companies, and having also endured the test of years, I may claim that my earthed water-tight system may now be adopted with confidence.

With regard to the saving of cost, experience shows that on an average this may be taken from 4s. to 5s. per lamp wired. There are other subsidiary advantages which I need not dilate on now, such as a decrease in the time required to carry out the work of wiring and the absence of damage to walls, ceilings, and decorations. Prof. Thompson would like the cost of wiring to be reduced to that of putting in gas pipes. This is no doubt desirable, but at the same time the comparison is hardly a fair one. It must be remembered that the electric wiring of houses is far more complete than the usual system of laying gas pipes. For instance, numerous switches are placed in convenient positions, and fuses and main switchboards have also to be provided. If these conveniences and safety appliances were omitted, and the wires taken straight off the mains, then the cost of wiring would not greatly exceed that of fixing pipes for gas. On the other hand, if this plan were adopted the advantages and safety ensured by the adoption of the electric light would be greatly minimised.—Yours, &c.,

R. FREDERICK YORKE.

Glasgow, Nov. 28.

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LEGAL INTELLIGENCE.

River Plate Electric Light and Traction Co.

In the Chancery Division last Friday Mr. Justice North heard an action, Guinness and another *v.* the River Plate Electric Light and Traction Co. (Limited).

Mr. VERNON, for plaintiffs, said the company had issued £150,000 of debenture stock and £50,000 of second debentures. The principal and interest had not yet become payable, but plaintiffs were desirous of enforcing their debentures, and they now moved for the appointment of a receiver and manager on the ground that the company's creditors were pressing for payment and the security was in jeopardy. The company had no funds wherewith to pay its debts or to pay the current expenses of carrying on its business, and it was impossible for the company to obtain such funds.

The company offered no opposition, and his lordship granted the application, but directed that the receiver and manager should not act for more than four months without the leave of the Court. He was, however, to act at once upon the plaintiffs undertaking to be answerable for his security and also upon the receiver's own undertaking to complete his security forthwith.

Brown v. Laing, Wharton and Down (Limited).

This case came before Mr. Justice North on Saturday, on a motion by second debenture-holders asking for judgment. The first debenture-holders were not parties to the action, as they were, it was said, content to rely upon their security, which they considered to be ample. The company consented to judgment. A receiver and manager was appointed by Mr. Justice Darling in the Long Vacation, and plaintiffs now asked that he should continue to act, as there were a number of contracts pending.

His lordship gave judgment as asked, and continued the receiver and manager.

National Telephone Co. (Limited) v. Commissioners of Inland Revenue.

In the House of Lords, on Tuesday, before the Lord Chancellor, Lords Macnaghten, Brampton, and Robertson, this appeal was heard. It raised the short question whether an agreement between the appellant company and one of their customers ought to be stamped with an ordinary sixpenny agreement stamp or, as the Commissioners insisted, with an *ad valorem* stamp of 7s. 6d., on the ground that the agreement came within the words "Bond, covenant, or instrument of any kind whatsoever," within the meaning of the first schedule to the Stamp Act, 1891. Justices Grantham and Channell, in giving judgment in the Divisional Court on Dec. 14, 1897, found in favour of the Commissioners. The case for the Commissioners was that on Feb. 10, 1897, an instrument was presented on behalf of the National Telephone Co. (the appellants) to the Commissioners under the provisions of Sec. 12 of the Stamp Act, 1891, for the opinion of the Commissioners as to the stamp duty with which the instrument was chargeable. The instrument (which was dated March 9, 1886) stated that one Samuel Ridley agreed with the South of England Telephone Co., head offices, 50, Old Broad-street, London, to pay £12 per annum in advance, from the date of the fixing of the telephone wire and apparatus, for the use of a private wire between 155, North-street, Brighton, with the South of England's local exchange system in Brighton.

Mr. ASQUITH, Q.C., and Mr. ROSKILL, for the appellants, contended that a security must be something collateral to an agreement to come within the words "bond, covenant, or instrument," otherwise any agreement, such as the hiring of a carriage for a month, might be chargeable with an *ad valorem* stamp.

The LORD CHANCELLOR said the appeal must be dismissed, with costs. This was a taxing Act, and must be construed strictly. But the words had been made as comprehensive as possible, and clearly included the present case. Otherwise anyone who wished to escape taxation would choose a form of instrument by which they could do so and could avoid executing a document under seal. This was clearly an instrument of the character which the Legislature intended to tax on an *ad valorem* scale, and the judgment below must be affirmed.

Repair and Maintenance of Tramway Routes.

In the Dublin Southern Police Court last week the summons issued by the Corporation against the United Tramway Co. for neglecting to keep their portion of the streets in good condition and repair was resumed. A fortnight ago (as reported in our issue for Nov. 17) the case was allowed to stand over, to see if some arrangement could be come to between the parties.

Mr. GORDON (for defendant company) now stated that no arrangement had been arrived at. It was reduced to a question of law. The question of fact applied to the state of the setts when they were put down by the company under the supervision of the Corporation and their state afterwards.

Mr. O'SHAUGHNESSY (for the Corporation) said the laying down of the roadway was one question and its maintenance was another. Whatever was laid down must be kept in such a condition that it was neither a danger or annoyance to the public and to vehicular traffic.

Mr. GORDON said it was not admitted that re-dressing of the setts was an effectual remedy for slipperiness. The setts became slippery a week after they had been put down. Sec. 1 of the Act stated that if the company did not do the work, the Corporation could do it on giving 48 hours' notice. This could not apply to sanding, as after 48 hours the streets might become muddy, when it would not be necessary, and when the streets were slippery it was necessary that it should be done at once. The slippery nature of setts was inherent, and these setts were laid under the supervision of the Corporation. They could not take them up and re-dress them every few days.

Mr. O'SHAUGHNESSY said the offence was an offence by the fact that the streets were not kept in proper order. The 48 hours' notice was to prevent the inconvenience of the Corporation taking possession of the tramlines.

Mr. GORDON said another section of the Act directed that snow should be removed by the Corporation, although the company had agreed to remove it. It was the state of the weather which caused the slipperiness. Snow was a condition of weather. The Corporation did not sand the setts which had been laid down for 15 years, but they asked the company to sand setts which had only been laid down 15 weeks.

Mr. O'SHAUGHNESSY said the company were responsible if the streets were slippery and dangerous to the public, no matter from what cause it arose.

Mr. FITZGERALD MURPHY (also for defendants) said, if it was admitted that the pavement became slippery from wear or sinking, then the company would be liable; but if the slipperiness arose from something inherent in the pavement, then they would not be liable. They admitted there was a danger to the public and that sanding was necessary, and the question was who was liable for the expense. It was for the Board of Trade to decide whether the company were to carry out the sanding or not, and if the Board decided they were, the Corporation should ask for a penalty. It cost the company £700 a year to sand the streets.

Eventually the magistrate (Mr. Swifte) reserved judgment.

Skewes v. Coode and Another.

This case came before the Lord Chief Justice and a special jury yesterday (Thursday), and was brought to recover £150 paid to the directors of Veale and Co. (Limited), electrical engineers, of St. Austell, Cornwall, upon the promotion of the company and the offer by circular of an allotment of shares. It appeared that plaintiff applied for 150 shares and forwarded a cheque for £150. The shares were not allotted, but the plaintiff alleged that the money was used by the company for its own purposes, and that no allotment of shares having been made—that being the object of the remittance—the money should have been returned. The defence was that the money was not paid to the defendant company, but to the bankers, and that it was paid, if at all, to the defendants as agents. In the alternative the defendants said that before the withdrawal of the plaintiff's application for shares in the company of Veale and Co. (Limited) the money sought to be recovered was paid by the authority of the plaintiff to Veale and Co. (Limited). The company went into voluntary liquidation on Sept. 23th last, and the plaintiff now sought the return of his money.

His LORDSHIP said that he thought that the proper ending of the case would be the withdrawal of a juror. If the directors were in a position to allot shares when they sent out the circular and the plaintiff applied for the shares he did not see how the plaintiff could proceed against the present defendants.

A juror was then, by consent, withdrawn.

Milver Portable Electric Battery Syndicate (Limited).

Mr. Justice Wright, on Wednesday, was informed by counsel that the debt against this company had been paid, together with a sum for costs, and that, as there were no other creditors, it was asked that the petition might be withdrawn.

His LORDSHIP: You do so at your own risk.

Order accordingly.

ELECTRIC LIGHTING, &c., IN THE CITY OF LONDON.

At yesterday's meeting of the Court of Common Council the Streets committee reported as to applications from the Postmaster-General for permission to open all the main thoroughfares in the City for the purpose of laying conduits and providing manholes for access to the same, in pursuance of the Telegraph (Telephonic) Communication, &c., Act, 1899, and recommended that no objection be offered to the public ways being disturbed as proposed, subject to the usual conditions, but that the Postmaster-General be informed that the Corporation is seeking Parliamentary powers to enable it to construct public service works for the accommodation of electric lighting, telegraphic, telephonic, and other electric cables and wires, &c., under the public ways of the City, and to compel (on such terms and conditions as may be prescribed in the intended Act) the removal into such works of all cables, mains, wires, and pipes already laid under the streets.

This was agreed to, and a similar notice was given to the Charing Cross and Strand Corporation.

The committee has ordered electric meters for the offices of the Public Health Department at £19. 5s.

With regard to the amount of salary that should be allotted to Mr. A. A. Voysey as electric inspector under the City of London Electric Lighting Order, 1899, the committee recommended that his salary should be increased from £250 to £500 per annum as from Michaelmas last, and be apportioned as under: £200 per annum as inspector under the City of London Electric Lighting Orders, 1890 and 1891; £200 per annum as inspector under the City of London Electric Lighting Order, 1899; £100 per annum for his services as electrical engineer.

This was opposed by Mr. MORTON, on the ground that the increase was excessive, and he moved as an amendment that the salary be increased from £250 to £300.

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Mr. Deputy MALTHOUSE seconded.

Mr. C. T. ALGAR (chairman of the Streets committee) said, if the Court fixed the salary under 1899 Order at £200 a year, he was sure the Charing Cross Co. would agree to pay that sum, and therefore the increase to be paid by the Court would be only £50, and Mr. Voysey was well worth that advance. The electrical inspector's duties commenced immediately the undertakers started their work, and from that time the company were liable for the salary. Moreover, Mr. Voysey had done a great amount of work quite outside his duties, had prepared no less than 154 reports since his appointment five years ago, and had rendered valuable assistance to the committee and the officers of the Corporation.

A ballot was taken, and the amendment was carried by 85 against 63.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week*]

NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers, or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London:—

NOW READY.

"The Electrician" Electrical Trades' Directory and Handbook for 1899.—The *Second Edition* of the "Big Blue Book" for 1899 is now ready. The volume contains the large Sheet Tables of Electricity Supply Stations and Electric Railways and Tramways. The price of the Directory and Handbook is now reduced to 5s. post free 5s. 9d.; abroad, post free, 6s. 6d. (United States 7s. 6d.).

TENDERS INVITED.

The *Rathmines* and *Rathgar* (Co. Dublin) Electric Lighting committee invite tenders for additional feeding and distributing mains, including trenching, troughing, cables, joint boxes, jointing and house services. Further particulars are given in an advertisement, and specifications, &c, may be obtained at the offices of the consulting engineer (Mr. Robert Hammond), 64, Victoria-street, S.W., after 25th inst. Tenders to the clerk (Mr. F. P. Fawcett), must be delivered at the Town Hall, Rathmines, not later than 4 p.m. of Dec. 13.

The *Gloucester* Electricity Supply committee invite tenders for (*a*) one Lancashire boiler and accessories and mechanical stokers; (*b*) one 300-kw. steam dynamo and accessories, steam, exhaust, &c., pipes, valves, &c.; (*c*) extensions of switchboard; and (*d*) condensing plant. Further particulars are given in an advertisement, and specifications, &c., can be obtained at the offices of the consulting engineer (Mr. Robert Hammond), 64, Victoria-street, London, E.C., after Dec. 1. Tenders to the town clerk (Mr. George Sheffield Blakeway), Guildhall, Gloucester, before Dec. 28.

The *Blackburn* Corporation invite tenders for the supply and delivery of overhead line equipment. Specifications, &c., can be obtained at the offices of the consulting engineers (Messrs. Lacey, Clirehugh and Sillar), 2, Queen Anne's-gate, Westminster, S.W., after 27th inst. An advertisement contains further particulars, and tenders must be delivered at the offices of the town clerk (Mr. Robert E. Fox), Town Hall, Blackburn, by Dec. 23.

The *Manchester* Tramways committee require tenders for the supply of steel tie bars, bolts and nuts for permanent way work. Specifications, &c., may be obtained from the secretary, tramways department (Mr. J. M. McElroy), Town Hall, Manchester. An advertisement gives further particulars, and tenders (addressed "Chairman of Committee") must be sent in before 16th inst.

The *St. Pancras* (London) Vestry invite tenders for the supply of two dry-back marine boilers, condensing plant, feed water heaters, steam and feed pipes. Specifications, &c., may be obtained from the electricity department, 57, Pratt-street, Camden Town, N.W. Further particulars are given in an advertisement, and tenders must be sent in to the Vestry clerk (Mr. C. H. F. Barrett), Vestry Hall, Pancras-road, N.W., by noon of 12th inst.

The Electric Lighting committee of the *Hackney* (London) Vestry invite tenders for accumulators. The specification, &c., can be obtained at the offices of Mr. Robert Hammond, consulting engineer to the Vestry, 64, Victoria-street, Westminster, London, S.W., on and after Dec. 4; and tenders must be addressed to Mr. George Grocott, Vestry clerk, Town Hall, Hackney, by 4 p.m. of Tuesday, Jan. 2, 1900. Further particulars are given in an advertisement.

The directors of the *Midland Electric Corporation for Power Distribution* (*Limited*), who are about to erect a power-house containing plant and machinery capable of an output of 10,000 e.h.p., together with conductors for the distribution of this power in the districts in which the company possess statutory powers, invite tenders from contractors who have previously carried out work on the same scale for the supply and erection of the requisite plant and conductors. Tenders to the secretary (Mr. G. Carpentier), 11, Cornhill, London, E.C., before 4 p.m. of Dec. 18.

Extension of Time.—The Council of the county borough of *West Ham*, London, E., invite tenders for (*a*) three 84-kw. steam dynamos, boosters, switchboard, steam exhaust and feed-water pipes; (*b*) accumulators; (*c*) water-cooling and condensing plant; (*d*) motors; (*e*) telephones. Tenders to Mr. Fred. E. Hilleary, town clerk, Town Hall, West Ham, E., by 4 p.m. of Dec. 8.

The *Blackpool* Corporation invite tenders for the supply, delivery, and erection of the following plant: (*a*) four boilers, accessories, pumps, and piping; (*b*) two 600-kilowatt steam alternators with condensers (or alternatively one 1,200-kilowatt steam alternator); (*c*) switchboard; (*d*) mains: (*e*) transformers; (*f*) storage battery. Tenders by 10 a.m. of Dec. 15.

The directors of the *Great Northern Railway Co.* invite tenders for the supply of new and the purchase of old stores for 12 months from Jan. 1st nex Tenders, addressed Stores committee, must be sent to the company's offices, King's Cross, London, not later than 10 a.m. Dec. 6. Mr. William Latta is secretary to the company.

The *Newcastle-upon-Tyne* Tramways committee invite tenders for a 2,000 H.P. steam dynamo. Tenders to town clerk by Jan. 16. Specifications, &c., from the consulting engineer (Mr. Charles Hopkinson), 29, Princess-street, Manchester.

The *Plymouth* Corporation invite tenders for tramcars, trucks, motors, trolley arms, &c. Tenders to the town clerk (Mr. J. H. Ellis), Town Hall, Plymouth, by Dec. 8.

The *Hampstead* (London) Vestry invite tenders for wiring the public baths, Finchley-road, N.W. Tenders by 14th inst.

The *Woking* Electric Supply Co. invite tenders for a 150-kw. steam alternator and a 75-kw. steam alternator. Tenders to Messrs. Preece and Cardew, 13, Queen Anne's-gate, Westminster, S.W., by 5 p.m. Dec. 11.

The *Oatlands Park Hotel Co.* (*Limited*) invite tenders for wiring and fitting 473 lamps at the Oatlands Park Hotel, Weybridge. Tenders by noon, Dec. 4.

The directors of the *Caledonian Railway Co.* invite tenders for the supply of stores for 12 months from Feb. 1, 1900. Tenders to the secretary (Mr. J. Blackburn), 302, Buchanan-street, Glasgow, by Monday, Dec. 11.

The *Hackney* (London) Vestry require tenders for refuse destructors. Tenders to vestry clerk by 4 p.m. of Dec. 12.

The *Lambeth* (London) Vestry require tenders for 25 arc lamp posts. Tenders to Vestry Hall, S.E., by Dec. 6.

TENDERS RECEIVED AND ACCEPTED.

The following tenders have been received by the Newington (London) Vestry for the supply of a steam dynamo and continuous-current transformers. This tender was advertised in our issue of Nov. 3:—

Johnson and Phillips (Willans engine) (*accepted*)	£5,053
Ditto (Allen engine)	4,610
British Thomson-Houston Co. (Willans engines)	7,239
Electric Construction Co. (Belliss engines)	6,514
Ditto (Willans engines)	5,995
Westinghouse Electric Co. (Browett-Lindley engines)	4,823
Ditto (Willans engines)	4,878
Ditto (Belliss engines)	5,374
British Schuckert Electric Co. (Willans engines)	4,790
Ditto (Belliss engines)	4,670
Brush Co. (Universal engine)	4,981

The following tenders have been accepted by the Poplar (London) Guardians for their electric lighting works, &c., which are being carried out to the specification of Mr. F. J. Warden-Stevens:—

Tinkers (Limited) (2 Lancashire boilers)	£945	0	0
John Fraser and Sons (water-pressure drums and tanks)	1,256	0	0
Körting Bros. (steam-jet plant—3 ejector condensers, 2 steam-jet pumps, and 2 injectors)	112	10	0
Clay, Henriques and Co. (auxiliary pumping plant)	231	10	0
Thames Ironworks Co. (enclosed high-speed engine & dynamo)	827	0	0
General Electric Co. (1 12-B.H.P. and 1 8-B.H.P. electric motor)	231	0	0
Greenwood and Batley (2 steam turbines and dynamos, direct-coupled)	630	0	0
Hart Accumulator Co. (battery of accumulators, and maintenance for 8 years at £22 per annum)	456	3	8
Veritys (Limited) (main switchboard and distribution boards)	523	0	0
Speedy, Eynon and Co. (wiring and fitting)	1,975	0	0
Fuller-Wenström Electrical Manufacturing Co. (1 enclosed 14-B.H.P., 1 partially-enclosed 20-B.H.P., and 1 7-B.H.P. electric motor)	419	0	0
James Carter and Sons (economiser)	99	10	0
Harvey and Williams (deep well and pumping machinery)	1,690	0	0

The Tramways committee of the Glasgow Corporation have considered the offers for the supply of two auxiliary engines required for the Port Dundas power station. The highest offer was by an English firm (£29,350), and the lowest (£7,858) by an American firm. The latter was not to specification, and it was agreed to recommend acceptance

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of the second lowest offer (£7,870. 10s.) by Messrs. Duncan Stewart and Co. The tender of the Westinghouse Co. for the switchboards required at the Port Dundas electric power station and at the sub-stations throughout the city is also recommended for acceptance at £33,593.

The following tenders have been accepted by the Maidstone Corporation for the supply of electric lighting plant :—

Thomas Parker (Limited) (steam dynamos)	£4,318
Callender Co. (mains)	4,123
Ditto (arc lighting)	851
Davey, Paxman and Co. (boilers)	1,318
Mirrlees, Watson and Yaryan Co. (condensers)	883
James White (switchboards)	808
General Electric Co. (meters)	530
Carrick and Ritchie (travelling crane)	245

The contract for accumulators has not yet been let.

The Llandudno District Council have accepted the tender of Babcock and Wilcox for the supply of a boiler for their electricity works, at £1,200.

The Chelsea Vestry recently received four tenders for the supply of three motor vans. The tenders were all for steam motors, and ranged from £475 to £700 each.

The Leeds Lighting committee recommend the following tenders for acceptance :—

British Insulated Wire Co. (cables, &c.)	£17,310
Brush Co. (transformers and sub-station electrical equipment)	5,734
Schofield, Son and Co. (construction of transformer stations)	2,298

The Coventry Corporation have accepted the tender of the Coventry Gas Fitting, Electrical and Engineering Co. for wiring St. Mary's Hall at £130.

APPOINTMENTS VACANT AND FILLED.

The Eccles Corporation invite applications for the appointment of borough electrical engineer. An advertisement contains further particulars, and applications, addressed Public Lighting and Electricity committee, must be delivered at the offices of the town clerk (Mr. W. H. Hickson), Town Hall, Eccles, by noon of Dec. 11.

The Bury St. Edmunds Corporation invite applications for the post of resident electrical engineer. An advertisement contains further particulars, and applications must be sent to the town clerk (Mr. C. E. Salmon) by 15th inst.

The Llandudno Council require an assistant electrical engineer. An advertisement gives further particulars, and applications must be sent to the clerk (Mr. Alfred Conolly), Council Offices, Llandudno, by 9th inst.

The County of London Electric Lighting Co. invite applications for the position of chief engineer. Applications to the secretary, Moorgate-court, Moorgate-place, London, E.C., by Dec. 4. See advertisement.

The Rochdale Guardians require a clerk of works, and eventually to act as engineer-in-charge. Applications to the clerk (Mr. R. A. Leach), Union Offices, Rochdale, before 11th inst. See advertisement.

The British Electric Traction Co. require a draughtsman skilled in the planning and laying out of a power station. See advertisement.

The Chair of Engineering at University College, Bristol, is vacant, owing to the appointment of Dr. Ryan as principal of the Woolwich Polytechnic. Applications to secretary by Jan. 16.

The Urban District Council of Radcliffe (Lancs.) require an electrical engineer with lighting and tramway experience. Applications to Mr. James Sharples, clerk to the Council, by Dec. 5.

The Devonport Corporation require a clerk of works for their electric tramways. Applications by 2nd inst.

The Huddersfield Corporation require a resident tramway engineer and clerk of works. Salary £300. Applications to town clerk by 11th inst.

The Newcastle-upon-Tyne Tramways committee recommend the appointment of Mr. A. E. Rossignol, of Glasgow, as resident electric tramway engineer, at £500 per annum.

The West Ham Corporation on Tuesday unanimously appointed Mr. James K. Bock borough electrical engineer, in succession to Mr. J. J. Steinitz.

Mr. Charles Turnbull, jun., of North Shields, at present with the National Electric Wiring Co. at Folkestone, has been appointed clerk of works to superintend the erection of electric lighting plant for the Tynemouth Corporation.

Mr. P. S. Thomson, formerly with the London Electric Supply Corporation, has been appointed assistant engineer (out of 46 applicants) to the Wimbledon District Council.

Mr. F. C. D. Atkin, of St. Pancras, has been appointed assistant distributing engineer at the Bury Corporation electricity works.

Mr. A. C. Cramb, of Islington, has been appointed electrician-in-charge at the Huddersfield Corporation electricity works, and Mr. J. F. Magoris, of Halifax, junior electrician-in-charge.

Mr. A. J. Brooks has been promoted to the position of assistant engineer at Bristol.

BUSINESS NOTICES.

The British Westinghouse Electric & Mfg. Co. (Ltd) has removed from 32, Victoria-street, S.W., to Westinghouse Building, Norfolk-street, Strand, London, W.C.

English Industrials (Limited) have opened an office at 62, Victoria-street, London, S.W.

Messrs. R. N. Pattison and C. Chalmers, electrical engineers, 50, West Campbell-street, Glasgow, trading as Pattison, Chalmers and Co., have dissolved partnership. Debts by Mr. Pattison, who continues.

BANKRUPTCIES, LIQUIDATIONS, &c.

The creditors of J. C. Howell, electrical engineer, 24, Queen Victoria-street, E.C., met at the London Bankruptcy Court last week. No offer being submitted, the estate went into bankruptcy. The debtor has filed accounts showing total liabilities £19,120, of which £10,348 are expected to rank, against assets £11,433, subject to realisation. He attributes his failure to severance of connection with a company in which he was interested and to the liquidation of another company. The debtor has been interested in J. C. Howell (Limited), B. Howell and Son (Limited), Porous Accumulator Co. (Limited), Crompton-Howell Electrical Storage Co. (Limited), J. C. Howell (No. 2) Co. (Limited), Epicycle Co. (Limited), Epicycle Manufacturing Co. (Limited), and the Pontypool Electric Lighting Power Co. (Limited).

A receiving order has been made against W. Rowbotham, electrical engineer, Holmville, Stanley-road, Teddington.

At Lincoln on Tuesday, William Henry Frederick Bowman, electrical engineer, Heaton-street, Gainsboro', was publicly examined. Liabilities, £141. 12s. ; assets, £14. 14s. ; deficiency, £126. 17s. Debtor said he studied electrical engineering at Messrs. Crompton's, and had about £1,400 capital to start with, and had lost it. He had speculated in putting down an electric light installation in the Albert Theatre, Gainsboro', for a Mr. Kirk at a cost of over £900, and had not received payment for it. An attempt at law to recover the money had failed. "He did a bit of betting and drank a little." Examination adjourned to Dec. 19.

It has been decided to reconstruct the Electric Light Insurance and Maintenance Co. (Limited), and for this purpose the company is to be wound up voluntarily. Mr. George Bunbury, Little Gadcombe, Leigh, Reigate, has been appointed liquidator, with authority to consent to the registration of a new company.

At a meeting of Round's Accumulator Syndicate (Limited), on May 11, it was resolved to wind up the company voluntarily, and to appoint Mr. A. Pigram, 70-71, Bishopsgate-street Within, E.C., as liquidator. This resolution was confirmed on June 1.

A similar resolution regarding the Power Accumulator Syndicate (Limited), was passed and confirmed on the same date.

Plant for Sale.—Particulars are given in an advertisement of a compound lighting or power set, including a Willans engine indicating 360 H.P., and a direct-coupled four-pole continuous current Crompton dynamo, which is to be disposed of by Messrs. Wheatley Kirk, Price and Co.

An advertisement contains particulars of some electric lighting plant which is for sale in London. Applications to Phillips' Monthly Machinery Register, Newport, Mon.

The Cambridge Electric Supply Co. have some second-hand transformers for sale. Further particulars from the secretary. See advertisement.

"Albert" Electrical Apparatus, &c.—The Electrical Transmission Co (Limited), of Albert Works, Hammersmith, London, W., have issued two useful price lists of (1) "Albert" arc lamps and accessories ; (2) "Albert" knife switches, giving full particulars and illustrations. It is claimed for the Albert arc lamp that it is inexpensive and at the same time of first-class construction ; that it is unaffected by vibration, and that the mechanism is extremely simple. The Albert switches are claimed to be designed to compete with the rough and cheaper class of switches now being offered, especially by foreign manufacturers. The claims for these switches are that the contacts and current-carrying parts are of ample area, of mixtures of metals most suitable for the currents they are to carry, and that the finish and get-up are of a high class.

"Warden" Oil Filter.—Messrs. Shelby and Co., 66, Leonard-street, London, E.C., inform us that they have secured an order from the Metropolitan Electric Supply Co. for a complete outfit of oil filters for the new generating works at Willesden, the total filtering capacity specified for being 360 gallons per day.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Nov. 22 to Nov. 28, with the ports of destination :—

Africa—Alexandria, £553 ; Cape Town, £303 ; Chinde, £941 (telegraph material) ; Durban, £713 ; Port Elizabeth, £412. *Argentina*—Buenos Ayres, £742 (telegraph material). *Australasia*—Adelaide, £61 ;

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Brisbane, £914 (including £649 telegraph material); Fremantle, £13; Melbourne, £1,489 (including £1,001 telegraph wire); Sydney, £1,513; Wellington, £41. *Brazil*—Rio Janeiro, £27. *Canada*—Halifax, N.S., 20 cases (telegraph paper). *Ceylon*—Colombo, £255. *China*—Shanghai, £137 (telegraph wire). *Denmark*—Copenhagen, £49 (telegraph wire). *France*—Boulogne, £70. *Germany*—Hamburg, £330. *Holland*—Rotterdam, £850. *Hong Kong*—£111. *India*—Calcutta, £1,161 (including £201 telegraph wire); Madras, £129. *Japan*—Yokohama, £300. *Malta*—£25. *Mauritius*—£23. *Norway*—Christiania, £31 (telegraph wire). *Russia*—Novorossisk, £80. *St. Helena*—£136,000 (telegraph cable). *Spain*—Bilbao, £56. *Straits Settlements*—Singapore, £45. *Sweden*—Stockholm, 63 tons (telegraph wire) and £45 (telegraph material). *United States*—New York, £63. *West Indies*—Barbadoes, £20; Trinidad, £18. Total, £147,520, against £15,962 in the corresponding week last year (Nov. 23 to 29).

MUNICIPAL, FOREIGN, AND GENERAL NOTES.

Asylum Lighting.—Mr. A. A. Campbell Swinton has been instructed by the committee of the Northumberland County Lunatic Asylum to report upon the proposal to light the asylum electrically.

Ballycastle (Ireland).—A proposal has been made to establish electricity works for this district at an estimated cost of £1,500. A committee of ratepayers is discussing the matter with the Council.

Bath.—The Electric Light committee has been asked to quote for supplying current for lighting the General Post Office.

Belfast.—In the report of the city electrical engineer, presented at the meeting of the Electric committee last week, it was stated that one of the two new 700 H.P. engines had been erected and was running; the other was in course of erection, and two of the boilers were also working. The equivalent of 49,000 8 c.p. lamps had been connected, and 600 more were applied for. The work of extending the mains was progressing.

Bognor.—Terms have been arranged between the District Council and the Urban Electric Supply Co. for the transfer of the Bognor provisional order to the company.

Bootle.—We have received from Messrs. Thomas Parker (Limited) a neatly-printed and illustrated 24-page pamphlet, descriptive of the Bootle Electricity Works, for which they were contractors. The Bootle works were described in our issue for April 28, 1899. The pamphlet also includes a description, with some views, of Messrs. Parker's works at Wolverhampton.

Bradford.—The Electricity committee recommend the Corporation to retain Mr. Alfred H. Gibbings as electrical consulting engineer at a salary of £350 per annum, and to appoint an electrical engineer as resident engineer and manager at a salary of £300. A sub-committee has been appointed to consider and report generally on the question of the extension of the new electricity works, and authority has been given to proceed with the work of laying the cables required for the new tramways, and to extend the electric lighting cables along Leeds-road. Four additions have been made to the list of firms permitted to wire premises in connection with the Corporation's supply of electricity.

Bury St. Edmunds.—An inquiry was held here last week into the application of the Council to borrow an additional £800 for extensions of the electric light mains.

Cardiff.—The Corporation is about to invite tenders for 2,300 tons of rails, necessary for reconstructing some of their tramways for electric traction. The rail to be employed will be of a special pattern, the design of the borough engineer, and is claimed to be an improvement on the Glasgow type, having an inch less depth, but a greater wearing surface. It has been agreed that the Corporation shall itself carry out the work of rail laying.

Death from Electric Shock.—At Bradford, on Wednesday, an inquest was held into the death of Edgar Driver, electrician, which took place on the 20th inst. He accidentally received an electric shock while executing some repairs to the electric lighting installation on the premises of Messrs. Isaac Holden, Ltd., Bradford.

T. W. PLATT, wireman, who was engaged with deceased, said he did not think that when the deceased caught hold of the wire the lights went out. He was probably perspiring freely owing to the heat of the room, and his boots were wet through. The trestle upon which deceased was standing was fixed near a washing machine, and there was a good deal of steam. The arc lamp upon which Driver was working flickered momentarily when he clutched at it, but he did not notice whether the other lamps were similarly affected.

Mr. S. LODGE, police surgeon, said he saw the body shortly after the accident. At the time of examination the palm of the right hand, with which deceased grasped the lamp, was darkly discoloured, and both hands were rigidly contracted. Later he conducted a post-mortem examination, in the presence of the medical officer of health (Dr. Arnold Evans), Dr. H. J. Campbell, and Dr. Percy Lodge. At this time the eyes, previously dilated, had assumed a normal character. The first incision into the chest showed the blood to be extremely fluid. Internally, however, there was nothing whatever the matter with the body. The heart was perfectly sound and healthy. It contained no blood, but the appearance of the small vessels on the surface of the heart indicated a very sudden obstruction. There was a bruise at the back of the head, but no corresponding internal injury. The brain was altogether perfect, and weighed 51oz. All the other organs were quite healthy. There was no sign of scorching, but the tendency to discolouration was more marked down the right than the left side. If deceased had been working in an oppressive atmosphere he might have suffered at the time from faintness, but there was no evidence of it at the post-mortem examination. Having heard the evidence of previous witnesses, in his opinion the electric current had been the cause of death, causing a sudden stoppage of the heart. There was no charring or wound, but discolouration and very powerful contraction of the hands.

By Mr. A. H. GIBBINGS: The discolouration of the right hand was general over the palm and in the inside of the fingers. There was nothing to correspond with this appearance on either of the feet. The emptiness of the heart might be due to one or to a succession of shocks. Death must have been instantaneous.

CHARLES HEATON, electrician employed by Isaac Holden and Sons, said that after the accident he tested the circuit for any leakage and to ascertain what voltage deceased had received. He first placed the voltmeter across the dynamo terminal, and this simply gave the voltage of the machine, which was 225; across the lamp terminal he obtained 37 volts; and another test indicated a leakage to earth from the dynamo itself. The fault was found to be due to a defect in the positive brushholder. The leakage had passed from the positive brush through the armature coil to earth. This was rectified before the expert examination was made.

Mr. A. H. GIBBINGS, the city electrical engineer, stated that on Monday he visited the premises of Isaac Holden and Sons and conducted an investigation into the working of the arc lamps in the basement. The lamp which deceased was said to have caught hold of was pointed out to him. The installation was situate in the basement of the warehouse, with the exception of the dynamo, which was behind the engine room. It consisted of a continuous-current dynamo and six differential arc lamps in series. No further lights were connected with this circuit, nor were there any other lamps supplied by the same dynamo. Presuming the figures of Heaton to be correct, it was evident that there had been a fault somewhere on the circuit. The dynamo and the circuit were in good condition when the inspection was made. He tested the voltage, and found that across the dynamo terminal it was 225 volts and across the last arc lamp 37 volts. The terminals of the arc lamps were out of reach, but the framework of all the lamps conveyed the current to the negative carbon. These were quite exposed, and between 6ft. and 7ft. from the ground. The framework being in this position, it would be possible to obtain a shock from any of these lamps at any time by touching a lamp with the hand and establishing a connection with any pipe or metal work adjacent, if there were a leakage. He considered that an unsatisfactory feature. Taking into consideration the position of the lamps, he thought there should be some rearrangements for the safety of the workmen. A leakage might occur at any time, and a person might receive a shock. No shock could have resulted had there not been a leakage, and a leakage might occur at any time without it becoming apparent, except by test. Under the lamp on which the deceased was working there was an iron plate. The maximum voltage which he could have received was 225. This was considered a low pressure. If he were in a damp state and his boots were wet, he would be a better subject for electrical contact. The committee which had reported upon the question of high and low voltage decided that a 700 volts continuous current was the dividing line between the two, but the Board of Trade had reduced this to 500 volts. That was not fixed in view of the possibilities of death, but from the point of view of an unpleasant sensation. No record existed of death having been caused by an electric shock of less than 1,000 volts, and in that case the current was alternating and not continuous current. The deceased, after clutching the arc lamp, came in contact by his feet with the iron plate beneath. The fact that he had a firm hold of the iron bar would prevent him from readily letting go, and would cause a contraction of the muscles. In all such cases it was decidedly advisable to endeavour to restore life by the artificial means adopted in cases of apparent death from drowning.

The CORONER: What is the highest voltage from which a person has recovered?—Witness: The highest of which I have heard is 2,500 volts. He believed very much higher voltages had been received without serious ill effects. Having regard to the strained position in which deceased was placed, he would probably receive the fullest possible force of any shock administered. Up to the present a pressure of 225 volts had not been considered dangerous. The arc lamps at Holden's works were of an old-fashioned type. It was not advisable to have such lamps so near reach. In that particular case it was a great disadvantage to have iron plates below the lamps.

The Coroner having summed up the evidence, the jury returned a verdict as follows: "That Edgar Driver met with his death accidentally by an electric shock; they find that no one personally is to blame, but they consider that some better protection should be made with regard to this type of electric lamp; it is also advisable that these installations be periodically tested for leakage."

Doncaster.—The Electrical committee hope to supply electric current by Christmas.

Edinburgh.—During November the equivalent of over 6,000 8 c.p. lamps have been connected.

Edinburgh and the Telephone.—The town clerk of Edinburgh has issued a report relative to the public telephone service within the city, dealing at length with the present position of the telephone system within the city owned by the National Telephone Co. The report states that in 1896 the Government acquired the trunk lines at a cost of upwards of £459,000, and since then trunk lines had been held by the Post Office and the local lines by the company, a working agreement existing between them. The failure of the system did not arise from the mere fact of monopoly, but from the monopoly having been contrary to the usual practice of a company with no compulsory powers, and with a tenure of limited duration without the subscribers being protected by a fixed maximum charge. As to the interference with the streets involved in an underground system, the opinion is expressed that an adequate and efficient telephone service can only be had through an underground system with twin wires. The Council holds that the power of the Postmaster-General, with the consent of the Town

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Council or upon appeal, to lay underground wires in the streets was only intended to be used when necessary for Post Office purposes, and that it still remains to be determined whether the Postmaster-General is within his legal rights, or has exceeded them, in coming to the aid of the company in that important matter. The report discusses, as possible alternatives to the present system, Government or municipal services, and embodies a proposed agreement between the Corporation of Edinburgh and the National Co. in the meantime. The main points of that agreement are: The Corporation to retain control of the streets, to lay underground wires between the points desired by the company, the particular line of route to be in the discretion of the Corporation, who may from time to time alter the position as they find it desirable The company undertakes to give telephone service to all persons within the city on equal terms, irrespective of distance from an exchange, and to maintain an adequate and efficient service; the Corporation reserve all their rights in the streets; the maximum rate of subscription charged for service will be in the subscriber's option at one of the following rates: (*a*) Unlimited service at £10 per annum; (*b*) a fixed charge of £3. 10s. per annum, with an addition of 1d. per call, without any charge for messages received, the company to pay a yearly rent of not less than £750 for the use of the streets; on Dec. 31, 1911, or within six months thereafter, the Corporation to have the option either to call upon the company to remove the tubes, &c., in the streets, or to take these over from the company at a valuation by arbitration. This agreement is subject to the approval of the Town Council within two months, and does not prevent or interfere with the Government or the Post Office taking up the telephone service at any time.

Electric Lighting Notices.—The following additional notices of intention to apply for provisional orders have appeared during the week:—

Limehouse (London) District Board of Works.

Corporations of Basingstoke, Birkenhead (for Bidston-cum-Ford and Noctorum), Brecon, Cheltenham (for Charlton Kings, Leckhampton, Prestbury, &c.), Hyde, Oswestry, and Ramsgate.

District Councils of Barmouth, Bridlington, Brierfield (Lancs.), Cheadle and Gatley, Clacton-on-Sea, Cleckheaton, Felixstowe and Walton, Long Eaton, Lytham, Maryport, Nantwich, Ormesby, Ormskirk, Penrith, Pwllheli, Redcar, Sandgate, Shildon and East Thickley, Southwolds, Sudbury, and Whitefield.

Companies.—Cobham Gas Co., for Cobham; County of Durham Electrical Power Distribution Co., for Jarrow, Hebburn, Felling, Seaham Harbour, Bishop Auckland, and Chester-le-Street; County of Surrey Electrical Power Distribution Co., for Wallington; Electrical Power Distribution Co., for Staines, Egham and Chertsey, Banbury, Neath, Briton Ferry, Aberavon, Sevenoaks, Sheerness, and Wellingborough; Freshwater and Totland (I.W.) Electricity Supply Co., for Freshwater, Totland, Yarmouth, &c.; Isle of Thanet Electric Tramways and Lighting Co., for Ramsgate; Llanrwst Electricity Supply Co., for Llanrwst and Trefriw; Marylebone Electric Supply Co., for Marylebone, London; Midland Electric Light and Power Co., for Leamington, and to confirm existing rights and powers under agreement with Corporation; Midland Electric Corporation for Power Distribution, for Smethwick, Perry Bar, Oldbury, Stourbridge, Bushbury, &c.; Midland Electric Supply Co., to revoke or amend provisions of Allerton, Woolton, Childwall, and Garston Electric Lighting Order (1896) to transfer undertaking, &c., to provide that, "notwithstanding any revocation or purported revocation by the Board of Trade as regards Garston, the said order shall have effect as though no revocation had been made, and to declare that no effectual revocation of the said order has in fact been made"; Ogmore Valley Electric Light and Power Co., for Ogmore Valley; Richmond (Surrey) Electric Light and Power Co., for Teddington and Twickenham; Capt. E. I. Bax and others, for St. Helens (I.W.); Urban Electrical Supply Co., for Stamford, Berwick-on-Tweed, Redruth, Dartmouth, Caterham and Warlingham, Bishop Auckland, Enfield, and Grantham; Ventnor Electric Light and Power Co., for Bonchurch. The Ogmore Valley Electric Light and Power Supply Co., who are applying for a provisional order, also seek an extension of their licence (granted in 1892) for 12 months.

In the following cases procedure by Bill for further powers has been decided upon:—

Farnworth District Council, to authorise the purchase of electric motors and apparatus, and to sell and let same on hire, &c.

Liverpool District Lighting Co., to supply electric current in Garston, to extend powers conferred under Allerton, Woolton, Childwall and Garston electric lighting order (1896); to enter into agreement with Garston District Council, &c.

Morley Corporation, to supply local authorities, companies, and others outside the borough with electricity; to make bye-laws with respect to electric wires, apparatus, and fittings, and to enable the Corporation to supply, deal in, and fix electric light wires, fittings, and other apparatus, to empower Corporation to refuse supply of electricity or gas to persons whose payments are in arrear, to alter date for filing accounts, &c.

North Metropolitan Electric Supply Co., to incorporate company, to generate and supply electricity "in bulk" to lighting authorities, companies and others in parts of the counties of Middlesex, Hertford, and Essex, to purchase land compulsorily for generating stations, &c.

Rawmarsh District Council, to purchase, sell, and let on hire, fix and set up electric lamps, wires, motors, &c., to make bye-laws and regulations in regard to the provision and use of same, to authorise supply of electric current outside district, to alter date for filing accounts, &c.

Rotherham Corporation, to extend area of electricity supply.

Salford Corporation, power to supply electricity to adjacent districts, to deal in and supply electric motors and apparatus, &c.

West Ham Corporation, to enable Corporation to make and enforce bye-laws with respect to electric light wires, apparatus, and fittings, &c.

Electric Traction Notices.—The following additional notices of applications for Provisional orders to construct and work tramways have appeared. In all cases authority to employ electric or mechanical traction is sought:—

Corporations of Ashton-under-Lyne, Bedford, Bootle, Bournemouth, Dewsbury, Hull, Middleton, Plymouth, St. Helens, Southampton, Warrington, and Wigan. Bedford, Middleton, and Warrington Corporations seek powers to attach brackets and wires to private buildings.

District Councils of Gorton, Kearsley, Radcliffe, Reddish, Surbiton, Whitefield, and Withington.

Companies.—British Electric Traction Co. (for Hemel Hempstead), Garston and District Tramways Co. (for Garston and district), Leamington and Warwick Tramways and Omnibus Co., Taunton and West Somerset Electric Railways and Tramways Co. (for Taunton), Urban Electric Supply Co. (for Camborne and Redruth), United Kingdom Tramway, Light Railway and Electrical Syndicate (Houghton-le-Spring and district), Weston-super-Mare and District Electric Supply Co.

In the following cases the procedure is by private Bill:—

Blackpool, St. Annes, and Lytham Tramways Co., to double existing lines, to obtain running powers over Blackpool tramways, to supply electricity in Lytham, to dissolve existing company, and to reincorporate new company, &c.

Bradford Corporation, to construct and work new tramways in Bradford, Farsley, Hunsworth, Birkenshaw, Clayton, and Queensbury, to take transfer of Clayton and Queensbury tramway orders, &c.

Bray and Enniskerry Railway Co., to construct railways, &c.

British Electric Traction Co., to construct and work tramways in Wellingborough and district.

Brompton and Piccadilly Circus Railway, to extend time, to pay interest during construction, &c.

Burnley Corporation, to construct new and reconstruct existing tramways, to work tramways within and beyond the borough, to increase speed on tramways, to enter into agreement with neighbouring local authorities as to the use and working of light railways, &c.

Cambridge Corporation, to construct tramways within the borough and in the parishes of Chesterton and Cherry Hinton, to supply electricity outside the borough.

Cardiff Corporation, to construct and work new tramways within and without the borough, &c.

City and South London Railway Co., to amend Act of 1893, to authorise the construction of a tunnel for the station at the termination of the railway under the City-road, Islington, of an internal diameter not exceeding 30ft.

Devonport Corporation, to construct and work tramways, to take a transfer of electric lighting powers of the East Stonehouse District Council, &c.

Farnworth District Council, to construct new tramways within and beyond the district, &c.

Glasgow District Tramways Co., to incorporate company, to construct tramways in Paisley, Dumbarton, Renfrew, &c., to acquire existing tramways, &c.

Hastings Tramway Co., to incorporate company, to construct tramways in Hastings, to connect same with and to take a transfer of Hastings, Bexhill, and district light railway, &c.

Ipswich Corporation, to construct and work tramways, &c.

Kingston-upon-Thames Corporation, to construct and work tramways, &c.

Lincoln Corporation, to construct new, to acquire or lease existing tramways, &c.

Liverpool Corporation, to construct and work new tramways, to attach brackets, wires, &c., to public buildings, to borrow money, &c.

Liverpool Corporation, to double existing single tramway lines, to empower them to attach to and suspend wires from private property, &c.

London United Tramways (Limited), to construct tramways in Hanwell, Ealing, Acton, &c.

Manchester Corporation, to construct tramways in Manchester and Salford, to re-lay existing tramways and to double single lines, to attach brackets, &c., to buildings, to take transfer of electrical powers of neighbouring authorities, to raise loans, to enter into arrangements as to interchange of traffic, &c.

Nottingham Corporation, to fix brackets, electrical wires, &c., to private buildings for electric tramway purposes.

Oldham Corporation, to attach wires to buildings for electric tramway purposes, &c.

Plymouth, Stonehouse, and Devonport Tramways Co., to construct additional tramways in Plymouth and East Stonehouse, to alter gauge, to enter into agreement with local authorities as to purchase of electrical plant, to raise further capital, &c.

Poole and District Electric Traction (Limited), to construct tramways in Christchurch, Bournemouth, and Winton, to acquire land compulsorily for generating stations, to alter purchase provisions of Tramways Act (1870), to enter into agreement with local authorities, and to amend provisions of Light Railway Order (1899).

Preston Corporation, to construct new tramways in Preston, Walton-le-Dale and Fulwood, to reconstruct existing lines, authority to Board of Trade to grant powers to local authorities to construct tramways outside area, &c.

Rawmarsh District Council, to construct and work tramways, to enter into agreement with adjoining local authorities.

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Rochdale Corporation, to construct new tramways in Rochdale and district, to purchase, lease, or work tramways, to supply electricity to neighbouring districts, &c.

Rotherham Corporation, to construct and work tramways, to enable Corporation "to acquire, hold, and exercise patent rights or licences with regard to motive power."

South Staffordshire Tramways Co. and South Staffordshire Tramways (Lessee) Co., to sell and transfer portions of undertaking to local authorities, to form agreement with the British Electric Traction Co., &c.

West Bromwich Corporation, to work tramways, to supply electricity and electric fittings outside the borough, &c.

West Ham Corporation, to construct new and alter existing tramways, &c.

Whitechapel and Bow Railway, to extend time, to acquire lands compulsorily, to enter into agreement with London, Tilbury and Southend and Metropolitan District Railway Cos., &c.

Greenock.—A meeting of the Police Board was held on Tuesday to consider offers for the leasing of the tramways. Only one offer was submitted—viz., from the local tramways company. This tender did not, however, comply with the conditions of the board, and the meeting was adjourned. Mr. W. M. Murphy declined to tender on the ground that the terms laid down by the board were onerous.

Hackney (London).—A good deal of time was devoted at the last meeting of the Vestry to a discussion of the question of the wages paid by contractors to the Vestry. It was explained that there was a difficulty in fixing a schedule of prices that would be binding for any extended period. The electrical trades would no doubt be subject to some advance in the price of labour, and in order that tenders might be invited in such a way that persons would know for what they were tendering and the parish at the same time get the best possible work, the Joint Lighting and General Purposes committee asked the Vestry to decide that in all contracts for electric lighting work contractors should pay the wages and observe the hours of the various trade unions where the work is executed, in London or the provinces; and this proposal was agreed to.

Leeds.—The Lighting committee at its last meeting decided to recommend the acceptance of certain tenders for additional electric lighting plant and to extend the mains.

Col. Sir F. Marindin, R.E., inspected the Boar-lane and Briggate and Chapeltown electric tramways on Nov. 23.

Light Railways.—The Board of Trade have confirmed the order for the construction of a light railway between Leeds and Bradford.

The Hertford County Council and the Metropolitan Tramways and Omnibus Co. (Limited) give notice of intention to apply for orders to construct light (electric) railways in the following districts: (1) Bushey, Watford, Rickmansworth, Great Stanmore and Harrow Weald; (2) the parishes of Hemel Hempstead and King's Langley; (3) Finchley, Barnet Vale, Chipping Barnet and Arkley, and (4) Cheshunt, Broxbourne, Wormley and Hoddesdon.

British Electric Traction Co., for powers (1) to construct light (electric) railways to a 3ft. 6in. gauge in Cowpen and South Blyth (Northumberland); (2) Worsborough and district (Yorks.); (3) Bowness, Windermere, Ambleside and Troutbeck; (4) Bradford, Dewsbury, Batley, Cleckheaton, Liversedge, Gomersal, Birkenshaw, Hunsworth, Heckmondwike and Thornhill, in the West Riding of Yorkshire; and (5) Fletton and Stanground (Peterborough).

Llanelly and District Electric Lighting and Traction Co. (Ltd.), to construct light (electric) railways in Llanelly and district.

Loughborough and District Electric Traction Syndicate, to construct and work light (electric) railways in Loughborough and neighbouring districts.

Oldham, Ashton and Hyde Electric Tramway (Ltd.) are applying for an order authorising the construction of light (electric) railways in Ashton-under-Lyne, Denton, Hyde and Dukinfield, to standard gauge.

Application is being made by Power and Traction (Ltd.) for an order to extend the light railway authorised by the Aldershot and Farnborough light railway order. The line will be constructed to a 3ft. 6in. gauge.

Wakefield District Light Railway Co., to construct light railways in Wakefield and district.

Warrington and Northwich Light Railway Co. seek an order to incorporate a company, to authorise the construction and working of light (electric) railways in Warrington and Northwich.

Wigan and District Tramways Co., to construct light railways in Pemberton, Ashton-in-Makerfield, Abram and Ince-in-Makerfield, to a 3ft. 6in. gauge.

Messrs. H. W. Blundell, F. Terrell and W. B. Pritchard, for an order to construct a light railway from Wareham to Lulworth and Osmington (Dorset), the line to be constructed to the standard gauge.

Mr. David Cook applies for an order to construct a light (electric) railway from Ramsgate, through Sandwich, Deal, Walmer, St. Margarets to Dover, forming a connection with the Dover tramways, and from thence through Folkestone, Cheriton, Hythe, Dymchurch, New Romney, with a branch to Littlestone, and thence through Rye and Winchilsea to Hastings.

Messrs. John Fell, J. Lewis and W. J. Kershaw are applying for power to construct a system of light (electric) railways in Marsfield and district.

Mr. Thomas Nevins will apply for an extension of the Cheltenham and district light railway order.

Messrs. H. Pleydell Bouverie and others are applying for an order to construct a light railway in Bridgwater, Stowey and Stogury.

City of Gloucester Tramways Co., for powers to construct light (electric) railways in Gloucester, Tuffley, Hempsted, &c.

London County Council.—Quite a Pickwickian episode was reported at Tuesday's meeting, when the Finance committee announced that the Islington Vestry wished to borrow £13,200 for additional plant at the electric lighting station. The Finance committee not deeming the particulars accompanying the application sufficient, decided to apply for further particulars, to which application the Vestry replied that all particulars which were reasonable and fair had been furnished, and added "that the estimates had been prepared by the electrical engineer and approved by its Electric Lighting committee, and that the Vestry having perfect confidence in the judgment of both, deems it inconsistent with its position as electric lighting undertakers for the parish to recognise the claim of the Council's officials to be supplied with the details in question." In view of this answer, the Finance committee recommended "That the Islington Vestry be informed that, until the particulars required by the Council are supplied, the Council is unable to arrive at a decision upon the application of the Vestry for sanction to the borrowing of £13,200 for the provision of additional plant at their electric lighting station at Eden-grove." Prodigious! Mr. Torrance thought the report should be taken back. Dr. Napier said an important matter of principle was raised by the report, and it should not be decided without debate. The contention of the Vestry was that if they had the power to borrow money, it was not the duty of the Council to fix the mode of repayment or to hold an inquiry into the manner in which the money was to be spent. Next year he supposed there would be an appeal to the Local Government Board about that point, and the Board would doubtless lay down some rule. Mr. T. W. Williams agreed, and remarked that, considering the Council could swallow an excess expenditure of £156,000 by one of its own committees, it need not be too inquisitive regarding the Islington Vestry. The report was referred back.

The Asylums committee recommended that a scheme be prepared for the provision of a supply station for the supply of water and electricity for the Hoxton Asylum, with details of cost. Agreed.

Mile End (London).—The Mile End Board of Guardians will at an early meeting discuss a recommendation of the Works committee to modify and alter the telephone and electric light installations at the workhouse, at an estimated cost of £400.

Newington (London).—The following recommendations of the Electric Lighting committee have been agreed to by the Vestry: "That, having regard to the satisfactory progress made by the contractors in remedying the defects in both arc and incandescent lamps constituting the public street lighting, the position of matters as between the Vestry and the contractors be deferred for one month; and that notice be given to the South Metropolitan Gas Co. to discontinue the gas street lamps from Saturday, Dec. 2."

Paddington (London).—The Works committee have been instructed by the Vestry to report as to improving the lighting of Westbourne-grove and Bishop's-road, and upon the advisability of adopting the electric light.

St. Pancras (London).—The Vestry have authorised an expenditure of £896 for the laying of electric mains in four additional streets.

Scholarship.—Mr. F. H. Nicholson has been nominated by the council of the City and Guilds Technical College, Exhibition-road, S.W., to the free pupil scholarship offered every three years by the Brush Co. to that institution. The nomination has been accepted by the board of the company.

Sheffield.—An inquiry was held here on Friday into the application of the Corporation to borrow £100,000 for electric lighting extensions. The town clerk (Mr. H. Sayer) said the works were purchased last year from the Sheffield Electric Light and Power Co. The undertaking was a large one, and was purchased at a greatly enhanced value. The Corporation had practically no capital to work upon, and this was the first application for any loan in connection with the undertaking. At the time the works were taken over the company had in hand the erection of certain extensions of their premises, and these had been completed by the Corporation, who also needed money to purchase machinery, to extend the mains, &c., owing to the greatly increased demand for electric current. Of the £100,000, £35,000 was for machinery. There was £20,000 for underground mains, and £10,000 would be expended during the year ending Dec. 31. This expenditure was entirely for private lighting, but £7,600 would be required for public lighting. Nothing had been done yet in this matter, but it was suggested that some of the principal streets should be lighted by arc lamps placed on the electric tramway poles. There was £3,700 for building extensions, £7,000 for transformers and meters, £16,000 for boilers and other appliances, with £5,000 for contingencies. Of the total sum £51,201 had already been spent, and £48,799 was for future works. There was no opposition.

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Southwold.—Mr. F. J. Warden-Stevens has been appointed consulting engineer in connection with the electric lighting scheme for this borough. The Corporation are applying for a provisional order.

Speed of Tramcars.—The Cork Electric Tramways and Lighting Co. has been prosecuted at the local police court for having contravened the Board of Trade regulations in regard to the speed of their tramcars in exceeding eight miles an hour. A fine of 10s. with costs was imposed.

Theft.—At the Westminster Police Court, on Saturday, Stanley Selborne Clark, electrician, was sentenced to four months' hard labour for stealing £17. 6s. belonging to the Safety Concentric Wiring Co.

Willesden.—At the meeting of the Willesden Urban District Council on Tuesday the agreements for the purchase of land for the generating works in Taylor's lane (3¼ acres) and main sub-station in Salisbury-road (1 rood 5 perches) were sealed on the recommendation of Mr. E. T. Ruthven-Murray, the consulting engineer. Application will be made forthwith to the Local Government Board for permission to borrow the necessary moneys for the purchase of this land.

Workmen's Compensation.—The St. Pancras Vestry, on Wednesday, discussed the question of insurance against risk under the Workmen's Compensation Act, 1897. In the course of the discussion it was stated that the Electricity committee (by a sub-committee) had thoroughly investigated the whole subject of insurance, and it was pointed out that last year the Vestry paid £40 in premium, and that the insurance company had paid £90 in claims as compensation for injuries. As greater experience of the working of the Act had now been obtained, the premiums had been reduced by £17. The object of the sub committee had been to consider whether the Vestry should in future insure all the men as at present or only a portion. The recommendation of the Electricity and Public Lighting committee, asking that their action in connection with this matter should be approved, was agreed to.

Wrexham.—The Council have obtained sanction to borrow £20,000 for electric lighting purposes.

Zinc.—Following on the copper, india-rubber and other threatened combines, reports are current in Paris that a combination of the principal zinc producers of the world is imminent, German, Belgian and American producers being at the head of the movement.

COMPANIES' MEETINGS AND REPORTS.

Blackheath and Greenwich District Electric Light Company (Limited).

The third ordinary general meeting of this Company was held on Friday. Sir JOHN A. WILLOX, M.P., presided, and said that the Company in its present form had been in existence little more than a year, but he thought it would be granted that the board had lost little time in the prosecution of the necessary works. Engineering works, involving the construction of heavy and substantial buildings, the provision of machinery, and the laying of cables must not be unduly hurried. The expenditure amounted in all to £84,000, a great part of which had been spent on buildings and plant and in the purchase of land. Within a year of the practical beginning of the works the Company had actually commenced the supply of electric current. It had been a borrowed light, it was true, and he was afraid that it had not been in all respects satisfactory, but he hoped the blame for the flickering and unsteady light would not be imputed to this Company. In a short time it would be proved that the Company had established a system at once efficient and reliable. Up to October 31st 7,000 lamps of 8 c.p. had been ordered, and nearly half that number had been connected with the Company's mains; and since that date further orders had been secured, as well as several applications for motor power. The board had succeeded in not only obtaining an extension of the Company's area of supply, but had been enabled to exclude "poachers" from its district. While not afraid of competition, it was as well to avoid it when possible. He moved the adoption of the report and accounts.

Mr. H. W. BOWDEN seconded.

Mr. E. HILL thought the Directors' fees (£1,409) were too heavy, especially until the Company reached the dividend-paying stage.

Mr. HORACE BOOT, of Tunbridge Wells, criticised several items of expenditure, emphasising the contention that the cost of certain works was higher than usual. He rather regretted that the board had been taking current from another Company and supplying an unsatisfactory light. It would have better to have waited until the Company's own generating station was ready, because nothing was so detrimental to the reputation of a concern like this as for it to be considered that the light was a bad one. He agreed with the previous speaker in thinking that the Directors' fees were excessive.

The CHAIRMAN, in reply, said the board had spent a considerable sum of money in providing larger premises than would be immediately required. The chimney shaft, for example, which was a very expensive piece of construction, would serve for a generating station double the size of the present one. It was therefore not fair to compare the cost of the buildings with the size of the plant in them. Without definitely committing himself to a date, he believed that the Company would be supplying current from its own generating station before Christmas.

The report was then adopted.

Cape Electric Tramways (Limited).

The ordinary general meeting of this Company was held yesterday (Thursday), Colonel Sir CHARLES EUAN-SMITH, K.C.B, presiding. He said he might again congratulate the shareholders upon the result of the working of the Company for the past year. After making full provision for Debenture interest, the Board were in a position to pay 6½ per cent., compared with 5½ per cent. last year, and they had also been able to place £8,000 to reserve, against £2,000 for 1898, carrying forward over £15,000. They could have proposed a further distribution of 2½ to 3 per cent. out of the earnings, but decided that they were best securing the interests of the shareholders by not dividing the whole of their funds. The circumstances of the time were such as demanded a conservative and cautious treatment of the resources of the Company, for the object of the Board was to place the Company's future upon a sure and sound basis, so that they might be prepared, as far as possible, for any unforeseen circumstances. In October last the tramways, both of the Cape Town and Port Elizabeth established a record, as they received £14,653, whereas the highest takings hitherto since the commencement of the Company were £13,180. He did not think that they had anything to anticipate from South Africa generally but marked prosperity and advancement. With regard to the action pending between the Eastern and South African Telegraph Co. and themselves he could not say very much on that occasion, because it was still *sub judice*. The Directors believed they had a complete answer to the extravagant claim which had been set against the Company, but they had been anxious to avoid litigation. They had been informed no case been given against a tramway company which supported a position that in America, where many similar cases had been tried, a verdict had in analogous to the one which was being supported by their Company. The Directors had taken every step to have the Company properly represented, and they awaited with confidence the decision which might be given. The action had been brought against this Company on the ground that the operation of their tramways disturbed the working of the Telegraph company's cables.

The report was then adopted, and the dividend approved.

The directors' report states that the profit and loss account for the year to June 30, after provision for debenture interest, shows a net credit balance of £43,406. 2s. 6d., which, added to £7,459. 4s. 3d. brought forward, makes a gross available profit of £50,865. 6s. 9d. From this sum 6½ per cent., represented by two interim dividends, has been paid, absorbing £26,000. £8,000 has been placed to the credit of reserve, leaving £16,865. 6s. 9d., from which remuneration to directors has to be deducted. During the year the Cape Town system has carried 8,489,490 passengers, against 7,254,309 in the preceding year. The Port Elizabeth system has carried 2,563,259 passengers, against 2,195,714. The grand total of passengers carried is 11,052,749. The plant and equipment of the lines has been maintained at the highest point of efficiency and excellence. There have, unfortunately, been during the year several accidents of a more or less unavoiable character. Since the close of the official year a powerful syndicate, representing many important interests in Cape Town, has obtained from the Cape Parliament sanction for the construction of important suburban tracks situated outside the area already occupied by the lines in the possession of the company. These negotiations have been carried out in pursuance of an agreement and understanding entered into by the company with the syndicate, which is likely to prove of great and material advantage to this company, but of which the details cannot as yet be fully explained. The tracks to be immediately started by the syndicate will commence from the terminus at Kloof-street, from there will proceed to Camps Bay, beyond Sea Point, and will finally effect a junction with our lines at Sea Point. The directors regret to say that, notwithstanding every effort to arrive at a mutually amicable solution of certain questions at issue between them and the Eastern and South African Telegraph Co., that company has commenced an action at law against the Cape Electric Tramways Co. for damages alleged to have been caused to the cables of the Eastern and South African Telegraph Co. by the operation of the tramways company. This action is set down for hearing before the Supreme Court at Cape Town in January next. The extension of the Cape tramway system to the Docks Line Gates at Cape Town has not yet been carried out.

MUTUAL TELEPHONE CO. (LTD.).—A meeting of the shareholders of this Company was held at Manchester on Wednesday. The chairman (Mr. W. Thomson) said the directors' report recorded the steps taken to obtain a telephone licence, and also the directors' view of the attitude taken by the Manchester Council towards the company. The chairman stated that if the Corporation respected its own word the company would be granted a licence. The Post Office authorities had said that the moment the company got a vote in their favour by the Corporation they would grant a licence. If, at the meeting of the Council on Wednesday, Dec. 6, the Council gave the company their support in their application for a licence, he felt sure such licence would be granted. A large number of local authorities outside Manchester had passed resolutions in their favour. If the company did not get the support of the Manchester Corporation they might be able to get a licence to serve the other districts. They had had a very hard fight, and were now nearly at the end of it. Mr. Evans (a director) asked how the reduced charge of £3. 10s. a year fixed by the National Company for the use of a telephone would compare with the charge proposed by this company, but the Chairman replied that the company would be able to serve the public better and more cheaply than the National Company. A memorial to the City Council in favour of the granting of a licence to the company was adopted. It would appear that the Mutual Co.'s subscription is to be £2. 17s. 6d. per annum, and a ½d. *or* 1d. per call.

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CITY NOTES.

MEMORANDA.—Bank rate 6 per cent. (Nov. 30, 1899). Price of silver 27 15/16d. per oz. (Nov. 30). Consols (2¾ per cent.) 103¼—103⅜ for money, 102⅞—102⅞ for account; 2½ per cent. 99⅝—100¼ (Nov. 30). Stock Exchange Settling Days: Consols, Dec. 1; Stocks and Shares Continuation Day, Dec. 12; Ticket Day, Dec. 13; Pay Day, Dec. 14; Mining Share Carry-over Days, Dec. 11 and 23.

ALUMINIUM CO. (LTD.).—Mr. G. H. Clarkson, having resigned the post of secretary, has been elected director, and Mr. P. S. Court has been appointed secretary.

ELECTROLYTIC ALKALI CO. (LTD).—As long ago as November, 1897 (*The Electrician*, Nov. 19, 1897, p. 110) we referred to the satisfactory development of the electrolytic soda industry and to the approaching flotation on a large industrial scale of the Hargreaves-Bird process. In our issues for Feb. 12, 1897, Feb. 18, 1898, and July 28, 1898, the progressive success accomplished has been recorded. A further development of this enterprise is now shown by the issue of the prospectus of the Electrolytic Alkali Co. (Limited) with a capital of £500,000 in 200,000 Seven per Cent. Cumulative Preference shares and 300,000 Ordinary shares of £1 each. Subscriptions are now invited for an issue of £300,000—100,000 Cumulative Preference and 200,000 Ordinary shares (of which £50,000 Ordinary shares is reserved as part purchase consideration to be paid to the General Electrolytic Parent Co., Limited, the owners of the Hargreaves-Bird and other electrolytic patents in the United Kingdom). Of the amount realised by this subscription £200,000 will be available for the purchase of land, erection of works and plant, working capital, &c. 2s. 6d. per share is payable on application, 2s. 6d. on allotment, and the balance in three equal calls at intervals of not less than two months. We are informed that no promotion money is to be paid, and that the directors and their friends have subscribed about £100,000 of the capital required. It will be seen from the abridged prospectus which appears on another page that the directors are practical men, closely associated with the chemical industries. The field for the company's operations is shown in the Government alkali report for 1896, when 792,506 tons of salt were decomposed in that year in the chemical industries of the United Kingdom. The present issue of capital of the company whose prospectus we are reviewing would, it is said, suffice to treat less than one-ninetieth part of the quantity. The new company will, we learn, instal plant at Middlewich, Cheshire, equal to an output of about 250 tons of bleaching powder per week; and the placing upon the market annually of 12,000 tons of this powder and 21,000 tons of soda crystals, or its equivalent in soda ash, is a venture of some magnitude and will require a large capital to establish the enterprise. However, the project, as shown in past issues of *The Electrician*, has passed beyond the stage of experiment and doubt, and, leaving aside the question of capitalisation, may be said to have entered upon a stage of commercial and industrial success. The parent company has received several applications for licences to manufacture in Great Britain, and these have been handed over to the new company. The prospectus contains particulars as to the purchase price of £100,000—one-fourth in cash, one half in fully paid-up Ordinary shares, and the remainder in cash or in fully paid-up Ordinary shares, at the company's option. The subscription list opens on Tuesday next, Dec. 5, and will be closed on Thursday, Dec. 7, at 3 p.m., for town and country.

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee has appointed the 6th inst. a special settling day for £125,000 Three-and-a-half per cent. Mortgage Debenture stock of the *Metropolitan Electric Supply Co. (Ltd.)*. The committee have also ordered the stock, as well as £200,000 Four-and-a-half per cent. Debenture stock (in lieu of provisional certificates) of the *County of London and Brush Provincial Electric Lighting Co. (Ltd.)* to be quoted in the official list.

SULPHIDE CORPORATION (LTD.).—In the report of the directors of this corporation for the year to June 30 reference is made to experiments proceeding at the mine at Cockle Creek with the object of enriching the zinc residues and the establishment of a satisfactory method of the subsequent treatment of these tailings, &c. The experiments are said to have proved that the grade of zinc can be materially and inexpensively enhanced by a magnetic method of separation for which patents have been obtained.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount	Aggregate. Inc. or Dec.
	1899	£	£		£	£
*Birmingham Tramways.	Nov. 25	4,144	+ 654	21	87,425	+ 9,023
Blackpool Corporation...	„ 23	138	+ 12	34	20,022	+ 4,330
Blackpool and Fleetwood	„ 27	159	+ 20	21	19,575	+ 5,859
Bradford Corporation ...	„ 26	359	+ 163	67	22,276	...
Brisbane Trams	Oct. 11	1,610	+ 587	2	3,120	+ 1,269
*Bristol Trams & Carriage	Nov. 24	2,650	+ 195	21	66,752	+ 8 248
*Buenos Ayres & Belgrano	Oct. 29	2,213	+ 858	43	92,413	+42,210
City & South London Ry.	Nov. 26	1,035	− 79	22	21,488	− 30
Dover Corporation	„ 25	158	+ 25	34	7,462	...
Dublin United	„ 24	2,897	+ 433	...	...	...
Dublin Southern Dist....	„ 24	674	+ 102	...	...	...
*Glasgow Corporation ...	„ 25	9,047	+1,147	...	...	...
*Liverpool Corporation...	„ 18	6,963	+ 877	46	317,213	+37,516
Liverpool Overhead Rly.	„ 26	1,477	+ 160	22	35,738	+ 1,383
*Sheffield Tramways	„ 26	1,911	+ 890	47	67,666	+19,925
*South Staffs. Trams... .	„ 24	529	− 29	47	31,279	+ 1,540

* Partly electrical.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Nov. 22.		Price Wednesday, Nov. 29.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Nov. 29. Highest	Lowest
			TELEGRAPHS.					£ s. d.			
£110,900	100	4%	*African Direct Telegraph 4% Mort. Deb. (red.)	100	104	100	104	3 16 11	January and July.....	...	...
25,000	10	..	Amazon Telegraph.....	3	4	3	4	...	June and December ...	...	...
£125,000	100	5%	Do. 5 per Cent. Debentures	85	90	85	90	5 11 1	...	...	...
£375,520	Stock	15/0	Anglo-American	66	69	66	69	5 0 5	Feb., May, Aug., Nov.	...	...
£3,062,240	Stock	30/0	Do. Preferred	117	118	117	118	5 1 11	„ „	117⅞	116¾
£3,062,240	Stock	18/0	Do. Deferred.....	17¾	18¼	17¼	18	5 0 0	...	19⅛	17⅜
205,993	10	5/0	Brazilian Submarine	15½	15⅞	15	15¼	4 11 0	Mar., June, Oct., Dec.	15⅝	15⅜
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1900)	107	111	107	111	4 11 6	June and December ...	...	...
$10,000,000	$100	$1¼	Commercial Cable Capital Stock	198	202	198	202	3 19 9	Jan., Apr., July, Oct.	201¼	...
£1,332 823	Stock	4%	* Do. 4 per Cent. Debenture Stock.....	103	105	103	105	3 16 6	„ „	105	101½
16,000	10	8/0	Cuba Submarine Ordinary	9	10	9	10	8 0 0	February and August	9¾	...
6,000	10	10,0	Do. Preference 10 per Cent.	19	20	19	20	5 0 0	„ „	...	...
12,931	5	2/0	Direct Spanish Ordinary.....	4	5	4	5	4 0 0	April and October.....	...	...
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference	9	10	9	10	5 0 0	„ „	...	...
£30,000	50	4½%	Do. 4½ per Cent. Debentures	103⅝	107⅞	103⅞	107⅞	4 4 1	January and July.....	...	...
60,710	20	3 0	Direct United States Cable.....	12	12¼	11¾	12¼	5 14 3	Jan., Apr., July, Oct.	12	...
£130,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red.)...	101	104	101	104	4 7 10	June and December ...	...	...
£4,000,000	Stock	5%	Eastern Ordinary	153	163	156	161	4 7 6	Jan., Apr., July, Oct.	162	157
£1,795,000	Stock	3½%	Do. 3½ per Cent. Preference Stock	99	103	99	102	3 8 8	„ „	100½	99½
£1,432,268	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.).....	117	122	117	122	3 5 7	May and November ..	...	...
250,000	10	2/6	Eastern Extension	15½	16	15½	16	4 7 6	Jan., Apr , July, Oct	16	15½
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	118	123	118	123	3 5 7	February and August	...	...
£16,200	100	5%	* Do. 5% (Austln. Gov. Sub.) Deb., 1900 (reg.)...	99	103	99	103	4 17 4	January and July.....	...	...
£64,400	100	5%	Do. (Bearer)	100	103	100	103	4 17 1	„ „	...	...
£17,400	100	5%	*Eastern and S. African 5% Mort. Deb , 1900 (reg.)...	99	103	99	103	4 17 1	„ „	...	...
£24,500	100	5%	Do. (Bearer)	100	103	100	103	4 17 1	„ „	...	...
£300,000	100	4%	* Do. 4 per Cent. Mortgage Debentures, 1909 ...	101	104	101	104	3 16 11	February and August	...	...
£200,000	25	4%	Do. 4 per Cent. Mauritius Sub. Debs.(red.) ...	101⅞	104⅞	101⅞	104⅞	3 16 10	May and November .	103	101
180,227	10	1/9	Globe Telegraph and Trust	11¼	11⅝	11¼	11⅝	4 9 4	Jan., Apr., July, Oct.	11⅝	11½
180,042	10	3.0	Do. 6 per Cent. Preference	15½	16	15½	16	3 15 0	„ „	15 3/8	15⅜
150,000	10	5/0	Great Northern of Copenhagen	31	33	31	33	3 15 9	January and July.....	...	...
£89,500	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb. (red.)...	100	103	100	103	4 7 5	...	...	...
17,000	25	12/6	Indo-European.....	48	52	48	52	4 16 2	May and November ...	48½	48
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904 ...	106	109	106	109	5 10 1	March and September	...	...
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.)	103	106	103	106	3 15 6	June and December ..	...	...
11,839	8	4/0	Reuter's.....	7	8	7	8	5 0 0	April and October.....	...	...
3,381	£100 Cert.	6%	Submarine Cables Trust	130	135	128	133	4 10 9	„ „	130	...
15,609	10	...	West African Telegraph	2½	3½	2½	3½	4 9 3	December and July ...	...	...
£200,000	100	5%	* Do. 5 per Cent. Debentures (red.)	99	102	99	102	4 18 0	March and September	...	...
30,008	2½	...	West Coast of America	½	1	½	1	..	...	...	...
£150,000	100	4%	* Do. 4 per Cent. Debentures	102	105	102	105	3 16 8	January and July.....	...	...
88,321	10	2/8	West India and Panama	1	1½	1	1½	...	May and November ...	1⅛	1
34,563	10	6/0	Do. 6 per Cent. 1st Preference	10½	10⅝	10	10⅛	5 14 3	„ „	...	...
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	9	10	8	9	6 13 4	„ „	...	...
£80,000	100	5%	* Do. 5 per Cent. Debentures	105	108	106	109	4 13 7	January and July.....	...	...
£389,731	Stock	4%	Western & Brazilian 4 per Cent. Debenture Stock ...	104	107	104	107	3 15 0	June and December ..	105	...
£158,100	100	6%	*Western Union 6 per Cent. Sterling Bonds (red.) ...	98	103	98	103	5 16 .	March and September .	...	...

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Nov. 22.	Price Wednesday, Nov. 29.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Nov. 29. Highest	Lowest
			TELEPHONES.			£ s. d.			
44,000	£5	3/0	Chili Telephone (fully paid)	2 3	2 3	6 13 4	August	...	...
224,850	10s.	0/1½	Consolidated Telephone Const. & Manufacturing	¼ ¼	¼ ¼	4 15 3	July	...	...
71,000	1	0/6	Monte Video Telephone Ordinary	¾ ¾	¾ ¾	5 0 0	October	...	...
86,492	1	1 0	Do. 5 per Cent. Preference	¾ 1	¾ 1	5 0 0		...	...
490,000	5	3/0	National	5 5½	5 5½	5 14 3	February and August	5½	5½
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Preference	14 15	14 15	4 0 0	,, ,,	...	...
15,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference	14 15	14 15	4 0 0	,, ,,	...	...
250,000	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref.	5¼ 5½	5¼ 5½	4 10 11	,, ,,	5 7/8	5½
1,329,471	Stock	3½%	* Do. Debenture Stock 3½ per Cent. (red.)	100 102	100 102	3 8 8	June and December	...	...
171,504	1	0/4	Oriental	¾ 1	¾ 1	5 0 0	April and October	...	...
58,000	5	6/0	United River Plate	4¾ 5¼	4¾ 5¼	5 14 3	July	...	...
16,639	5	...	Do. 5% Cumulative Preference (£3. 10s. paid)	3¼ 3¾	3¼ 3¾	...		...	...
£179,947	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	105 108	105 108	4 13 9	June and December	...	...
			ELECTRICITY SUPPLY COMPANIES.						
100,000	1	...	Bl'ckb'rn & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.)	¾ 1	¾ 1	...		...	...
6,000	10	7/9½	Bournemouth and Poole Electricity Supply Ord.	12¼ 13½	12¼ 13½	2 18 10		...	...
6,000	10	4/6	Do. 4½ per Cent. Cumulative Preference	10 11	10 11	4 1 10		...	...
19,661	5	2/6	Brompton & Kensington Electricity Supply Ord.	7½ 8½	7½ 8	3 15 0		...	...
12,000	5	3/6	Do. 7 per Cent. Preference	9 10	9 10	3 10 0	March and September	...	...
20,000	5	...	Calcutta Elec. Supply Ordinary (£4 paid)	5½ 6	6½ 7	...		...	...
30,000	5	4/0	Charing Cross & Strand Electricity Supply Corp.	10 11	10 11	4 1 10	February & August	10¾	10⅝
20,000	5	...	Do. (Nos. 3,001 to 50,000)	9½ 10½	9½ 10½	...		...	...
20,000	5	2/3	Do. 4½ per Cent. Preference	5¾ 6¼	5¾ 6¼	3 12 0	,, ,,	...	...
34,000	5	2/6	Chelsea Electricity Supply Ordinary	8 9	8 9	3 6 8	March	8¼	8⅛
£100,000	Stock	4½%	* Do. 4½ per Cent. Debenture Stock (red.)	111 113	111 113	4 0 9	June and December	...	...
$1,200,000	$1,000	5%	Chicago Edison 1st Mort. 5% 30 year Gold Bonds (red.)	100 110	100 110	4 10 11	April and October	...	...
60,000	10	7/0	City of London Electric Lighting Ordinary	11½ 12½	11½ 12½	4 16 0	February and August	12½	11⅝
40,000	10	6%	Do. 6 per Cent. Cumulative Preference	13 14	13 14	4 5 9	January and July	13⅝	...
£400,000	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	125 130	125 130	3 17 5	June and December	126½	126
40,000	10	...	County of London and Brush Prov. Ordinary	10½ 11½	10½ 11½	...		11	...
20,000	10	6/0	Do. 6 per Cent. Cumulative Preference	13 14	13 14	4 5 9	March and September	13½	...
£200,000	Stock	7/8	Do. 4½% Deb. Stock Certs. (all pd) (red.)	111 114	111 114	...		112¾	...
15,000	5	10%	Kensington and Knightsbridge Ordinary	12 13	11½ 12½	4 7 9		...	...
10,000	5	6%	Do. 6 per Cent. 1st Preference	7½ 7¾	7½ 7¾	3 17 5	January and July	...	...
110,000	3	...	London Electric Supply Ordinary	3 3¼	2¾ 3¼	...		3 7/8	3 5/8
48,050	5	3/0	Do. 6 per Cent. Preference	6 6½	6 6½	4 13 2		6⅝	6 5/8
£100,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures	104 106	104 106	3 16 4	Mar., June, Sept., Dec.	105½	...
62,500	10	5/0	Metropolitan Elec. Supply Ord. (Nos. 1 to 62,500)	15 16	14½ 15½	3 4 6	April and October	15⅝	15
22,500	10	3/7½	Do. (Nos. 62,501 to 85,000)	14½ 15½	14½ 15½	3 3 10		...	...
£220,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage	117 119	117 119	3 15 7	June and December	...	...
6,452	10	6/0	Notting Hill Electric Ordinary	15½ 16½	15½ 16½	3 15 0	March	...	...
10,000	5	5/0	Oxford Electric Ordinary	6¾ 7¼	6¾ 7¼	3 9 0	,,	...	...
300,000	1	8%	Rand Electric	⅞ 1	⅞ 1	10 13 4		...	...
£130,070	Stock	5%	River Plate El. Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb.	80 90	80 90	5 11 1		...	...
500,000	$100	$2	Royal Electric Company of Montreal Shares	160 180	160 180	4 8 11		...	...
£123,200	100	4½%	* Do. 4½ per Cent. 1st Mortgage Debentures	104 106	104 106	4 5 6	April and October	...	...
31,980	5	5/0	St. James's and Pall Mall Electric Ordinary	16 17	15½ 16½	4 7 11	February and August	16½	16
20,000	5	3/6	Do. 7 per Cent. Preference	9 9½	9 9½	3 13 8	,, ,,	...	...
65,000	5	...	South London Electric Supply Ordinary (£4 paid)	3½ 3¾	3½ 3¾	...		3 5/8	3¾
79,900	5	5/0	Westminster Electric Supply Ordinary	14½ 15½	14 15	4 0 0	March and September	14½	14
			ELECTRIC MANUFACTURING, &c., COMPANIES.						
125,000	1	...	Aron Electricity Meter 6 per Cent. Cum. Pref.	⅞ 1	⅞ 1	...		...	...
40,000	5	5/0	British Insulated Wire Ordinary	11½ 12½	11⅝ 12⅝	4 0 0		...	...
27,500	5	3/0	Do. Preference	6½ 6¾	6½ 6¾	4 8 11		...	...
90,000	2	2/0	Brush Electrical Engineering	1¾ 2¼	1¾ 2¼	4 14 1	September	1¾	...
90,000	2	1/2½	Do. 6 per Cent. Pref. Non-Cumulative	2¼ 2½	2⅜ 2⅝	4 16 0	,,	2 5/8	2½
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Deb. Stock	110 115	110 115	3 18 5	February and August	...	...
£50,000	Stock	4½%	* Do. 2nd Debenture Stock (red.)	104 107	104 107	4 4 11	June and December	...	...
20,000	5	5/0	Callender's Cable Construction Ordinary	13 14	13 14	5 7 2	,, ,,	...	...
20,000	5	...	Do. 5 per Cent. Cumulative Preference	5½ 6	5½ 6	...		5 13/16	...
£90,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb. (red.)	113 116	113 116	3 18 7	November and May	...	...
300,000	1	0/9½	Castner-Kellner Alkali Co. (fully paid)	1⅝ 1⅞	1½ 1⅝	5 6 8		...	...
60,000	1	0/7½	Chadburn's Ship Telegraph Ordinary	1 1½	1 1½	...		...	...
60,000	1	0/7½	Do. 6 per Cent. Cumulative Preference	1 1½	1 1½	4 16 0		...	...
32,098	3	2/11⅝	Crompton and Co. (Nos. 1 to 32,098)	3½ 4	3½ 4	4 10 9	January and July	...	...
£100,000	100	5%	* Do. 5 per Cent. First Mortgage Deb. (red.)	100 103	100 103	4 17 10	,, ,,	...	...
60,000	1	0/3	Davis and Timmins 6 per Cent. Cum. Pref.	¾ 1	¾ 1	...		...	...
99,261	5	1/9½	Edison and Swan United ("A" Shares) (£3 paid)	2 2¼	2 2¼	7 4 0	February and August	...	...
17,139	5	2/9⅝	Do. (£5 paid)	3½ 4¼	3½ 4¼	6 13 4	,, ,,	4¼	...
£314,023	Stock	4%	Do. 4 per Cent. Mortgage Deb. Stock (red.)	95 97	95 97	4 2 6	June and December	...	...
26,100	5	5/11½	Edmundson's Electric Corporation Ord. (fully pd.)	5 5½	5 5½	5 9 1	Half-yearly	...	...
112,100	2	1/2⅜	Electric Construction Co. (Limited)	2 2¼	2 2¼	5 2 3	January and July	2 3/8	...
25,000	2	2/9⅝	Do. 7 per Cent. Cumulative Preference	3 3¼	2¾ 3¼	4 6 2	July	3	...
182,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	104 107	104 107	3 15 8	January and July	...	...
91,195	1	...	Elmore's Patent Copper Depositing	½ ¾	½ ¾	...		...	...
15,000	10	8/0	Henley's Telegraph Works Ordinary	...	13 14	5 0 0	February and August	...	...
30,000	£5	9/4	Do. 4½ per Cent. Preference	...	5½ 5¾	3 8 3	,, ,,	5⅝	...
£50,000	Stock	4½%	Do. 4½ per Cent. Mortgage Deb. Stock (red.)	111 114	111 114	3 19 6	,, ,,	...	...
50,000	10	5/0	India Rubber, Gutta Percha, &c., Works	21 22	21 22	4 8 11	,, ,,	...	...
£300,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	100 104	100 104	3 16 11	March and September	...	...
37,350	12	12/0	Telegraph Construction and Maintenance	37 41	37 41	4 8 3	March and July	...	...
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909	103 106	103 106	3 15 6		...	...
20,000	5	4/5⅝	Do. Manufacturing Ordinary	9½ 9¾	9 10	4 0 0		...	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5½ 6	5¼ 6	4 3 4		...	...
30,000	5	5/0	Willans and Robinson Ordinary	10½ 11	10½ 11	4 1 10	April and October	...	...
30,000	5	3/0	Do. 6 per Cent. Cumulative Preference	7 7⅛	7 7⅛	4 0 0	,, ,,	...	...
£100,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Debentures	106 108	106 108	3 18 8	May and November	...	...
			ELECTRIC RAILWAYS, TRAMWAYS, &c.						
12,000	10	6/0	Blackpool and Fleetwood Tramways	19 20	18 20	4 0 0		...	...
£167,900	100	5%	Brisbane Tramway 5 per Cent. Debentures	104 106	104 106	4 14 4		...	...
50,000	10	7%	Bristol Tramways and Carriage Ordinary	23 24	23 24	2 17 2	February and August	...	...
25,000	10	...	Do. Cumulative Preference (£4 paid)	4⅜ 4½	4⅜ 4½	...		...	...
£100,000	Stock	4%	Do. 4 per Cent. Debentures	118 119	118 119	3 7 3		...	...
30,000	10	9/0	British Electric Traction Ordinary	16½ 17	16½ 17	3 10 7		17	16 13/16
30,000	10	6/0	Do. 6% Cum. Pref. (Nos. 30,001 to 60,000)	13½ 13¾	13 13½	4 8 11		13⅝	...
£200,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures	126 129	126 129	3 17 10		...	...
40,000	5	1/9	Buenos Ayres & Belgrano 6% "A" Cum. Pref.	5½ 5¾	5¼ 5¾	5 9 1		5 5/8	...
27,500	5	...	Do. "B"	5 5¼	4¾ 5¼	...		...	...
265,585	Stock	5%	Do. 5 per Cent. Debentures	108 111	108 111	4 10 1		109¾	...
35,250	10	3/0	Central London Ordinary	10½ 10¾	10½ 10¾	2 15 10	June and December	10⅝	10⅜
178,303	10	2/4 1/16	Do.	...	...			...	...
£855,000	Stock	2½%	City and South London Railway Con. Ordinary	63 66	63 66	3 4 6	January and July	64	63
37,000	10	...	Do. (Nos. 23,501 to 60,000) (£4. 10s. paid)	3½ 4½	3½ 4½	...		...	...
£150,000	Stock	5%	Do. 5 per Cent. Perpetual Preference (1891)	143 148	143 148	3 8 0	January and July	...	...
£200,000	Stock	5%	Do. (1896)	135 140	135 140	3 11 11		...	...
£187,701	Stock	4%	Do. 4 per Cent. Perpetual Debenture	132 134	132 134	2 19 9	May and November	...	...
20,000	10	7½%	†Imperial Tramways Ordinary	23 24	23 24	...	March and September	...	...
10,000	10	6%	† Do. 6 per Cent. Preference	15½ 15¾	15½ 15¾	3 13 10	,, ,,	...	...
£200,000	Stock	4½%	† Do. 4½ per Cent. Debenture	115 116	115 116	3 18 0	January and July	116½	11⅝
...	10	...	Kidu'rm'nst'r & Dist. E.L. & Tr'ct'n 5% Pref. (£6 pd.) xd	...	5¾	...		...	...
37,500	10	2½%	Liverpool Overhead Railway Ordinary	9 9½	8⅞ 9	3 12 3	February and August	...	...
10,000	10	5%	Do. 5 per Cent. Preference	13¼ 13¾	13¼ 13⅝	3 12 9	,, ,,	...	...
125,000	Stock	4%	Do. 4 per Cent. Debenture	104 105	104 106	3 16 3	January and July	...	...
24,000	5	...	New General Traction Ordinary	3¾ 4¼	3¾ 4¼	...		3⅞	...
30,000	5	6/0	Do. 6 per Cent. Cumulative Preference	5¼ 5¾	5 5¼	5 9 1	May	...	...
13,334	10	...	Potteries Electric Traction Ordinary	13 14	13 14	...		...	...
20,000	10	5/10	Do. 5 per Cent. Cumulative Preference	10½ 11	10½ 11	4 10 11		...	...
£540,000	Stock	3%	Waterloo and City Ordinary	101 104	101 104	2 18 0	June and December	...	...

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THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,125. [No. 7. Vol. XLIV.] FRIDAY, DECEMBER 8, 1899. PRICE SIXPENCE (by post, 6½d.), Abroad, 8d., or 15 cents. or 80 fr., or 70 n.f.

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NOTES.

MR. E. K. SCOTT raises a number of interesting points in his note, in another column, on the hysteresis loss in armatures, and the questions he asks are probably not easy to answer. There is, in fact, a good deal of uncertainty as to the relation of the hysteresis loss in armature cores to the hysteresis loss which is found in the same iron when it is put through a cycle of magnetisation by reversing the field in the manner in which the field is reversed in ordinary magnetic tests. According to Prof. BAILEY's experiments, the hysteresis loss, in weak and even fairly strong fields, is greater when the reversal takes place by rotation than when reversal takes place by reducing the field to zero and reapplying it with opposite sign. Sometimes it was found to be quite 40 per cent. greater. His figures showed that the induction had to raised above 15,000 C.G.S. units before the hysteresis loss due to a revolving field became lower than that due to ordinary reversals. At what may fairly be described as very high inductions—namely, at inductions exceeding 18,000—the hysteresis of rotation fell off rapidly, and as the induction rose to 20,000 C.G.S. units or more it almost vanished, the effect predicted by Mr. SWINBURNE from Prof. EWING's theory occurring.

As to the question of vibration, what Prof. EWING showed was that under sufficiently violent vibration a piece of iron would possess almost no retentiveness, and consequently during a slow cyclic process of magnetisation the rising and falling curves could be compelled by vibration to come into practical coincidence. But this is not the same thing as saying that no dissipation of energy is produced by the interactions of the magnetic molecules when a strongly vibrated piece of iron is being magnetised. The molecular bonds have to be broken up somehow, and to break them up will require the expenditure of work, whether that is supplied by the magnetising force itself or by the source of energy to which the vibration is due. So far as we know, Prof. EWING has never suggested that vibration furnishes a means of getting iron to respond to changes of magnetising force without dissipation of energy—that is to say, without hysteresis loss He has only proved that whatever loss there occurs must be supplied otherwise than from the magnetising current. As to the last question raised in Mr. SCOTT's Paper, we cannot agree with the suggestion that simply to maintain iron in a constant state of induced magnetisation requires more energy to be expended when the iron is vibrated than when it is not. Apart from this, however, the vibration which occurs in even the worst balanced dynamo can scarcely be regarded as sufficient to affect the question of hysteresis loss in the armature core, though the question of rotation *versus* reversal is undoubtedly one of great practical interest.

THE statements made by Prof. S. P. THOMPSON at the Institution dinner on Wednesday night, with regard to the establishment of local centres of the Institution, where Papers read in London will be discussed simultaneously with the meetings at Westminster, are of extreme interest, and no doubt all members living away from the metropolis will appreciate the benefits conferred by this new movement. On inquiry we learn that a meeting of members of the Institution living in the North-Eastern District is to be held in Newcastle-on-Tyne on Wednesday next, under the presidency of Mr. J. F. C. SNELL (borough electrical engineer of Sunderland), when a petition to the Council will be drawn up, as required by the articles of association. This meeting, at which Prof. THOMPSON and other members of the Council will probably be present, will be held at the Durham College of Science, at 8.30 p.m.

WE have commented on previous occasions on the impardonable action of the Cardiff Electricity committee in refusing to allow Mr. APPELBEE, the resident engineer, to appoint his own staff, and in insisting on the assignment of the post of assistant engineer to a "glorified fitter." There

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have recently been several interruptions to the supply at Cardiff, and according to a member of the Electric Lighting committee, in a recent report on the accidents, Mr. APPELBEE cast the blame on certain of his subordinate officials. On Saturday evening last a failure occurred, due, we believe, to a fuse blowing in a sub-station, and this has been the cause of fresh attacks on Mr APPELBEE by members of his committee. Mr. APPELBEE, we may mention incidentally, was absent in London at the time of this last mishap, in connection with the Cardiff Corporation's action against Messrs. FERRANTI.

THE report of the board of United States naval officers, the text of which we print in another column, is, strange to say, almost the first published report made by an impartial and independent authority on systematic tests made on a practical scale with Mr. MARCONI'S wireless telegraph apparatus. It is to be regretted, however, that Mr. MARCONI did not think fit to take the latest pattern of his instruments to show our American cousins. The maximum distance over which messages were satisfactorily transmitted was in this case only 16½ miles, whereas it has been authoritatively stated (see *The Electrician*, Vol. XLIII., p. 663) that during the recent naval manœuvres signals were exchanged between vessels 74 miles apart. Mr. MARCONI should also have made use of the apparatus he claims to have invented for preventing interference, about which so much has been said and so few results exhibited. It is gratifying to see that the United States Navy Board have duly observed the danger from shock and the possible deleterious effect on the compass. Note should also be made of the maximum speed recorded in the report, which is much less than figures published in this country with reference to previous trials. Even if a speed smaller than this could only be attained, the invention would still be of enormous utility ; but the field of usefulness would be incalculably increased if speeds could be approached such as now obtain in ordinary land-line telegraphy and the mode of manipulation assimilated. Twelve words a minute "for skilled operators" would be very slow for commercial and Press messages. We believe that several (and probably among them Mr. MARCONI and his associates) are working at this problem.

American Cable Enterprise.—A bill has been introduced in the Washington House of Representatives for the laying of a Government cable to Hawaii, the Philippines, Japan and China.

Cable Interruptions and Repairs:—

	Date of Interruption.	Date of Repair.
Latakia—Cyprus	June 21, 1899 —	...
Cayenne—Pinhieros	Oct. 11, 1899 —	...
Zanzibar—Mombassa	Oct. 27, 1899 —	...
Aden—Zanzibar	Nov. 26, 1899 —	Dec. 3, 1899

The Goldsmiths' Institute.—The annual prize distribution at the technical and recreative Institute of the Goldsmiths' Company took place last night. The Attorney-General (Sir Richard Webster), Prime Warden of the Goldsmiths' Company, introduced Mr. H. H. Asquith, Q.C., M.P., who distributed the prizes.

London and Budapest Telegraph Line.—On Monday the direct telegraph line between London and Budapest was opened by the exchange of congratulatory telegrams between the Duke of Norfolk and the Hungarian Minister of Commerce. The line is nearly 1,400 miles long, and chiefly of copper. The route followed is across the Channel to France, and thence through Switzerland and Austria to the Hungarian capital.

North Wales University College.—The authorities of the University College of North Wales, Bangor, have for long desired to develop their electrical engineering department, but have been hampered in carrying out their wishes in this direction by lack of funds. The Drapers' Company, London, have generously voted the University College of North Wales a sum of £600, payable in two instalments, towards maintaining the electrical engineering department for not less than three years.

Presentation to Sir John Donnelly.—On Wednesday evening, Nov. 29, a presentation was made to Major Gen. Sir John Donnelly, K.C.B., who his just retired from the post of secretary to the Science and Art Department, which he held for a period of 40 years. Sir John Gorst made the presentation on behalf of the present and past members of the staff of the department, and expressed the high sense of esteem in which Sir John Donnelly was held both by his superiors and by his subordinates.

French Cable Enterprise.—A meeting of the Cable Committee of the Ministry of Commerce was held in Paris on Saturday, and discussed the outlines of the bill prepared by the French Government for connecting up the French colonies to France by French-owned submarine cables. The meeting lasted two hours, and proposals were accepted by the committee that a bill should be laid before the Chamber embodying details which a specially appointed sub-committee is now considering. The project is meeting with strong support from certain quarters in Paris, and it is anticipated that, notwithstanding the opposition of experts, the bill will receive legislative sanction.

The Magnetic Blow-out Patent.—A decision was rendered on November 10th by Judge Thomas, in the United States Circuit Court for the Eastern District of New York, in which he held that the magnetic blow-out patent No. 283,167, dated August 14, 1883, is invalid and void, because not involving patentable subject matter, and the bill of complaint in the case of the Thomson-Houston Electric Co. *versus* the Nassau Electric Railway Co. which was based on this patent, was dismissed. This is the broad basic magnetic blow-out patent that is so well known in the electrical industry. The Nassau Electric Railway Co. was a defendant for the Lorain Steel Co., whose apparatus it was sued for using.

Royal Institution.—At the monthly meeting held on December 4th a letter was read from the Goldsmiths' Company enclosing a donation from that company of £1,000 in order to mark its sense of the importance of the centenary of the Royal Institution, and for the continuation and development of original research, especially for the prosecution of further investigations of the properties of matter at temperatures approaching absolute zero. A vote was passed expressing to the court of the Goldsmiths' Company the profound and grateful appreciation by the members of the Royal Institution of this second munificent manifestation of the company's practical interest in the work of the Institution.

Tramway Employés and Electric Traction.—The Dundee Corporation intend employing their present staff on the various electric tramway routes which are approaching completion. The manager, Mr. Fisher, has arranged a series of lectures on the subject of electric traction, to give the men an opportunity of knowing the principles of the working of the system. In his first lecture, delivered last Friday, he announced that he proposed to confine himself in these lectures to describing the essential points necessary to enable the men to drive an electrically propelled car, and to keep it and its equipment in best order. The lecture was attentively listened to by his audience, a number of them asking questions at the close.

Failure of Supply in Copenhagen.—Owing to an outbreak of fire in the main conduit of the Copenhagen central electric light station, and the consequent fusing of the electric light cables, Copenhagen was plunged into electric darkness late on Monday night last. Our Copenhagen correspondent informs us that the cables run through a brick conduit from

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the central station into distributing boxes under the street; there are about 18 cables in the conduit. The fire originated in this conduit, and was due presumably to earths on the mains, which have lately given considerable trouble on this account. The fire was got under in about an hour and a half, but all the mains in the conduit were destroyed. To make matters worse, it appears that water was poured into the conduit before the mains were disconnected. The damage did not extend beyond the conduit, and is estimated at about £2,000. The authorities are withholding fuller particulars, since they wish to keep the matter as dark as possible. Some days must elapse before the electric lighting is restored, and meanwhile the city is experiencing considerable inconvenience. Work had to be completely suspended on Monday night in several of the newspaper offices.

Underground Rapid Transit in New York.—The Rapid Transit Commissioners, says our New York correspondent, will advertise for bidders for the underground electric system. The contractors' bond has been reduced to $5,000,000, with a cash payment as guarantee of $1,000,000. While building the road, for which five years are allowed, he must pay the interest on the bonds issued by the city to furnish him the money for the work, and in addition 1 per cent. annually on the amount of these bonds, which it is calculated will entirely redeem the issue at the end of the 50 years for which he is to operate the completed road. Besides this, he is to pay the city a certain percentage of all the gross earnings above $5,000,000 yearly, the size of this percentage and the sum for which he undertakes to build the road both being the subjects for competitive bidding. After building the road the contractor must furnish an additional bond for the million dollars to ensure his paying the city's proportion of the gross earnings, and at the same time his cash guarantee of $1,000,000 and the original bond of $5,000,000 will be released. The contractor must bid for the entire contract, bidding by sections, of which there are four, and must build by sections, beginning at the southerly terminal.

Large Electric Railway Generators.—We learn that a contract has been awarded to the Westinghouse Electric Co., of Pittsburg, for the heavy generating machinery for the new power house of the Manhattan Railway Co. and the apparatus for sub-stations. The apparatus consists of eight three-phase alternating-current generators, each of 6,650 H.P. capacity, together with such step-down and converting devices for the sub-stations as will be necessary to transform the alternating current into continuous current at 500 volts, to be fed to the third rail of the elevated system. The Westinghouse Co. state that the 6,650 H.P. generators will be the largest ever designed or constructed, being something over 40ft. in height, while the rotating field-magnets of the generator, which form at the same time the engine flywheel, have a diameter of 32ft. The weight of each machine and engine complete will be nearly 1,000 tons. The current generated by these large machines will be conveyed to sub stations conveniently located about the city, and in these sub-stations will be installed 20 rotatory converters in units of 2,000 H.P. each. The first of the large dynamos is due for delivery in about nine months, so that it is expected that electric trains will be running on a portion of the Manhattan system within the incoming year.

Accident in a City Sub-Station.—At about 6:40 p.m. on Wednesday evening an accident of a rather serious nature occurred in one of the transformer sub-stations of the City of London Electric Lighting Co., causing a failure of supply in the whole eastern district of the company's area. It appears that the cut-out controlling one of the transformers had fused badly, failing to clear the contacts and causing an arc. The arc spread to other mains in the proximity and short-circuited them. Eventually it burned free, but not before the whole of the transformer sub-station was filled with smoke. Eight out of the 22 sub-stations belonging to the company were affected by the short-circuit, causing a stoppage of supply varying from 10 to 40 minutes. The accident was localised in less than 20 minutes, and the repair of the sub-station was promptly put in hand. The fuses, cut-outs, mains, instruments, &c., were all replaced by 7 a.m. yesterday morning, the company's staff showing their usual activity (engendered, we fear, by hard experience) in dealing with breakdowns. The type of cut-out which caused the trouble is one that is no longer being employed by the company.

Obituary.—The death is announced of Frau Anna von Helmholtz, widow of the late distinguished physicist, Hermann von Helmholtz. Frau von Helmholtz was the daughter of the professor of law, Robert von Mohl, and married Prof. von Helmholtz, who then occupied a professorial chair at Heidelberg, in 1861. Her *salon*, both at Heidelberg and in Berlin, whither her husband was transferred in 1871, was, says *The Times*, a great centre for those who were interested in German science and art, and was frequently visited by the late Emperor and the Empress Frederick. In particular, Herr and Frau von Helmholtz cultivated music, and belonged to the most intimate circle of Richard Wagner's friends. A brother of Frau von Helmholtz, Dr. von Mohl, resides in Cairo as a member of the Administration of the Egyptian Debt, and her only daughter is the wife of Herr Arnold von Siemens, head of the firm of Siemens and Halske.

The death is announced at Edinburgh on the 6th inst. of Mr. David Bruce Peebles, head of the firm of Messrs. D. Bruce Peebles and Co. Mr. Peebles was born in 1826 at Dundee, and at an early age entered the Great Western Railway Co.'s locomotive works at Swindon. In 1866 he started in business for himself at Fountain Bridge, and subsequently established extensive works at Bonnington. Mr. Peebles was best known in gas engineering circles, but his name has been prominently before the electrical world for some years. He was a past president of the Royal Scottish Society of Arts and a Fellow of the Royal Society of Edinburgh.

The Institution's Visit to Switzerland.—The photographs taken during the tour of the Institution of Electrical Engineers in Switzerland last September are now exhibited in the library of the Institution (28, Victoria-street, S.W.), where they will remain on view until next Tuesday. Some of these are very fine, and reflect great credit on the amateur photographic artists. As might be expected, the views of scenery are the most pleasing, among which we may particularly mention those taken by Messrs. Fawcus and Mountain; a successful snapshot of a falling avalanche, taken by Dr. C. Bauer; and some beautiful cloud and snow pictures, due to Mr. A. A. C. Swinton, which will awaken envy in the minds of all photographers. So far as electro-technical matters are concerned, the photographers have naturally experienced difficulty in obtaining good views. The best is undoubtedly a small but extremely sharp picture of a pole lightning arrester, taken by Mr. J. T. and Dr. D. K. Morris, showing at once the characteristic features of Swiss overhead construction and Swiss mountain scenery. Another is a good view of a transformer tower, due to Mr. C. W. S. Crawley; and there are also some good reproductions of motorcars and of overhead equipment on the Burgdorf-Thun Railway. "Figure studies" are very numerous, some most amusing. Prof. Perry and Mr. Crompton seem to have been singled out as victims most frequently. As most of the members have kindly placed their negatives at the disposal of the exhibition committee, copies of some of the photographs can be obtained on application at the library. An album of selected photographs is being prepared, copies of which will be presented to the Institution, the President, and the Secretary by members who took part in the trip. Copies of this album may also be obtained by individual members if ordered this week.

The Efficiency of Electrical Transmission of Sound.—At the meeting of the Académie des Sciences, on November 27th, M. Dussaud made the following communication with regard to some experiments he had made on the efficiency of electrical transmission of sound. These experiments were made to find the best conditions for electrical transmission of sound through telephone circuits. At the transmitting end it was found that the efficiency could be increased by increasing the number of microphone discs and enclosing these in a resonance tube in which the vibrating air-column could be agitated by the voice. The results were still more satisfactory if the air could play readily on to both faces of the plates. Small carbon

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blocks separated the plates from each other at the receiving end. The efficiency of the line is considerably improved by increasing the number of facets at the poles of the electro-magnet, each facet having opposite it a separate disc, these discs being most advantageously arranged when the air-column can play on to both faces. With this arrangement of transmitter and receiver the efficiency was so good as to register on a phonograph. Using the phonograph as a criterion of the transmission efficiency, it was found possible, using ordinary telephone currents, to register, at distances of several miles from the transmitting end, ordinary telephone conversations, theatrical performances, and public speeches. At the invitation of the Department of Public Instruction, these experiments were repeated in their presence on November 15th last. The transmitter was set up in the physical laboratory of the University of Geneva, and the receiver in the large amphitheatre of the same building. More than 1,000 persons in the hall were able to hear clearly, and without missing a single word, the speeches addressed to the transmitter. Further, the efficiency was such that the intensity and quality of voice of different persons could be readily distinguished and recognised, despite the numerous transformations which the energy had undergone from the voice of the speaker to the phonograph.

United States Navy Report on Wireless Telegraphy.—The United States Navy Board, which recently performed the experiments with Mr. Marconi's wireless telegraph apparatus, duly recorded in our columns, has now issued the following report:—

We respectfully submit the following findings as the result of our investigation of the Marconi system of wireless telegraphy: It is well adapted for use in squadron signalling under conditions of rain, fog, darkness, and motion of speed. Wind, rain, fog, and other conditions of weather do not affect the transmission through space, but dampness may reduce the range, rapidity, and accuracy by impairing the insulation of the aerial wire and the instruments. Darkness has no effect. We have no data as to the effects of rolling and pitching, but excessive vibration at high speed apparently produced no bad effect on the instruments, and we believe the working of the system would be very little affected by the motion of the ship. The accuracy is good within the working ranges. Cipher and important signals may be repeated back to the sending station, if necessary, to ensure absolute accuracy. When ships are close together (less than 400 yards) adjustments, easily made, of the instruments are necessary. The greatest distance that messages were exchanged with the station at Navesink was 16·5 miles. This distance was exceeded considerably during the yacht races, when a more efficient set of instruments was installed there. The best location of instruments would be below, well protected, in easy communication with the commanding officer. The spark of the sending coil or of a considerable leak, due to faulty insulation of the sending wire, would be sufficient to ignite an inflammable mixture of gas or other easily lighted matter, but with direct lead (through air space, if possible) and the high insulation necessary for good work no danger of fire need be apprehended. When two transmitters are sending at the same time, all the receiving wires within range receive the impulses from transmitters, and the tapes, although unreadable, show unmistakably that such double sending is taking place. In every case, under a great number of varied conditions, the attempted interference was complete. Mr. Marconi, although he stated to the Board before these attempts were made that he could prevent interference, never explained how nor made any attempt to demonstrate that it could be done. Between large ships (heights of masts 130ft. and 140ft.) and a torpedo-boat (height of mast 45ft.), across open water, signals can be read up to seven miles on the torpedo boat and eighty-five miles on the ship. Communication might be interrupted altogether when tall buildings of iron framing intervene. The rapidity is not greater than twelve words per minute for skilled operators. The shock from the sending coil of wire may be quite severe and even dangerous to a person with a weak heart. No fatal accidents have been recorded. The liability to accident from lightning has not been ascertained. The sending apparatus and wire would injuriously affect the compass if placed near it. The exact distance is not known, and should be determined by experiment. The system is adapted for use on all vessels of the navy, including torpedo-boats and small vessels, as patrols, scouts, and despatch boats, but it is impracticable in a small boat. For landing parties the only feasible method of use would be to erect a pole on shore and then communicate with the ship. The system could be adapted to the telegraphic determination of differences of longitude in surveying. The Board respectfully recommends that the system be given a trial in the navy.

Opening of the Greenock Corporation Electricity Works.—As briefly noticed in our last issue, the Greenock electricity works were opened on November 30th. As the internal work in the station is hardly sufficiently completed to enable any satisfactory photographs to be procured, we shall defer giving a detailed description of the plant until it is all erected and finished. We may, however, mention that the boiler house plant consists of two Babcock and Wilcox boilers, fitted with the firm's own chain grates, and Green's economiser. The engine-room plant, the contract for the whole of which was placed with the India-Rubber, Gutta-Percha and Telegraph Works Co., will consist of three Belliss-Silvertown sets, one of 150 H.P. and one of 250 H.P. being already erected, while a second 250 H.P. set will be erected shortly. The small engine is connected to two 250 volt dynamos, and the larger ones will be connected to a single 500 volt machine each. The switch-board is quite one of the Silvertown Co.'s best, and when completed will have a very fine appearance. The contract for the street work was placed with Messrs. Callender, who have laid a very complete network of their well-known mains, as well as 44 Brockie-Pell arc lamps, along the main streets. Before asking Mrs. Cameron to switch on the light, Bailie Cameron, the convener of the Electricity committee, gave an account of the history of the undertaking. The Corporation of Greenock obtained a provisional order in 1883, but did not think of making use of it until three years ago, when their movements were accelerated by the application of two private companies for permission to come into the town to supply electric light. Mr. Fedden was appointed engineer a little over a year ago, and the estimates he made amounted to £30,000, while the offers subsequently received totalled only £1,700 in excess of this. The erection of the works to their present stage had only taken seven months and ten days, which he thought was a record. After the ceremony, an exhibition of domestic electrical appliances, &c., was opened by the provost, and in the evening, at the invitation of the Silvertown Co., about 70 guests dined at the Tontine Hotel. Provost Wood, of Partick, in proposing the success of Greenock and its industries, incidentally mentioned that in his own town the negotiations with their big neighbour, Glasgow, had fallen through; but he still thought that some day in the future the two undertakings would be amalgamated, and that he hoped that when his good friend Mr. Chamen—whom he saw present—came to take over their station, he would find one in every way worthy of the rest of his work in Glasgow. He also mentioned that they were hoping to follow the example of Shoreditch, and combine their electrical station with a dust destructor, but that up to the present they had been interdicted. Mr. Chamen subsequently, referring to Provost Wood's remarks, said he felt sure that when he came to take over the Partick station in the future he should find it all that could be wished. He would be very pleased to take over the electricity station, but as for the dust destructor——— !

MEETINGS OF SCIENTIFIC AND ENGINEERING SOCIETIES, &c.

TO-DAY (FRIDAY), December 8th.

INSTITUTION OF CIVIL ENGINEERS.

2.30 p.m. Students' Visit to the Works of the Baker-street—Waterloo Railway. Assemble at the Works, near Charing Cross Railway Bridge.

PHYSICAL SOCIETY.

5 p.m. Meeting in the Physical Laboratory of the City and Guilds Technical College, Leonard-street, Finsbury. Papers to be read: (1) "Cylindrical Lenses," by Prof. S. P. Thompson, F.R.S.; (2) "Exact Formulæ for Lenses," by T. H. Blakesley; (3) "On an Organic Compound of Great Double-Refraction," by Prof. S. P. Thompson, F.R.S.

INSTITUTION OF MECHANICAL ENGINEERS.

8 p.m. General Meeting. Paper to be read: "A Continuous Mean-Pressure Indicator for Steam Engines." By Prof. W. Ripper.

TUESDAY, December 12th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Paper to be submitted for discussion: "Combined Refuse-Destructors and Power-Plants." By C. Newton Russell.

WEDNESDAY, December 13th.

INSTITUTION OF ELECTRICAL ENGINEERS.

7.30 p.m. Students' Meeting at 28, Victoria-street, S.W. Paper to be read: "Electric Tramways." By R. Grigg.

THURSDAY, December 14th.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary General Meeting. The following Paper will be read: "Electrical Time Service." By F. Hope-Jones.

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CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

Chemical Work of Becquerel Rays.—The mysterious source of energy of the Becquerel rays has been made to do many things already, and an important addition to its range of operations has just been made by Paul and Sklodowska Curie, who have found that these supremely interesting rays are capable of converting oxygen into ozone. It is easily observed by keeping any of the new radiant substances in a stoppered bottle. On opening the bottle the characteristic smell of ozone is perceived. It is dissipated slowly, and is reinforced on closing the bottle for 10 minutes. The pressure of ozone is also proved by the colouring of a mixture of starch and potassium iodide spread on a piece of paper. Here we have, then, another constant expenditure of the energy of the rays whose source is unknown. They also have a variety of other chemical effects. The glass of the bottles turns violet or black in contact with the radiant salt, and the colour gradually penetrates through the thickness of the glass, although the latter be free from lead. The rays also modify the chemical structure of a platino-cyanide screen. The least luminous salts show the highest chemical activity.

[M. and Mme. Curie, *Comptes Rendus*, Nov. 20, 1899.]

Action of Coherer.—Tommasina's discovery of conducting chains among the particles of a coherer may, according to R. Malagoli, be further illustrated by placing, at the bottom of a beaker filled with petroleum or vaseline oil, a metallic disc carrying a layer of brass turnings, surmounted by a small metallic sphere connected with a feeble influence machine. The first phenomenon observed is the "electric dance" of the particles discharging the electric charge by convection. On diminishing the distance between the disc and the sphere, a moment arrives at which a number of particles form themselves into a chain, and a spark proceeds along the chain, welding it together, while all the loose particles fall back on to the disc. It is clear that the rate of oxidation of a metal has less influence upon the behaviour of the chain than has its fusibility. The dimensions of the particles will also have an important influence, since upon them depends the chance there is of a chain being formed. It should be difficult to decide theoretically as to whether numerous light particles would form a chain quicker than a small number of heavier particles; we may take it for granted, however, that some kind of convective discharge precedes the chain discharge in every case.

[R. Malagoli, *Nuovo Cimento*, October, 1899.]

Thermoelectric Measurements.—In the study of thermoelectric phenomena the most logical method consists in observing the temperature of the conductor itself. But the little-known thermal conductivity introduces a complication, and therefore it is usual to adopt some calorimetric method in measurements of the Peltier effect and the like. The reduction of the diameter of the wires necessary to make thermal conduction negligible brings about a pronounced evolution of Joulean heat, which often masks the effect to be measured. P. Straneo has therefore overhauled the direct method, with a view of making it practically available. The theory developed is complicated enough, but its application may be simplified considerably by periodically varying the direction of the current and finding the points at which a stationary condition is established. This, it will be remembered, is a device first adopted by Angström. The author was able to operate with iron and nickel rods 4mm. thick, and claims that his method is applicable under widely varied conditions. The experiments on the Peltier effect in a magnetic field, carried out by Pochettino, are a case in point.

[P. Straneo, *Nuovo Cimento*, October, 1899.]

Thermal and Electrical Conductivity.—F. Kohlrausch shows that the stationary distribution of temperature in an electrically heated body only depends upon the ratio c/w of its electrical to its thermal conductivity, and upon the difference of potential between the electrodes. From this he deduces a simple and reliable method of determining that ratio and also the thermal conductivity. Wiedemann and Franz's hypothesis that c/w is a natural constant has been invalidated by the researches of Lorenz, and therefore the distribution of temperature is not the same in all metals. The author assumes that the terminal surfaces of the body are kept at a certain difference of potential, and that the other surfaces are non-conducting both for heat and electricity. He regards c/w as a function of the temperature t, and obtains the integral

$$\int \frac{c}{w} dt = -\frac{1}{2}v^2 + cv + c^1,$$

when v is the difference of potential and $c_1 c^1$ are constants. If c/w is proportional to the absolute temperature, the temperature maximum is 163° for pure metals whose ends are maintained at 0° and a difference of potential of 0·1 volt. Gaps and holes in the metal are without influence upon the result.

[F. Kohlrausch, *Sitz. Berl. Akad.*, 38, p. 711, 1899.]

Diurnal Variation of Atmospheric Electricity.—Although 30 different theories of atmospheric electricity have been proposed, the number of well-ascertained facts concerning it is almost incredibly small, and there is up to the present not much to show for 150 years of research. What the old physicists called the "soft electricity of fine weather" is now recognised as the most important factor in the phenomena. It is generally known that the earth's surface has a permanent negative charge and the upper regions of the atmosphere a permanent positive charge, but the distribution of potential below an altitude of 1,000m. is as yet very obscure. With the aid of the Eiffel Tower observations, commenced in 1893, A. B. Chauveau has traced an interesting diurnal variation of the difference of potential between an elevated point and the ground. There is a maximum at 8 p.m. and another at 7 a.m., with minima at 3 a.m. and 4 a.m. respectively. At the central meteorological bureau close by the same curve is observed in winter, but in summer the day minimum is exaggerated and the night minimum reduced. Tropical stations, such as Batavia, hardly show the night minimum at all. The author, whilst pointing out the importance of the double oscillation, attributes the irregularities to the influence of the moisture of the soil.

[A. B. Chauveau, *Journal de Phys.*, November, 1899.]

Anode and Cathode Rays.—A. Battelli and L. Magri, having subjected the same highly-exhausted tubes to bipolar and unipolar discharges, formulate the following rules: In every species of tube both anode and cathode rays are generated, the former proceeding from parts at higher potentials, the latter from parts at lower potentials. In the case of bipolar discharges all parts of the tube generate anode rays, except the cathode, which generates cathode rays only. But when only one electrode is connected with the machine, both anode and cathode rays are generated by the electrode connected. This may be shown by deflecting the rays by a magnet, when that portion of them which produces fluorescence of the glass is deflected like cathode rays, while the other, of the violet colour of the anode light, is deflected in the opposite direction. The anode rays have an oxidising action, while the portions of a metallic screen which are impinged upon by the cathode rays are less oxidised, probably owing to a reducing counteraction of the cathode rays. The charges conveyed by the rays generated in unipolar discharges are studied by the authors by means of an ingenious combined vacuum tube and electroscope.

[A. Battelli and L. Magri, *Nuovo Cimento*, October, 1899.]

French Gift to Dover.—The French Association for the Advancement of Science has sent a handsome silver medal to the Dover municipality, in commemoration of the Association's visit to the town in September last. The mayor, Sir William Crundall, said that the medal would be placed with the Corporation plate. A letter of grateful acknowledgment was sent.

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HYSTERESIS LOSS IN ARMATURES.

BY ERNEST KILBURN SCOTT, A.M.I.C.E.

The hysteresis formula of Mr. C. P. Steinmetz, in which he showed that

$$\left.\begin{matrix}\text{Hysteresis loss in ergs per cubic}\\ \text{centimetre per cycle}\end{matrix}\right\} = nB^{1\cdot6},$$

B representing the magnetic induction in C.G.S. lines per square centimetre, and n a constant varying between

0·002 for soft iron wire,
0·003 for thin sheet iron,
0·0033 for (1) thick sheet iron,
0·042 to 0·045 for (2) thick sheet iron,
0·008 for annealed cast steel,

was originally got out with a view to its use for finding the iron loss of alternate transformers at the moderate values for B which are customary in such work. Most writers of books on dynamo design have, however, taken it for granted that the formula held good for dynamo work, and practically all of them give a formula reading somewhat as follows:—

$$\text{The hysteresis loss in watts} = \frac{n\cdot B^{1\cdot6} P.N.V.}{10^7},$$

where P is the number of pairs of poles,
N the number of revolutions per second,
V the volume of the armature core in cubic centimetres.

Now, as a matter of fact, this formula is of no use whatever for finding the hysteresis loss in an armature.

Let us first of all take a numerical example:—

In the fourth edition of "Dynamo Electric Machinery," p. 526, there is a detailed list of the various losses in a 50-kw. two-pole direct-driven Goolden dynamo, running at 500 revolutions per minute, the loss by friction, eddy currents, and hysteresis being set down at 255 watts. The writer happens to know the size of this machine, and, taking the cubic contents of the armature core at 55,000 cubic centimetres B at 14,000 C.G.S. lines per square centimetre, and the constant n at 003, we get, according to formula,

$$\left.\begin{matrix}\text{Hysteresis loss}\\ \text{in watts}\end{matrix}\right\} = \frac{0\cdot003 \times 14{,}000^{1\cdot6} \times 500 \times 55{,}000}{60 \times 10^7} = 590.$$

Again, referring to the table on page 163, giving the waste of power by hysteresis, we find that Dr. S. P. Thompson gives (for B at 14,000) the watts wasted per cubic foot at 100 cycles per second as 2,620. This is equivalent to 0·00925 watts wasted per cubic centimetre at one cycle per second, and we thus get

$$\text{Hysteresis loss in watts} = \frac{0\cdot00925 \times 500 \times 55{,}000}{60} = 423.$$

Or, averaging the two, *506 watts for hysteresis loss alone*—that is to say, a figure just about double that given under test for friction eddy currents and hysteresis altogether. We must either assume therefore that those who published the tests have been drawing the long bow by about 150 per cent., or else that these calculations from the usual hysteresis formulæ are worthless. 255 watts does seem a bit low, but those who have data available will soon be able to convince themselves that the ordinary formula is very much at fault.

If one looks up the writings of Prof. Ewing and others, it will be found that there are several hints that the condition under which iron is worked in an armature core is quite different from what happens in an alternating-current transformer.

In *The Electrician*, Vol. XXVII., p. 602, for example, Prof. Ewing wrote as follows:—

"The dissipation of energy which has been shown to accompany hysteresis in cyclic variations of magnetism is an obvious outcome of the mechanically irreversible character of these unstable molecular movements. When the molecule's equilibrium is upset it tumbles over and acquires kinetic energy in falling towards a new position of equilibrium. It oscillates about that, and communicates oscillations to its neighbours until the motion is damped out by setting up eddy currents in the surrounding conducting mass, and the energy of these currents is in turn converted into heat. . . .

"But what will be the heating effect when a magnetic cycle is performed, not by varying the amount of H, but by turning the iron round in a constant magnetic field? The question is of much practical interest, since that is the way that the magnetism is reversed in the core of a dynamo armature of the Gramme ring or drum type. . . .

"In a series of experiments on dynamo armatures by Mr. Mordey, when a successful attempt was made to separate the loss of power due to magnetic hysteresis from that due to Foucault currents, the loss due to hysteresis was found to be rather less than the amount of energy which would be used up in reversing the magnetism by varying the field without rotation.

"The molecular theory makes it probable that the work spent in reversing magnetism will be less when the reversal is accomplished by rotation in a constant field than when it is accomplished by reducing the magnetic force to zero and restoring it with sign reversed. A difference of this kind is especially to be looked for when the field is strong. In fields of no more than moderate strength the turning round of the iron will involve breaking of molecular ties, with those unstable movements to which the dissipation of energy is due. But when the field is very strong, so that the iron is nearly saturated, every molecule points steadily in the direction of the magnetising force all the while, and there is no opportunity for irreversible movements. This deduction from the molecular theory seems to have been first pointed out by Mr. J. Swinburne."

We now know that Mr. J. Swinburne's prediction that a piece of iron when revolved in a very strong magnetic field would exhibit no hysteresis is true, because it has been experimentally verified by Prof. Baily. Those who were present at the James Forrest lecture by Prof. Ewing last year will remember that when the plate carrying the little pivoted magnets was revolved in a weak magnetic field, breakings up of molecular groups occurred, but that in a strong magnetic field the magnets maintained a constant fixed position. There being no oscillation showed that there could be no loss of energy from hysteresis, although in the model there would be the friction of each magnet on its pivot.

Of course it is immaterial whether the armature revolves between fixed magnets, as in dynamos, or the poles revolve inside a stationary armature core, as in certain types of alternators.

The question is, Whether the magnetisation of an armature core may be considered a strong field? The writer thinks it may, as the teeth of slotted multi-polar armatures work ordinarily at a line density as high as 17,000 and 18,000 per square centimetre, whilst Gramme armature cores are frequently worked at 17,000.* The main core of multi-polar machines and the cores of smooth drum armatures work at anything between 6,000 and 14,000, but even in this case it is more than likely that the lines are crowded together near the periphery of the core and do not spread themselves equally over the total cross-section.

It is customary to work alternators (which must of necessity have a large number of poles, on account of the frequency) at a low line density both in the main core and in the teeth, say 4,000 in the former and 9,000 in the latter, but the reason for this proportionately larger core is to some extent the result of mechanical considerations. In the internal revolving pole form, for example, the core need only theoretically be the same depth as half the width of the pole face, but, of course where the poles are numerous, say 16 or 20 or more, the depth is usually much greater, to give mechanical strength. For alternators therefore the Steinmetz formula may be more nearly correct.

* It would almost appear from this that the Gramme armature design is not so far wrong after all, and that the increased eddy currents in the interior windings and the spider may be compensated for by reduced hysteresis loss. Certain it is that designers have recognised for some time the distinct disadvantage of carrying the core discs of drum armatures right down to the shaft, and prefer rather to cut the iron away at the centre and work at a higher line density, even although such cutting away means the extra cost of a spider to carry the discs.

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It is just possible that the discrepancy between the calculated result and the actual result may be due to mechanical vibration of the iron core, for Prof. Ewing has observed that if iron is kept in a state of vibration whilst under test the hysteresis loss is diminished. A tightly pressed armature core would not appear to offer much opportunity for vibration in the plates, but that it does occur is shown by the fact that paper insulation on the stampings tends to become powdery and fall out.

In commenting on Prof. Ewing's researches and on Prof. Hughes' experiments on the removal of strong residual magnetism by continued tapping, Prof. Fleming says in "The Alternate Current Transformer," Vol. I., p. 69:—

"In magnetising the field-magnets of an ordinary continuous-current dynamo, work has to be done to a small amount at first, to bestow upon the iron its initial magnetisation. If iron possessed the property of retaining strongly some 90 per cent. of its maximum magnetisation when the magnetising force is withdrawn, there would be no further need for a field exciting current; but as the least shock or vibration removes the slightly-held magnetisation of iron, we see that one function of the field exciting current and of the energy expenditure necessary to maintain it is to keep on reproducing the magnetism which the continual vibration knocks out of the iron. Hence in an ordinary dynamo we may consider that one part of the duty of the field exciting current is to keep on regenerating magnetisation, because mechanical vibration is continuously tending to remove it."

Does it not follow from this reasoning that, if a dynamo is coupled to an unbalanced engine—say one that knocks badly—the energy taken by the field coils would be *increased?* whilst, according to Prof. Ewing's observations, the hysteresis loss in the armature would actually be *diminished!*

INFLUENCE OF CHEAP FUELS ON THE COST OF ELECTRICAL ENERGY.*

BY R. E. CROMPTON.

The problems involved in this subject are worthy of the careful thought and consideration of members of this Institution. As water power is only available in the United Kingdom to a very limited extent, the bulk of our experience in generating, transmitting and distributing power on a large scale is certain to be based on power stations put down in the best positions where we can either raise steam or work gas engines by means of our cheap fuels.

Mr. Holliday in his Paper deals very exhaustively with several of the problems involved in dealing with inferior cokes or coals of the anthracitic description. My present Paper must be taken as a suggestive one of other important problems connected with this subject, in the hope that the matter will be carried further by those of our members who are working as engineers in charge of electrical power stations, and who are therefore likely to have already directed their thoughts in this direction. Perhaps the first and most important point that we ought to consider is the extent of our available supplies of cheap fuel. I do not think that this most important point has been sufficiently looked into. I am told that in certain districts where fuel of very considerable calorific value could be had almost for nothing at the pit's mouth, solely because the difficulties in burning it were so considerable that no one had thought it worth while to put down proper appliances, immediately appliances were set to work to deal with this fuel on a large scale the price doubled itself. It is of considerable importance to take this into consideration, and then to fix on a price which is likely to hold good for a sufficient period. To enable us to discuss the problem I have put myself into communication with several colliery proprietors, and have ascertained that in the Midland district, Nottinghamshire, Derbyshire, and Yorkshire, there are supplies of slack coals available, the average price of which during the last ten years has been about 2s. 6d. per ton at the pits, so that it could be delivered by railway carriage, including waggon hire, within an average radius of 50 miles for about 5s. 4d. per ton. At the present time, owing to exceptional demand, the present price is 1s. per ton higher than this, but I am informed that this higher price is not likely to be maintained, and that it would be fair to base my calculations on the assumption that a large supply of this coal would be available at the above price.

Whilst on this subject I must point out that railway rates and waggon hire are the same for inferior as for the best quality of fuels, so that this inferior fuel cannot be delivered to distant parts of the United Kingdom, such as in the case of our own works at Chelmsford, under 14s, so that it appears probable that it will rarely pay us to deal with these cheap fuels at an average radius in excess of 50 miles from the colliery. Where a system of canal transport is available, as in the Birmingham district, these conditions will of course be modified on account of the much lower rate for carriage and barge hire. From inquiries I have made, it is probable that the Cannock Chase class of slack may be delivered within an average radius of 50 miles from the colliery at about 5s. 6d.

There are three distinct classes of cheap fuels available for generating electrical energy. The first are those, in which the calorific value is chiefly in the contained carbon. These include the anthracite and small Welsh coals, and the refuse coke fuels dealt with by Mr. Holliday. The difficulties in burning these fuels are not great. They are cheap because they are friable, easily broken up by carriage into powder, and thus there is always loss in transit; such powdered fuel is liable to fall through the bars or be carried forward in the form of dust into the flues and chimney. All easily pulverised fuel is also likely to have additional earthy matter mixed with it, as whenever a heap of it is shovelled over, the earthy bottom gets mixed with it, and thus its liability to form clinker is increased. The second class of cheap fuel is the free-burning small coals of the Midland districts. In this class I include all the small and earthy coals which are only slightly bituminous, and which therefore have slight tendency to cake. The third class is the small and dirty or earthy bituminous coals of the North. These last are the most difficult to deal with, but as they possess high calorific value the problem of dealing with them successfully is the most interesting of all.

The first group of fuels have been dealt with, with considerable success, by several forms of furnaces in addition to those described by Mr. Holliday. In this class it is all-important to reduce as far as possible the loss of unburnt fuel by it falling through the fire bars or being carried forward into the flues in an unconsumed condition. So far probably the best method of dealing with the clinker from this class is the provision of large water ash pans, the steam rising from which appears to have the effect of preventing the clinker from clinging to the bars. A great portion of it separates as it forms into small drops of melted matter and falls through the bars into the water instead of forming large cakes which hinder the air admission. Up to the present the attempts to satisfactorily deal with the second and third classes of fuels have been chiefly connected with the use of automatic appliances for distributing the fuel over the bars, breaking up and getting rid of the clinker, and providing sufficient admixture of air at various points in the furnace to ensure satisfactory combustion of the gases. These last difficulties are at their greatest where a great portion of the calorific value of the fuel lies in its volatilisable products.

I think that most of us who have had experience in the use of automatic stokers will agree with me that although in some cases where a large range of boilers has been automatically fired, economies in labour have undoubtedly followed, yet the cost of clinkering the grates and afterwards removing the clinker from the boiler-room, and the cost of maintenance of the grates and furnaces have been so considerable, and these difficulties and costs increase so rapidly with the amount of ash present in the fuel, that in most cases, even with these automatic stokers, it has been advisable not to use the very cheapest class. With the third, or highly bituminous class, coking stokers have been used with more or less success. Most of these operate on the principle of spreading the coal on the front end of the grate, allowing it sufficient time to form itself into coke, and then by means of moving bars to break up and move this coke forward over the bars to the point where intense combustion and radiation is required. This method is correct in theory, but it has not worked out well in practice. The moving bars do not move the caked material forward with sufficient regularity, so that openings occur in the fire, and thus excess of air is allowed to dilute the gaseous heated products of combustion, and their temperature is thereby reduced. Clinker is seldom got automatically rid of, and in most cases a considerable amount of hand labour has to be expended on its loosening and removal.

From the above remarks it will be seen that one great difficulty in burning cheap fuels at a small cost for labour and maintenance is that of getting rid of the clinker. What we require is that the fuel should be tipped from the railway trucks or barges into conveyers and thence distributed to the furnaces without being touched by the firemen, and that after passing through the furnace the clinker and ashes should also be automatically taken away from the back of the furnaces and delivered into a railway truck without any hand labour being necessary.

There are two distinct methods of dealing with the cheap fuels which contain much volatilisable matter. The first is that described very fully in a Paper read on the March 16, 1897, by Mr. Humphrey (*vide* Min. *Proc.* Inst. C.E., Vol. CXXIX., p. 190) before the Insti-

* Paper read before the Institution of Electrical Engineers, November 23rd.

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tution of Civil Engineers on the Mond gas producer. With this system the fuel is gasified in separate gas producers and the gas then burnt under boilers or used in gas engines. I do not propose to deal with this system, although it may well be a most satisfactory way of utilising cheap fuels, as it has been most thoroughly described by Mr. H. A. Humphrey in his Paper. He showed that by this method 90lb. of sulphate of ammonia, which is about 70 per cent. of the total nitrogen in the fuel, may be recovered from it, and that the gas from each ton of coal is then capable under ordinary boilers of evaporating not less than seven tons of water. The repairs and upkeep of the system appear to be satisfactorily low.

I propose for the present to confine my remarks to suggestions to the form of furnace which may be attached direct to the boilers to burn these inferior fuels so as to evaporate the water at the least cost. Mr. Holliday has called our attention to the fact that in considering such furnaces and the boilers best suited to them, the use of cheap fuel has undoubtedly up to the present necessitated the use of larger furnaces and larger boiler plant, so that there has been considerable increase in the capital cost and hence in the maintenance charges which are a percentage of that cost, and this, of course, increases the real cost per 1,000 gallons of water evaporated. I think, however, that in the case of externally fired boilers, at any rate, arrangements may be suggested by which the grate area only need be increased, the size of the boiler remaining the same as for the best fuel; for if we so arrange our grate that those portions of it in which the preliminary work of igniting and caking the fuel is performed are at a comparatively low temperature this portion of the grate or furnace may be exterior to the boiler, and it follows that that portion of the furnace in which advanced combustion is carried on would be no larger than would be the case if we were burning the very best Welsh coal; but it is only fair to say that in the case of bituminous fuels, where it is necessary to prevent newly-formed volatisable products from coming into contact with the cold boiler surfaces, considerable additional space will have to be provided exterior to the boiler itself, as it is evident that in this case, in order to produce perfect combustion of these products, some form of combustion chamber which contains a large surface of highly incandescent material must be provided. Again, however carefully we may provide for the disposal of the clinker, portions of it are certain to adhere

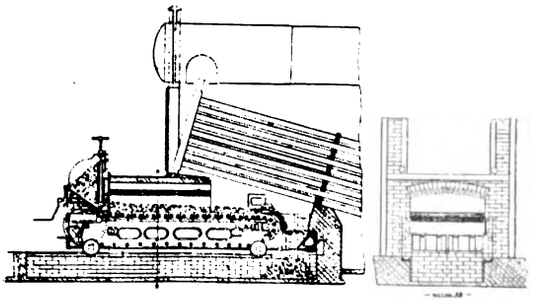

Fig. 1.—Crompton's Proposed Furnace with Extended Combustion Chamber.

to the bars and lining of the furnace or combustion chambers, and in order that these parts may be made easily accessible for cleaning, the whole furnace ought to be easily removable from the boiler—in other words, it should be built on a frame mounted on wheels running on rails.

Probably the simplest and most efficient method that has yet been contrived of continuously firing a large grate with cheap fuel is by the old Juckes revolving grate which has been in use for upwards of 30 years, and wherever it has been properly installed and well mounted has given satisfactory results. I remember seeing one of these grates in use in Messrs. Fowler's works in Leeds in 1871—that is to say, 28 years ago—and I am told that the performance has been so continuously satisfactory that Messrs. Fowler are still using this form of grate.

It appears probable that all the conditions I have above noticed could be satisfactorily filled up by a revolving grate mounted on a movable frame running on rails. In these days of electric motors there is no difficulty in providing power for working this grate. It can easily be constructed to deliver the clinker and ashes continuously into a transverse channel at the back end of the grate, from whence it could be removed by a conveyor to suitable trucks. Immediately above that part of the grate on which the fuel is ignited I propose to provide a combustion chamber in the form of a long bridge made of a special quality of fire brick. I have found by experiment that a good way of arranging this apparatus is in the form of an extended fire brick arch, each arch-shaped brick having a fin-like projection hanging down from its lower surface into the path of the gases. I have already used this form of combustion chamber for Lancashire boilers at our works at Chelmsford with satisfactory results. The extended surface of fire brick acts extremely well as a reservoir of heat even under the difficult circumstances of firing a Lancashire boiler the fire door of which must be frequently opened, but it is evident that this form of bridge will work much more efficiently in an automatically and hence continuously fired boiler where no necessity exists for so often opening the door and hence admitting cold air. As I have pointed out above, for burning the first group of cheap fuels this regenerative apparatus may be dispensed with. It is somewhat more necessary in the case of the second group, but it is absolutely necessary in the case of the bituminous smoky fuels of the third group.

Up to the present the weak point of smoke-consuming apparatus has been that it has generally stopped short at supplying additional air so as to obtain more perfect combustion of the fuel, and although this has resulted in a larger proportion of the CO being converted into CO_2, yet as this has been effected by passing a considerable excess of air through the furnace, the heated products have been so diluted and cooled that not only is the output of the boiler

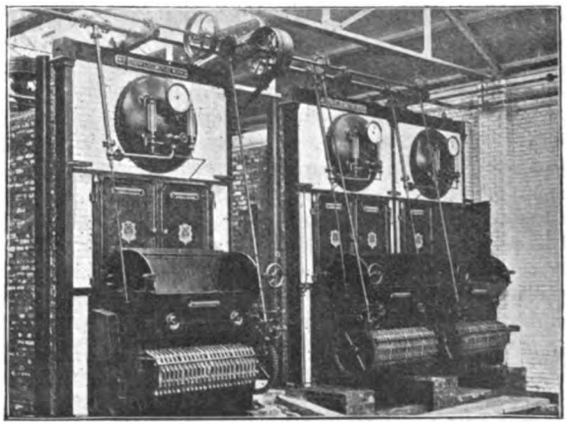

Fig. 2.—Boilers fitted with Babcock and Wilcox New Revolving Grate.

diminished, but also its efficiency greatly reduced. The only satisfactory method of dealing with the question is to provide the combustion chamber I have above described. I need hardly remind those who are accustomed to boiler tests that the efficiency of a boiler is largely proportionate to the proportion of CO_2 present in the gases as they leave the furnace. On tests we always try to get this proportion as high as possible. In my experiments at Chelmsford, I have been able when my combustion chambers were worked successfully, and when using highly bituminous fuel, to bring the proportion of CO_2 up to 11 per cent., which is sufficient proof that a very small excess of air was passing, and that the products were consequently undiluted.

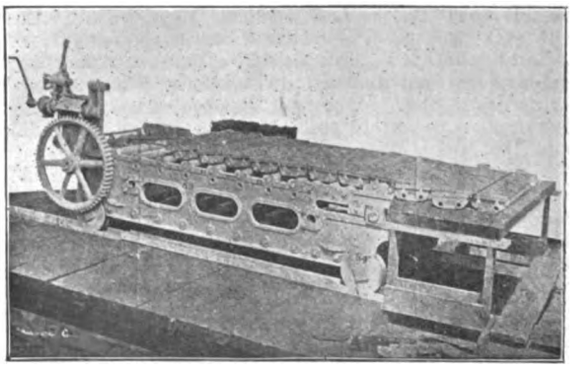

Fig. 3.—General View of Babcock and Wilcox Revolving Grate.

How important it is that the excess of air should be kept down is shown by the following table:—

—	Test of water-tube boiler at St. Pancras.		Test of water-tube boiler at Glasgow.		Result of the Glasgow test if excess of air had been prevented.	
	B.T.U.	%	B.T.U.	%	B.T.U.	%
Heat transferred to water	10,463	72·6	8,228	68·0	9,960	83
Heat carried off with products of combustion and excess air...	1,792	12·4	2,959	25·25	1,440	12
Heat in unburnt fuel mixed with ashes ...	316	2·2	417	3·45	240	2
Heat radiated & otherwise unaccounted for	1,829	12·7	390	3·22	360	3
B.T.U. in fuel.....	14,400	100·0	12,012	100·0	12,000	100

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In column 1 I give the figures of an often-quoted test made with a water-tube boiler using the best Welsh coal, hand-fired. In this case only about 12·5 per cent. of the heat was carried off with the products of combustion and excess air. Owing probably to considerable radiation losses the efficiency of the boiler in this case was not extremely high, being under 73 per cent. In column 2 I give the results of a test made at Glasgow with a water tube boiler, coal having a calorific value of 12,000 B.T.U. being fired by automatic stoking apparatus. From the inefficient working of this apparatus it was found difficult to keep the bars properly and evenly covered, so that what otherwise would have been an extremely good result was spoilt, as the heat losses due to heat carried off with the products of combustion and by exces air were over 25 per cent., so that the total efficiency therefore worked out at only 68 per cent.

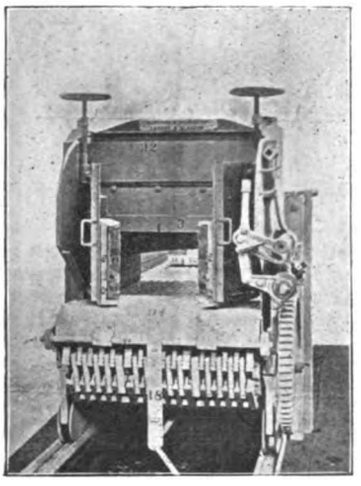

FIG. 4.—Front View of Babcock and Wilcox Revolving Grate.

In column 3 I give the results that ought to have been obtained at this test with automatic stoking of this class of fuel if this excess of air had been properly controlled.

Since I commenced the preparation of this Paper I have learnt that the Babcock and Wilcox Co., who have already done so much to reduce the cost of steam raising, have actually perfected and brought into practical use a form of furnace which combines a considerable number of the requirements that I have laid down in this Paper as necessary for the satisfactory and economical burning

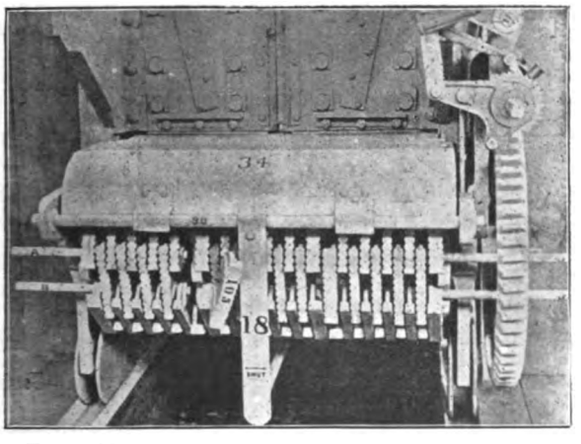

FIG. 5.—Front of Babcock and Wilcox Revolving Grate, showing Detail on a Larger Scale.

of cheap fuels. In the Babcock and Wilcox new revolving grate, illustrations of which I am able to put before you on the screen, it will be seen that they provide a modern revolving grate which performs the duties of feeding the fuel on to the front of the grate and delivering the ashes and clinker at the back of the grate in a most satisfactory manner. The whole grate is mounted on a removable frame running on rails so that it can be removed from the furnace and ready access given to the parts for examination, renewal, or repair. The difficulty of getting rid of the clinker and ashes at the back of the grate without admitting air at this point was a matter in which the old Juckes grate was defective. This is got over by means of a very heavy cast-iron flap which rests on the revolving bars at their back end. The bars have to move forward under this flap, and as it has a sharp edge the clinker and ashes are removed from the bar, slide over its inclined surface, and are delivered into an air-tight receptacle at the back, from whence they can be removed by a conveyer or other convenient means. It is probable that this revolving furnace is a great step in advance, and probably the only addition that is required to perfect it is the addition of the combustion chamber which I have described.

In order to show the proportion the cost of fuel bears to the total cost of generating energy in a modern power station of moderate size I have extracted figures from the log book of the power station of our new Chelmsford works, from which I have prepared the accompanying table, which shows that, under the actual conditions of working the plant during the last 49 weeks and at an average price of 17s. 5d. per ton of coal (which was Nottinghamshire steam hard of the best quality), the cost of the fuel was 64 per cent. of the total cost of 0·77d. per Board of Trade unit delivered to the tools. The plant is of moderate size; including spares, its maximum rate of output at present is about 250 kilowatts. It is not easy to give the average rate at which it is worked, but it is probable that this is at the rate of about 120 kilowatts during 54 hours per week and 50 kilowatts during the night shift during 62 hours per week. If the plant had been worked at the higher rate throughout the night as well as the day shift, the output would have been increased from 368,000 Board of Trade units to 680,000 Board of Trade units, and the cost prices would have been modified, as shown in the second column—that is to say, that the cost of coal would then have been about 76 per cent. of the total cost, which would stand at 0·63d. per unit. If, however, this plant were put to work within the radius of 50 miles from collieries, where cheap coal at 5s 4d. per ton could be supplied, and the furnaces of the boilers modified to suit this fuel in the manner I have indicated, the figures in the third column would be obtained at the rate of output in column 1, and those in the fourth column at the rate of output in column 2; and it must be observed that in these two columns I have not reduced the cost of labour to the extent that might fairly be claimed by the saving in stokers' wages.

It is needless for me to point out to you that increasing the size of this plant would largely reduce the labour charge, so that it is probable that (exclusive of interest and depreciation) the total cost price of one farthing per unit would be reached in many cases, providing that the coal obtainable at 5s. 4d. per ton is burnt in a satisfactory manner. The fact that such figures are now easily within reach ought to be a powerful stimulus to the investment of capital in power distribution works.

Table showing the Proportion which the Cost of Fuel bears to the Total Cost in Chelmsford New Works Power Station.

—	Actual cost per B.O.T. unit at output of 368,000 units in 49 weeks.	Calculated cost if full night shift be worked, giving 680,000 units in same period.	Cost as in Col. 1 if coal at 5s. 4d. per ton were available.	Cost as in Col. 2 if coal at 5s. 4d. per ton were available.
Coal at 17s. 5d. per ton delivered at boilers ...	d. 0·488	d. 0·480	d. 0·15	d. 0·148
Stores ...	0·0293	0·016	0·0293	0·016
Labour, superintendence, two complete shifts, including flue and boiler cleaning ...	0·236	0·127	0·236	0·127
Repairs ...	0·016	0·009	0·016	0·009
Total ...	0·769	0·632	0·431	0·300
Coal to total cost ...	64 %	76 %	35 %	49 %

BOOKS RECEIVED.

(Copies of any of the undermentioned works can be had from *The Electrician* office post free, on receipt of published price.)

"Electric Lamps and Electric Lighting." By Dr. J. A. Fleming, F.R.S. Second and revised edition. (London: *The Electrician* Printing and Publishing Co.) 6s.

"Papers on Alternating Currents of Electricity." By T. H. Blakesley. Fourth edition. (London: Whittaker and Co.). 5s.

"The Official Gazette of the United States Patent Office." No. 8. Vol. LXXXIX. Published by authority of Congress. (Washington: Government Printing Office.)

"Picture Frame Making and Decorating." By C. G. Leland and T. Bolas. Being No. 3 of the Useful Arts and Handicrafts Series. Edited by H. Snowden Ward. (London: Dawbarn and Ward.) 6d.

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THE MAJERT ACCUMULATOR.

The accumulator invented by Dr. Majert, and manufactured by the "Akkumulatorenwerk Obersee" Co., presents some features in its construction which render it worthy of note. To begin with, the positive and negative plates are of different types. The former, in which the chief interest of the battery lies, are of the Planté, whilst the latter are of the Faure type, and consist of frames

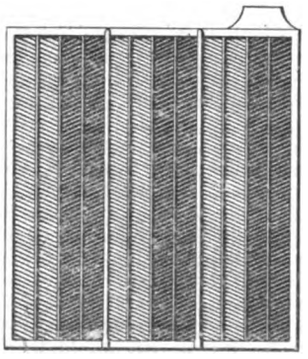

FIG. 1.—Negative Plate of Stationary Battery.

divided up by a lattice of peculiar construction, shown in Figs. 1 and 2. Fig. 1 shows the pattern which has been adopted for central station work, and consists, as will be seen, of a frame divided into several portions by perpendicular bars, which are connected by flat, obliquely placed cross pieces which form an angle with each other where they meet the perpendiculars. Fig. 2 gives the form of plate which has been adopted for traction work. The frame is divided by

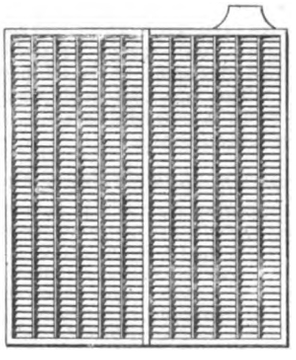

FIG. 2.—Negative Plate of Traction Battery.

vertical and horizontal rods crossing each other at right angles The openings in each end plate are narrower on the one side than on the other, whilst in the centre plates the openings contract from one side to the middle, so that a firm hold is given to the pastilles. These frames are filled in with a paste admixed with some substance which renders it porous. The positive electrodes (Fig. 3)

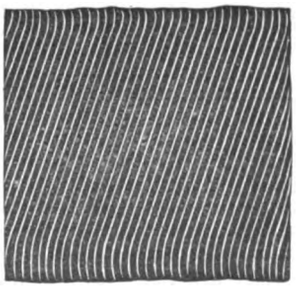

FIG. 3.—Piece of Positive Plate. Full size.

are made of plates of rolled lead, which are furrowed with fine, deep grooves, so that their surface appears something like the under side of a mushroom. This grooving is effected by means of a sort of planing machine (Fig. 4) with a tool whose cutting edge is at an angle of 70deg. with the plate, and turns up shaving after shaving without completely detaching it, thus enormously increasing the effective area of the electrode, whilst the fine laminæ retain between their surfaces the peroxide formed during charge. Expansion of the working surface can take place without affecting the supporting portion of the plate. The roller seen to the left of the tool presses the lead sheet hard down against the iron plate upon which it is fixed, to prevent the sheet itself from being raised by the action of

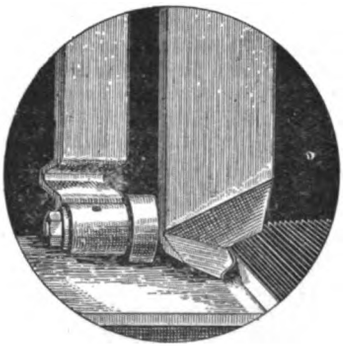

FIG. 4.—Machine for Shaping Positive Plates.

the tool. The battery is made in two patterns, which have been designed for central station and traction work respectively; and from a report on a year's working of 100 batteries of the latter type, containing 20,000 positive electrodes, it appears that a small number were injured by a careless short-circuit of the battery, whilst in regular work only 18 had to be replaced. This is an encouraging

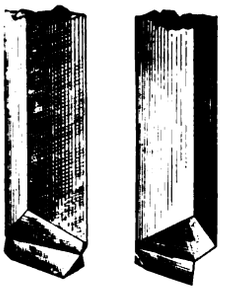

FIG. 5.—Cutting Tool. Half full size.

result when one considers the heavy strain on batteries which is involved by the constant stopping and starting of tramcars and the jolting to which they are subjected; and if the Majert accumulator will give equally good results when used for the propulsion of vehicles on ordinary roads, it may yet prove a rival to the oil engines which at present hold the field for motor cars and carriages.

METHODS OF SUPPRESSING ARCS IN SWITCHES, FUSES, &c.*

BY ERNEST KILBURN SCOTT, A.M.INST.C.E.

PART I.—SWITCHES.

When two terminals through which current is flowing are drawn apart, the area of contact becomes gradually less and less, until just before connection is actually broken the area is so small that the metal vaporises. This vapour is equivalent to inserting a resistance between the terminals, and if there is a well-sustained voltage then current is forced across, and the C^2R loss appearing as heat in a very confined space, we get an arc which, unless suppressed in some way, will continue to feed itself by vaporising still more metal. Except under very special circumstances, to be mentioned later, we cannot *prevent* an arc forming. We can, however, *suppress* it after it has formed, and the writer proposes to discuss some of the devices which have been devised from time to time with this object.

Quick Break.—At a very early stage in electrical work it was found that, by separating two contacts at a very *rapid* rate, the path of vaporised metal increased, so quickly that the current was unable to maintain its value, and the arc broke down.

Material of Contact.—Another point soon noticed was that the higher the melting point of the metal the less the arcing, due to the fact that less conducting vapour was set free in a given time. An absolutely infusible metal, if such were possible, would not arc;

* Paper read before the Northern Society of Electrical Engineers, Dec. 5.

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neither would a metal having zero resistance : it follows, therefore, that switch contacts should have as low a resistance and as high a melting point as possible ; the low resistance of copper and the high fusing point of platinum, for example, as is arranged in Berend's switches, which have copper contacts fitted with platinum tips to take the arc. Carbon is one of the most refractory of conducting substances which electrical engineers use, but unfortunately, owing to its granular formation, a good contact cannot be depended

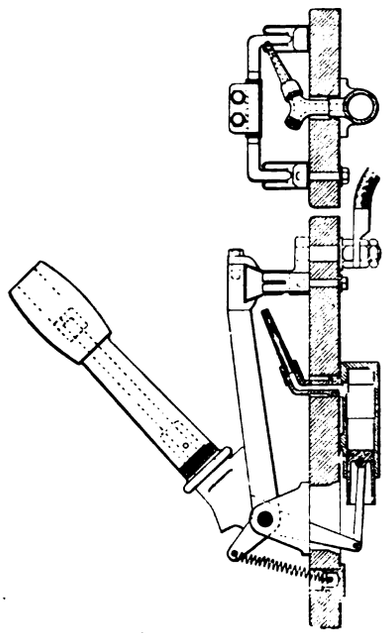

Fig. 1.—Pneumatic Blow-out Switch.

on ; and even if it could, the resistance would in most cases be too great for practical work. The best that can be done, therefore, is to employ it as a subsidiary contact block by arranging the carbon in multiple with the main switch in such a way that the main contacts are opened first, current being thus shunted through the carbons, which act as a resistance and at the final break receive the full effect of the arc.

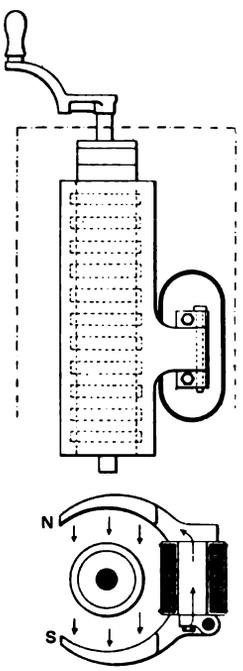

Fig. 2.—Magnet Blow-out Controller.

Multiplication of Breaking Points.—Other things being equal, the arcing which takes place between two sharp points is much less than that between flat surfaces. It is also found that breaking a given current at a number of points does not volatilise nearly so much metal as if all the arcing occurred at one point, this being probably due to the cooling effect of the larger volume of metal necessitated where there are a number of breaking points. Once an arc is fairly established there would be, of course, no cooling effect worth mentioning, however large the surface.*

There is a limit at which a quick break, multiplication of contacts, the employment of carbon, &c., gives satisfaction, and with the increasing employment of high voltage and large powers much ingenuity has been called into play.

Pneumatic Blow-out —As the arc is primarily the result of a stratum of metallic vapour reaching from one piece of metal to another, it follows that a simple way to stop arcing would be to dissipate the conducting vapour in some way, and an effective method of doing this is to blow out the arc. This idea was first introduced on the Thomson-Houston arc lighting machines, each machine being fitted with a small blower capable of giving two jets of air at about 10lb. pressure. (In some of the larger American stations an air-pump and reservoir is laid down capable of supplying several machines.) The bare idea of applying a pneumatic blow-out to a switch has been suggested many times, but although such an excellent arrangement, it is only within the last year or so that it has

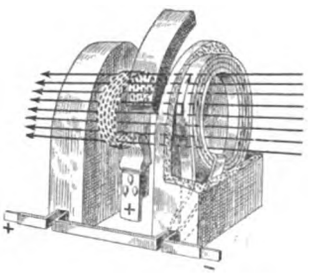

Fig. 3.—Solenoid Blow-out Controller.

had practical application, it being now used for switches for long distance transmission of power work in America. The writer got out designs for a high-tension switch, fitted with air blow-out, as early as 1895, and Fig. 1 shows such a switch for 2,200 volts 75 amperes, fitted with loose handle and spring quick break. In being pulled into the off position air is forced from the cylinder at back of marble slab, and is directed against the contacts by means of two fibre nozzles.†

To Stop Arcing by Partial Vacuum.—At the central station of the Burgdorf-Thun three-phase electric railway at Spiez, the switch contacts are so arranged that when drawn apart a partial vacuum is set up which has the effect of shutting down the arc. The arrangement is very simple, the switch contact being driven into an ebonite tube, into which it fits fairly closely, and at the bottom of which there is the other contact.

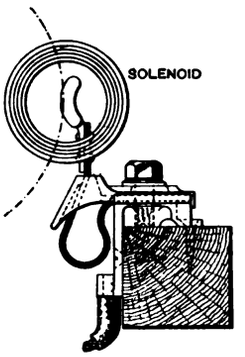

Fig. 4.—Contact of Solenoid Blow-out Controller.

Magnetic Blow-out.—It was thought at one time that the *magnetic blow-out device* of Prof. Elihu Thompson had solved the trouble of arcing at switch contacts, but experience has shown that it has its limitations.‡ As is well known, it was originally designed for lightning arresters ; it was then brought into use for circuit breakers on tramway switchboards, but its principal application has been on series parallel controllers for tramcars. The arrangement of a con-

* Simply striking at an arc with a mop of cocoanut fibre or other material that will not easily catch fire is very effective. At Deptford arcs of 3,000 H.P. and 10,000 volts have been repeatedly broken in this way.

† It may be noted that the main switches used on the Brooklyn electric lighting system are fitted with an electrically-controlled pneumatic attachment, but the actual break is made under oil. It is therefore not a blow-out switch, but one in which compressed air is used for actually operating the switch. A similar arrangement is used at Niagara, and on the Pennsylvania Railroad.

‡ It is interesting to note that Mr. J. D. F. Andrews as early as the year 1887 carried out experiments in which this magnetic blow-out idea was used. He was endeavouring to produce a satisfactory alternating-current rectifier, and to overcome the sparking used laminated iron brushes magnetised by means of coils wound upon them.

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troller blow-out is shown diagrammatically in Fig. 2. It will be seen that the north and south poles of the magnet are so arranged that lines of force stream right across the cylinder contacts, and as this distance is about 9in., a good deal of energy is required to produce a strong magnetic field between them. Whilst the car is in use the magnet coil must always be kept in the main circuit of the trolley wire, because if it were only cut in just before the motorman moved his controller handle, the pole-pieces would not be magnetised in time to blow out the arc formed between the segment and contact finger. There would also probably be further trouble due to self-induction. It will thus be seen that keeping the magnet continuously excited is a serious drawback, on account of energy being used up all the time. A further obvious objection is that, owing to the confined space, the area of the magnet iron is limited, and thus, although the blow-out works satisfactorily up to the point when the

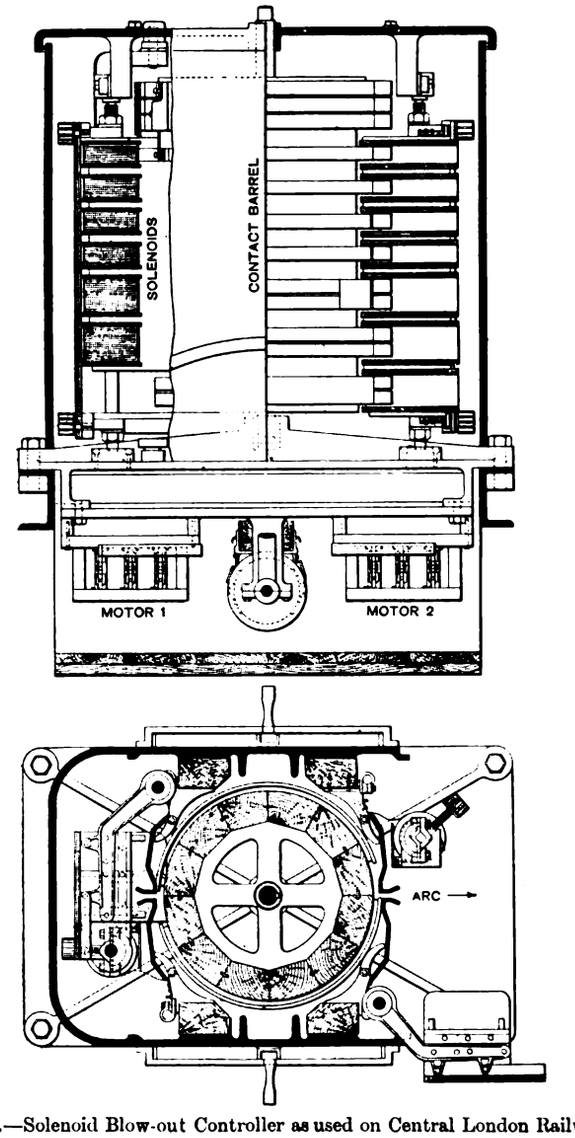

FIG. 5.—Solenoid Blow-out Controller as used on Central London Railway.

magnet becomes magnetically saturated, for any extra large currents which have to be taken the magnetic field is not strengthened in proportion, and the blow-out thus falls short just at the very time that effective operation is most sorely needed.

Solenoid Blow-out.—These drawbacks led Mr. S. H. Short to introduce what is known as the "solenoid blow-out controller," in which the electric magnet is replaced by a number of small solenoids (one to each contact). Each solenoid consists of a spiral of copper ribbon insulated with asbestos, forming a disc about 3in. in diameter and $\frac{3}{8}$in. in thickness, with a hole in the centre $1\frac{1}{2}$in. in diameter. This spiral is embedded in a vulcabeston partition placed between the contact fingers of the controller. The two ends of the copper ribbon are brought through the edge of the vulcabeston partition, as shown in Fig. 3, and are connected with the adjacent solenoids throughout the entire length of the fingerboard. The opening in the centre of the spiral comes just opposite the contact of the finger with the cylinder, and it is through this that the blowing-out effect is produced. The main trolley current passes through these solenoids for an instant only when an arc is to be broken, this being accomplished by a contact finger, and its corresponding controller segment shunting the current through the solenoids at every running notch of the controller. Fig 4 shows a detail of the finger contact in relation to the solenoid.

The advantages of the arrangement are :—

1. There are no metallic pole-pieces in close proximity to the points where the arc is formed, and consequently less danger of the current being grounded. The contact fingers and segments of the cylinders are also quite free and open for inspection and repair.

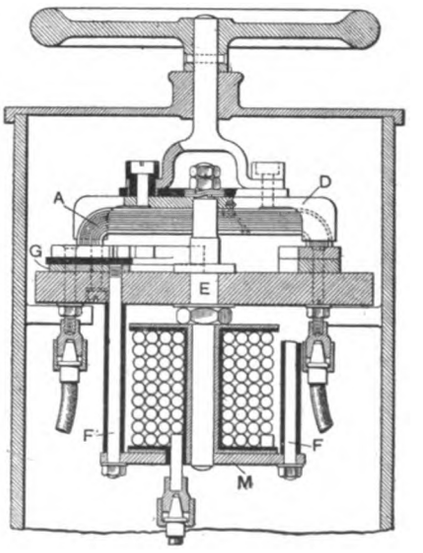

FIG. 6.—Hopkinson and Wood's Magnet Blow-out.

2. As the solenoid does not get saturated, the blow-out effect increases in direct proportion to the current whose arc is to be destroyed.

3. The magnet blow-out drives the arc in a direction parallel to the axis of the controller cylinder, and thus causes the flame to impinge against the vulcabeston partition, burning holes, and sometimes forcing the arc round to the next contact finger. With the solenoid blow-out the arc is driven directly away from the cylinder in a direction at right angles to its axis, and the insulating partitions are therefore never swept by the arc; nor is it possible for the arc to jump to the next segment, as the solenoid effect is produced between each of them individually.

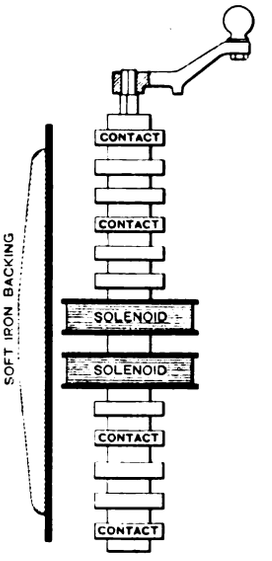

FIG. 7.—Oerlikon Magnet Blow-out Controller.

4. There is no magnet to excite, and the action is therefore instantaneous; whilst there is very little waste of energy, as the solenoid is only in circuit at the instant of the formation of the arc.

5. The magnet blow-out depends solely for its action on the magnetic field, and this has the effect of cutting the arc instantly in two (made manifest by the sharp report produced). Excessive self-induction in the windings of the motors is the result, and the insulation of the armatures and field magnets is thus very liable to be punctured. The solenoid, on the other hand, appears to have the property of easing down the current quietly, something like the effect of a fuse.

Fig. 5 shows the controller fitted with solenoid blow-outs, as used on the Central London Railway.

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Hopkinson and Wood Magnetic Blow-out.—Fig. 6 shows the magnetic blow-out as applied to a point contact switch by Messrs. Mather and Platt. A is the laminated contact brush and D is an iron cover, the magnetic circuit being D, F, M, F, and G. A similar arrangement to this was fitted on the controllers of the Hartlepool electric tramcars by the Electric Construction Co., Limited.

The Oerlikon Series Parallel Controller.—In this controller the magnetic field is set up by two stationary solenoids which surround the main contact cylinder. The centre of this cylinder is of iron, and the return circuit is formed by a metal backing to plate carrying the vulcabeston partitions. The arrangement is said to be very effective, and, as will be seen from Fig. 7, it takes up very little space.

Car Lighting Switch and Fuse.—The General Electric Co. of America make a very neat car lighting switch and fuse in which is incorporated the magnetic blow-out idea. The arrangement is shown in Fig. 7A, and it will be noticed that there is a small electromagnet immediately below the fuse wire. Although only $\frac{1}{8}$in. is allowed between the terminals, yet this is found sufficient for a 500-volt car circuit when the blow-out device is used.

Combined Solenoid Blow-out and Fuse.—A clever combination of the solenoid blow out and fuse has recently been devised. It consists of a fuse wire carried round a porcelain block many times and attached to terminals at either end. The fuse wire itself thus forms a solenoid, and when a heavy current passes the magnetic field given by the spiral is sufficient to deaden the arcing, the direction of the magnetic field being such that what arcing does occur is driven outwards from the centre support.

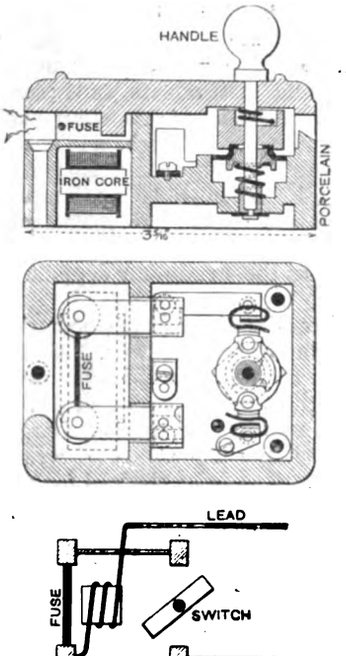

FIG. 7A.—Car Switch and Fuse with Magnetic Blow-out.

Circuit-Breaker and Shunted Fuse.—Circuit-breakers which have been so uniformly successful for voltages of 500 or so failed with several thousand volts even when the break was increased to several feet. This fact and the inconvenience of operating very large switches therefore necessitated some special method of using this valuable appliance for high-tension work. This was found in the addition of a thermal device in the form of a shunted fuse, as first suggested by Mr. Mordey in 1888. The circuit-breaker contacts are arranged to give a comparatively short opening, and when the breaker is opened by the usual magnetic device current is thrown on to the fuse, which, being enormously overloaded, goes off with violence, sufficient time having, however, elapsed to enable the circuit breaker contacts to get a fair distance apart. It is interesting to note that one of the principal arguments with those advocating circuit-breakers has always been that the employment of circuit breakers saved the cost of fuse renewals, and also the time necessary to get a new fuse into place. The addition of the shunted fuse nullifies these points, and it is a question therefore whether it would not be cheaper and better to employ a fuse only.

The writer does not propose to describe lightning arresters* in detail, but there are forms in use which are so nearly akin to circuit-breakers that it may be interesting to briefly refer to them.

(To be concluded.)

* The name lightning arrester is a misnomer, as its purpose is to give the lightning the shortest possible path to earth, its *arresting* properties being only necessary for stopping the arc which follows after the lightning flash, and which arc is apt to be kept up by the machinery working on the circuit.

THE TORONTO MAGNETIC OBSERVATORY.*

BY R. F. STUPART, DIRECTOR.

On the recommendation of the Royal Society and the British Association, the British Government determined in 1840 to establish a fixed magnetic observatory in Canada, and it was decided that it should be placed under the general supervision of the Ordnance Department of the Army. Arrangements having been completed, Lieut. Charles James Buchanan Riddell, R.A, was selected for duty in Canada. Leaving his detachment, consisting of four non-commissioned officers of the artillery, to embark with the instruments on a vessel bound direct to Quebec, he proceeded himself to Canada by the more expeditious route of the United States. Having waited on the Governor-General at Montreal to present a letter of introduction with which he had been furnished by the Master-General of Ordnance, and having communicated with the commanding engineer, to whom he was the bearer of instructions and authority to build an observatory, he proceeded to examine different localities which were suggested as convenient sites. The preference was finally given to Toronto, where a grant of two and a half acres of land belonging to the University of King's College was offered by the council of the University. The first observatory building was of logs, rough cast on the outside and plastered on the inside: it was completed during the summer of 1840, and the observations were begun in September. The operation of the observatory as an Imperial establishment was brought to a close in the early part of the year 1853, and was resumed under the authority of the Provincial Government in July of the same year.

In the autumn of 1853 the present observatory was commenced, to take the place of the old building. Very great care was taken during construction to ensure freedom from magnetism in all the stone used, and all nails and fastenings were of either copper or zinc. For 23 years the position of the observatory was, as far as known, faultless: observations were carried on systematically and carefully, and results were given to the scientific world which, with those obtained under the old military *régime*, have made the Toronto observatory famous in the history of terrestrial magnetism.

In 1876, however, trouble began with the erection of buildings close to the observatory, causing some very small changes in zero values. Then followed a few years later electric light circuits, which produced a change in the force instruments whenever the currents were turned on and off: this difficulty was in part overcome by the light company courteously agreeing to arrange their wires in the vicinity of the observatory in such a manner that the currents would counteract each other. The next difficulty occurred when a large addition was made to the neighbouring buildings before mentioned: tons of iron were used in construction in all too close proximity to the magnetic instruments, and much time and labour have been required to determine the precise effect of this "iron mine" on the various instruments. It was not, however, until the autumn of 1892, when the trolleys began to run, that we began to suspect that sooner or later the magnetic observatory would have to be removed to another site. The magnetic instruments in the observatory consisted of those brought out by Lieut. Riddell in 1840, of which eye readings have been taken six times each day, and of another set of instruments, consisting of a bifilar for the measurement of the horizontal component, and a balance needle for the vertical force, and a declinometer, all of which record photographically.

Electric cars first ran in Toronto on August 17, 1892. The line first put in operation was that on Church-street, which was followed on September 5th by one on King-street, between George and Dufferin streets. During the first few weeks, while a very small vibration of the needle was discernible on the V.F. curve, it was generally almost inappreciable, and it was not until September 20th that the movement increased to an extent sufficient to really impair the value of our magnetic curves. A marked increase of current must have been used on that day and afterwards. On October 10th the cars first ran on Yonge-street, and there was only a very small increase in the vibration, but a decrease of about 0·000070 of a dyne was observed when the current was on.

About 10 a.m. January 14th there was a marked increase of vibration, and the vertical force increased about 0·000200 of one dyne. This disturbed period was only temporary, and shortly after 5 p.m. on the 17th there was a reversal to the small vibrations. This continued until May 15th, when larger vibrations began again, and continued with varying intensity during the summer, while the decrease of the vibration with the current ranged from about 0·000200 to 0·000500. This disturbance was very great between September 12th and October 17th, and at intervals during the following year; but there was no radical change in conditions until December 17th, 1894, when a decrease of V.F., while the current was on, was changed to an increase, this occurring when the cars first ran on McCaul-street. Throughout 1895 the vibration and amount of permanent deflection

* Paper read before the Canadian Institute.

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was very nearly as it has been since; but on October 15th the increase of V.F. with the current was again changed to a decrease, this occurring at the time that the railway company made certain changes in the feed wires. It is noticeable that, although several changes occurred in the V.F., it at times having been less with the current on and at other times greater, the horizontal force showed a decrease on all occasions with the turn on of the current. This decrease during the past two years was 0·000200 to 0·000500 of a dyne. No appreciable deflection of the declinometer magnet was noted, the only effect being a continuous vibration, which rendered the curves very ragged and difficult to read with accuracy. A study of the traces during the times that the various electric lines were put in operation showed that, with the currents ordinarily used, there was little effect at three-quarters of a mile, and a further survey with a portable instrument afforded further evidence in the same direction.

Before definitely recommending that the magnetic observatory should be removed from Toronto, the director wrote to various well-known magneticians, present at the meeting of the British Association in August, 1897, requesting the favour of their presence at the observatory to inspect the photographic magnetic curves there obtained, with the view of expressing an opinion as to the advisability of continuing the records at the present site, or of removal to some point distant from electric tramways. Prof. Rücker, F.R.S., Prof. Carey Foster, F.R.S., Prof. Fitzgerald, F.R.S., Dr. Van Rijckevorsel, and Prof. Frank Bigelow, were the gentlemen who courteously accepted the invitation, and were pleased to sign a statement that, in their opinion, the value of the magnetic observations at Toronto had been seriously impaired by the trolley system, and advised removal to some other site.

It then having been decided to remove the observatory, a point was chosen nine miles north-east of the former magnetic observatory, latitude 43° 47′N., longitude 79° 16′W., easily accessible by railway, and yet very unlikely to be invaded by the trolley system. At present there is no electric railway within seven miles, and little prospect of one within five miles for many years. The new observatory, which was commenced in June and finished during the early days of September, consists of two parts—a circular stone cellar and an above-ground structure. The cellar is 19ft. in diameter, the walls 2ft. in thickness, the floor concrete, and the roof covered with felt and gravel, in which, on stone piers sunk in concrete to a depth of 6ft. below the floor, are placed the self-recording photographic instruments—namely, the declinometer for recording changes in the direction of the magnetic needle, and the bifilar and vertical force instruments for registering respectively changes in the horizontal and vertical components of the earth's magnetism. Above ground, and connected with the observatory by a flight of steps, is an erection which is divided into two portions, in the larger of which absolute magnetic determination will be made, piers being provided on which to place the necessary instruments, and an adjustable opening on the roof for transit work: the smaller portion is an office, which will be heated by a copper stove.

Observations were first made in the new observatory on September 10th, and by October 1st all the instruments had been adjusted in their new position and everything was running smoothly. Results already obtained show that values will differ but slightly from those obtained at the old observatory, and a very careful comparison was made before dismounting the old eye-reading instruments in Toronto. Very great care was taken in selecting materials for the building. Every stone used was tested for magnetic effect, and none but copper and zinc nails and fastenings have been used.

There appears to be every prospect that the new observatory will be admirably suited for the purpose for which it was designed, and there is strong reason to think that the series of observations at Agincourt will be practically a continuation of the old and valuable series of observations made in Toronto. All photographic records will be sent for development to the Toronto observatory, which continues to be the central office of the Meteorological Service of Canada.

ELECTRICITY WORKS ACCOUNTS.

The Prescot Electric Supply Works.

The Prescot undertaking commenced supply in 1891, and in 1895 a Provisional Order was granted the British Insulated Wire Co., who are the owners of the works.

Up to the end of last year the total capital expended on the supply works by the company had amounted to £24,124, representing £95·4 per kilowatt capacity of the station. It will be noticed that, although the number of consumers was increased from 60 to 80 in 1898, yet the equivalent lamp connection has dropped from 4,750 to 3,800 8 c.p. lamps, while the output has diminished by no less than 59 per cent.

We are informed that this retrogression is due to the expiry of a contract with a large consumer. It is interesting to note the high load-factor which obtains at Prescot—viz., one of 17 per cent. in 1897 and 18·7 per cent. in 1898. In view of the retrograde alteration in the two factors which vitally influence the costs, it is not very surprising to find that the latter have increased. As compared with those of 1897, the total costs of 1898 are more than 0·9d. per unit higher, the rise in the works costs being 0·86d. and in the management and property charges 0·08d. per unit. Considered in relation to the output of only 84,189 units sold, the total costs in 1898 at 3 16d. per unit are certainly much less than might have been expected.

The total revenue from all sources averaged 3·8d. per unit sold, of which 2·23d. accrued from ordinary consumers for current, 1·06d. from public lighting, and 0·45d. from sale and repair of various apparatus.

The result of the year's operations was a working profit of £226, representing 1·18 per cent. of the mean capital expended. £160 was contributed to the depreciation fund, leaving a clear balance of £66 for the year.

St. Helens Municipal Electric Supply Works.

Having started supply in October, 1896, the year ended at March 31st last was the second completed year of working of the St. Helens undertaking. The capital expenditure to that date was £21,770, of which during the year under notice the expenditure on buildings was £1,071; on machinery, transformers, meters, and instruments £461; on mains £5,511; on traction line equipment and traction plant £679, and on engineers' fees and general charges £487.

During the year the lamp connections have crept up from the equivalent of 4,526 to 6,463 8 c.p. lamps, with an increase in the number of consumers of 16. The output made a good stride—viz., from 35,758 to 65,091 units sold—an advance of 82 per cent., while the maximum demand has risen to 108 kilowatts.

The financial results of the year's operations show that the business is making rapid headway. At an average revenue of 5·75d. per unit the total receipts amounted to £1,559, and after deducting the expenditure of £1,217 there remained a working profit of £342. The interest charges were £417 and the sinking fund charge £265. There was thus a deficit for the year of £340. The price charged for current for lighting purposes has now been reduced from 6d. to 4d. per unit.

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

Aberdeen (Municipal)	Jan. 6, 1899	Kingston-upon-Hull (Mun.)	June 9, 1899
Ayr (Municipal)	Sept. 22, ,,	Kingston-on-Thames (Mun.)	April 21, ,,
Bedford (Municipal)	May 19, ,,	Lancaster (Municipal)	Oct. 21, 1898
Belfast (Municipal)	Sept. 15, ,,	Leeds (Municipal)	Dec. 1, 1899
Birmingham (Company)	Sept. 15, ,,	Leicester (Municipal)	Jan. 20, ,,
Blackpool (Municipal)	Sept. 29, ,,	Leyton (Municipal)	Sept. 8, ,,
Bournemouth (Company)	April 28, ,,	Liverpool (Municipal)	June 9, ,,
Bolton (Municipal)	Nov. 24, ,,	Manchester (Municipal)	Aug. 11, ,,
Bradford (Municipal)	April 14, ,,	Newcastle and District (Co.)	Oct. 6, ,,
Brighton (Municipal)	May 12, ,,	Newcastle-upon-Tyne (Co.)	April 14, ,,
Bristol (Municipal)	July 14, ,,	Northampton (Company)	Oct. 20, ,,
Burnley (Municipal)	Aug. 25, ,,	Norwich (Company)	Nov. 17, ,,
Burton-upon-Trent (Mun.)	April 21, ,,	Notting Hill (Company)	Mar. 17, ,,
Bury (Municipal)	Sept. 22, ,,	Nottingham (Municipal)	July 21, ,,
Cambridge (Company)	Mar. 10, ,,	Oldham (Municipal)	Dec. 1, ,,
Cardiff (Municipal)	Jan. 6, ,,	Oxford (Company)	May 19, ,,
Charing Cross (Company)	Mar. 17, ,,	Pontypool (Company)	May 5, ,,
Chelsea (Company)	Mar. 31, ,,	Portsmouth (Municipal)	July 14, ,,
Cheltenham (Municipal)	Nov. 10, ,,	Preston (Company)	Sept. 29, ,,
Chester (Municipal)	June 23, ,,	Reading (Company)	Oct. 13, ,,
City of London (Company)	May 12, ,,	Richmond (Company)	Oct. 13, ,,
Clerkenwell (Company)	Aug. 18, ,,	Scarborough (Company)	Nov. 3, ,,
Derby (Municipal)	Dec. 9, 1898	St. James' & Pall Mall (Co.)	Feb. 24, ,,
Dewsbury (Municipal)	Nov. 24, 1899	St. Pancras (Vestry)	May 26, ,,
Dover (Company)	June 2, ,,	Sheffield (Company)	Dec. 16, 1893
Dundee (Municipal)	Nov. 4, 1898	Shoreditch (Vestry)	Oct. 27, 1899
Eastbourne (Company)	July 22, ,,	Southampton (Municipal)	Nov. 10, ,,
Edinburgh (Municipal)	Nov. 17, 1899	Southport (Municipal)	July 7, ,,
Exeter (Municipal)	Aug. 5, 1898	South Shields (Municipal)	July 7, ,,
Glasgow (Municipal)	Sept. 1, 1899	Stafford (Municipal)	Oct. 21, 1898
Guildford (Company)	May 5, ,,	Sunderland (Municipal)	July 28, 1899
Halifax (Municipal)	July 21, ,,	Taunton (Municipal)	June 16, ,,
Hammersmith (Vestry)	May 26, ,,	Tunbridge Wells (Mun.)	Sept. 1, ,,
Hampstead (Vestry)	Aug. 25, ,,	Wakefield (Municipal)	Dec. 1, ,,
Hanley (Municipal)	April 28, ,,	Walsall (Municipal)	June 23, ,,
Harrogate (Municipal)	Oct. 20, ,,	Wandsworth (Company)	Aug. 12, ,,
Harrow (Company)	June 16, ,,	Westminster (Company)	Feb. 24, ,,
Hast'gs & St. Leonards (Co.)	April 29, 1898	Whitehaven (Municipal)	July 28, ,,
H'use-to-H'useCo. (K'ns'gt'n)	Mar. 31, 1899	Windsor (Company)	Dec. 30, 1893
Hove (Company)	Mar. 10, ,,	Wolverhampton (Municipal)	June 30, 1899
Huddersfield (Municipal)	Oct. 6, ,,	Woolwich (Company)	Jan. 13, ,,
Islington (Vestry)	Oct. 27, ,,	Worcester (Municipal)	April 7, ,,
Kens'gton & Knightsbr' (Co.)	Mar. 3, ,,	Yarmouth (Municipal)	Nov. 3, ,,

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	PRESCOT.		ST. HELENS.	
Undertaking Worked by	The British Insulated Wire Co. (Limited).		St. Helens Corporation.	
Date of Commencement of Supply	1891.		October, 1896.	
System of Supply	Alternate-current transformers in sub-stations.		Alternate-current transformers, 2 and 3-wire.	
Chief Engineer	H. W. Sprunt.		J. S. Highfield.	
YEAR ENDED	DEC. 31, **1897.**	DEC. 31, **1898.**	MAR. 31, **1898.**	MAR. 31, **1899.**
QUANTITIES—				
Units generated	153,890	111,639	54,348	105,709
,, **SOLD (TOTAL)**	133,790	84,139	35,758	65,091
,, sold to consumers	93,282	48,139	35,758	60,296
,, sold for public lighting, &c.	35,508	36,000	nil	4,795
,, used on works	2,500	12,500	4,500	7,209
UNITS SOLD PER 8 C.P. LAMP CAPACITY	27·1	10·6	9·16	15·9
Maximum supply demanded	90 kilowatts	70 kilowatts	70 kilowatts	103 kilowatts
Number of public lamps	12 arc, 102 (16-c.p.) glow	23 arc, 104 (16-c.p.) glow	—	4 arc
Number of consumers	60	80	63	79
Connections to mains in 8-c.p. lamps	4,750	3,800	4,526	6,463
CAPACITY OF PLANT IN 8-C.P. LAMPS	4,940	7,910	3,905	4,600
CAPACITY OF PLANT IN KILOWATTS	158	253	125[a]	150[f]
CAPITAL—	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.
AUTHORISED (TOTAL)	— / —	— / —	£26,500 / £212	£51,500 / £343
Share	— / —	— / —	— / —	— / —
Loan (including Debenture charges)	— / —	— / —	26,500 / 212	51,500 / 343
RECEIVED (TOTAL)	£14,112[a] / £89·3	£24,124[a] / £95·4	9,646[b] / 77·2	9,646[b] / 64·3
Share	— / —	— / —	— / —	— / —
Loan (including Debenture charges)	— / —	— / —	9,646[b] / 77·2	9,646[b] / 61·3
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	— / —	— / —	16,500 / 132	41,500 / 277
Share (unissued)	— / —	— / —	— / —	— / —
Share (uncalled)	— / —	— / —	— / —	— / —
Loan (including Debentures)	— / —	— / —	16,500 / 132	41,500 / 277
REPAID (TOTAL)	— / —	— / —	— / —	— / —
RESERVE OR SINKING FUND	— / —	— / —	— / —	— / —
DEPRECIATION FUND	1,000 / 6·33	1,160 / 4·58	— / —	— / —
EXPENDED (TOTAL)	14,112 / 89·3	24,124 / 95·4	13,560 / 108	21,770 / 145
Lands and buildings	525 / 3·32	3,497 / 13·8	— / —	— / —
Plant	5,019 / 31·8	7,870 / 31·1	— / —	— / —
Mains	7,467 / 47·4	11,329 / 44·8	— / —	— / —
Miscellaneous	1,081 / 6·84	1,429 / 5·65	— / —	— / —
BALANCE OF CAPITAL ACCOUNT	— / —	— / —	−3,914[c] / −31·3	−12,124[c] / −80·8
REVENUE—	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.
TOTAL	£1,504 / 3·415d.	£1,333 / 3·806d.	£919 / 6·170d.	£1,559 / 5·750d.
Revenue from supply	1,391 / 2·495d.	776 / 2·214d.	899 / 6·035d.	1,500 / 5·532d.
,, meters, &c.	22 / 0·040d.	29 / 0·083d.	20 / 0·134d.	37 / 0·136d.
,, public lighting	444 / 0·797d.	370 / 1·056d.	— / —	22 / 0·081d.
,, sale of lamps, &c.	47 / 0·084d.	158 / 0·451d.	— / —	— / —
,, miscellaneous sources	— / —	— / —	— / —	— / —
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	£1,243 / 2·230d.	£1,107 / 3·159d.	£950 / 6·379d.	£1,217 / 4·490d.
WORKS COSTS	1,098 / 1·969d.	990 / 2·824d.	752 / 5·045d.	877 / 3·235d.
Generation of electricity	*1,002 / 1·797d.*	*901 / 2·570d.*	*746 / 5·005d.*	*823 / 3·035d.*
Fuel (including cartage, &c.)	566 / 1·016d.	465 / 1·326d.	119 / 0·799d.	163 / 0·601d.
Oil, waste, water, stores	88 / 0·158d.	56 / 0·160d.	41 / 0·275d.	30 / 0·111d.
Wages at station	346 / 0·621d.	360 / 1·027d.	491 / 3·295d.	557 / 2·054d.
Repairs and maintenance at station	3 / 0·005d.	19 / 0·054d.	96 / 0·644d.	73 / 0·269d.
Distribution of electricity	*30 / 0·054d.*	*23 / 0·066d.*	*6 / 0·040d.*	*53 / 0·195d.*
Wages, &c.	20 / 0·036d.	20 / 0·057d.	— / —	— / —
Repairs, renewals of mains, &c.	10[e] / 0·018d.	3[e] / 0·009d.	6 / 0·040d.	53 / 0·195d.
Public lighting	*66 / 0·118d.*	*66 / 0·188d.*	— / —	*1 / 0·004d.*
Attendance	56 / 0·100d.	56 / 0·160d.	— / —	1 / 0·004d.
Renewals	10 / 0·018d.	10 / 0·029d.	— / —	
MANAGEMENT AND PROPERTY CHARGES	145 / 0·260d.	117 / 0·334d.	193 / 1·329d.	340 / 1·254d.
Royalties	— / —	— / —	— / —	— / —
Rent, rates, taxes	*17 / 0·031d.*	*15 / 0·043d.*	*143 / 0·960d.*	*153 / 0·564d.*
Management	*128 / 0·230d.*	*102 / 0·291d.*	*55 / 0·369d.*	*187 / 0·690d.*
Salaries	82 / 0·147d.	60 / 0·171d.	—[e] / —	104 / 0·383d.
Stationery, &c.	9 / 0·016d.	7 / 0·020d.	37 / 0·248d.	71 / 0·262d.
Establishment charges	8 / 0·014d.	7 / 0·020d.		
Law charges, &c.	29[b] / 0·052d.	23[d] / 0·080d.	18[d] / 0·121d.	12[g] / 0·044d.
FINANCIAL RESULTS—	Total / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded
WORKING PROFIT FOR YEAR	£661 / 5·07%	£226 / 1·18%	−£31 / −0·251%	£342 / 1·94%
Sum carried to Depreciation Fund	500 / 3·83%	160 / 0·84%	— / —	— / —
Sum carried to Reserve or Sinking Fund	— / —	— / —	— / —	265 / 1·50%
Net interest on loans (incl. Debenture charges)	— / —	— / —	306 / 2·57%	417 / 2·36%
BALANCE FROM LAST ACCOUNT	519 / 4·21%	710 / 3·71%	— / —	−377 / −1·91%
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	710 / 5·44%	777 / 4·06%	— / —	— / —
Deficit	— / —	— / —	*337 / 2·84%*	*677 / 3·83%*
ORDINARY DIVIDEND PAID	— / —	— / —	— / —	— / —
PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE	65·3%	83·1%	103%	78·1%
Expenditure per kilowatt capacity	£7. 17s. 5d.	£4. 7s. 6d.	£7. 12s. 0d.	£8. 2s. 5d.
REVENUE PER KILOWATT CAPACITY	£12. 1s. 0d.	£5. 5s. 5d.	£7. 7s. 0d.	£10. 8s. 0d.
Expenditure per 8-c. lamp capacity	5s. 0½d.	2s. 9½d.	4s. 10½d.	5s. 2½d.
REVENUE PER 8-C.P. LAMP CAPACITY	7s. 8½d.	3s. 4½d.	4s. 8½d.	6s. 7½d.
REVENUE PER 8-C.P. LAMP CONNECTED	8s. 0½d.	7s. 0½d.	4s. 0½d.	4s. 9½d.
Price charged for lighting, per unit	6d. to 3d.	5d. to 3d.	6d.	6d.
Price charged for power, per unit	1d.	1d.	—	3d.
Price charged for public lighting	By special contract.	By special contract.	—	3d. per unit.

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Telephone: 949 Holborn. *Telegrams:* "ELECTRICIAN NEWSPAPER LONDON."

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NEW ELECTRIC LIGHT AND POWER SCHEMES.

There is every prospect of continued activity in the electrical field, not only during the ensuing year but for several years to come. This is evident from the large number of new schemes for electric light and power supply which it is proposed to bring before Parliament during the coming session. Practically all the important towns in the United Kingdom have already their electricity supply works, and yet the number of provisional order notices and private Bills to come on this session exceeds considerably those in previous years. This is not merely because the advantages of the electric light are becoming more appreciated in the smaller towns and less thickly populated districts. In fact, if the aggregate capacity of the schemes in kilowatts or horse power this year be compared with the capacity for any preceding year, the total would probably be greater. This is due partly to the continued spread of electric traction, and partly to the increasing number of large projects for supplying "electricity in bulk." These latter refer not only to new districts not hitherto blessed with a public supply of electrical energy, but also, as last year, to a number of projects for supplementing the supply to districts which have long been occupied. In 1898 the Metropolitan Electric Supply Co. acquired powers to build its new station at Willesden, from which it is now supplementing the supply from its overloaded local stations by means of two-phase currents generated at 10,000 volts pressure and reduced in the supply district to low-pressure continuous current by means of rotatory transformers. If we except the famous Deptford station, the Willesden station of the Metropolitan Electric Supply Co. is the first of its kind in this country to be situated several miles from the centre of its supply area. It will shortly be followed, however, by the South London Electric Supply Corporation, which is extending its mains over great distances, and is adopting single and two-phase systems of transmission and distribution; by the County of London and Brush Provincial Co., which has erected a station, not so far from the centre of their district, it is true, but whose new station will have a great deal in common with those supplying "in bulk" from a distance; and also by the station now being erected, in pursuance of powers obtained last year by the Kensington and Knightsbridge Co. and the

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Notting Hill Co. conjointly, in the neighbourhood of Hammersmith, where three-phase current at high pressure is to be generated and, after transformation by motor generators, distributed as low-pressure continuous current over the supply areas of the two companies. The metropolitan schemes this year include one of these "in bulk" systems—viz., that of the Charing Cross and Strand Electricity Supply Corporation, which seeks powers to purchase land in West Ham, and thence to supply electrical energy both to its existing distribution system and that contemplated in the City of London.

A curious Bill is that promoted by the City of London Co. This seeks powers for the compulsory acquisition of land to erect a new generating station in Southwark, and also to relieve the company from the obligations imposed on it by the City of London Electric Lighting Act of 1893 and the notorious contracts between the Commissioners of Sewers and the predecessors of the City of London Co. A Bill of unusual character is also introduced by the Corporation of the City of London. The Corporation desires to erect conduits or subways for the accommodation not only of electric lighting but also of telegraph and telephone wires, and to obtain powers to compel "the several companies, other bodies and persons" owning such wires (which would therefore include the Postmaster-General) to make use of this accommodation. If this were to apply only to wires and cables which may be laid down subsequently to the passing of such an Act, something might be said in its favour, but the endeavour to compel the removal of all wires and cables already under the streets and the placing of them in "such underground accommodation, receptacles, galleries, and approaches" may be designated an absurdity. The metropolitan provisional order notices also bear an unusual character this year. Of the five on the list, three are endeavours by local authorities to attack the position of a company which has held powers in their districts for some time and has not made use of them, while a fourth is an application by this same company for powers in another parish, evidently with the idea of strengthening its position. The fifth relates to Marylebone. While the Metropolitan Co. is firmly established there, and has of late been obtaining more consumers than it can supply (for whose benefit it has erected its new station in Willesden); while also the Marylebone Vestry are continuing the negotiations started a year ago for the acquisition of the Marylebone portion of the Metropolitan Co.'s undertaking, a new company—the Marylebone Electric Supply Co.—is applying for a provisional order. Whatever else may characterise the electric supply undertakings of the largest city in the world, at all events they suffer from an excess of Parliamentary procedure.

It is in the provinces that the greater number of "electricity in bulk" systems are contemplated. Brief particulars of all the various provisional order notices and notices of private Bills have already been published in our columns, and a list of the more important ones is repeated in our issue of to-day. It is interesting to compare two of the most important schemes—viz., those of the North Metropolitan Electric Supply Co. and the Lancashire Electric Power Co. Both companies wish to operate over an immense area, the former in portions of Middlesex, Hertford, and Essex which have been almost untouched by the electricity supply business, and the latter in the whole southern portion of Lancashire bounded by the River Ribble, where several electric supply concerns are already in operation and others are in process of construction. It is evident that the question of the authorisation of competing electricity supply concerns in the same district will again come up for consideration, and we cannot but hope that those of the "in bulk" companies who would be able to cheapen considerably the cost of electrical energy in districts already supplied by local authorities will not share the fate of the General Electric Power Distributing Co. of last year.

As might be expected, traction schemes are again very numerous, and procedure under the Light Railways Act is becoming more and more popular. Not only in the provinces, but also in the neighbourhood of London, have schemes been submitted for the approval of the Light Railway Commissioners, and the London County Council itself is among the applicants. Although there may be divergence of opinion as to the applicability of the Light Railways Act to all these new schemes, it is to be hoped, for the sake of the progress of electric traction, that the Act will not be read so rigidly as to exclude all those "light railways" which have a similarity to tramways. Local authorities may not have great advantages under this Act, but at all events companies have; and so long as electric tramway concerns are hampered by the Tramways Act of 1871, with its 21 years purchase clause, this application of electricity cannot be developed to its full extent.

One thing remains to be considered. Who will manufacture the plant for all these undertakings? Will the British manufacturer continue in his present groove and leave it to American, German, and Swiss firms to supply the modern types of machinery required? It is reasonable to suppose that a large proportion of the more important "in bulk" schemes will require two and three-phase generators and converting plant, and yet there is not a firm in this country that has manufactured a dozen such machines. In the Paper read recently by Lord Charles Beresford he referred to the possible opening for British manufacturers in China; but where is the need to go to China, when our manufacturers are beaten by foreign makers not only in our colonies and dependencies, but also in our own country? If the prime cause of this be, as some persist in stating, the difficulty of getting the raw material owing to this country's output of iron and steel not keeping pace with the demand, by all means let iron and steel be bought abroad. It is hardly a reason for British labour and British engineering skill vacating its position in the industrial world.

REVIEWS.

Copies of any of the undermentioned works can be had from *The Electrician* office post free, on receipt of published price.)

A Century of Copper. Part I., Statistics. By Nicol Brown and Charles Corbett Turnbull. (London: Effingham Wilson, 1899.) 2s. 6d.

The authors of this pamphlet have succeeded in making statistics interesting and at the same time fairly complete, a feat not always accomplished. The gradual growth of the copper trade is traced step by step from the year 1801 to 1898. In the decade from 1801 to 1810 the average price of copper was £160 per ton, and, of the £91,000 tons which the world produced, 65,000 came from Great Britain (Cornwall, Anglesea, and Ireland). During the following decade the output of Great Britain increased and that of other countries decreased, "other countries" being chiefly represented by Germany, Sweden, and Norway. Between 1821 and 1830 the introduction of steamers and railways created an increased demand for copper, which was met by the supply, Great Britain still leading, and in fact continuing to be the greatest copper producer during the following 20 years, after which the output from the Cornish mines began to decrease rapidly. Between 1831 and 1840 copper was first imported from Chili, a country which yielded no less than 202,000 tons between 1891 and 1898. The United States began to produce in 1845, and is now the

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greatest copper-producing country in the world, having yielded 1,411,000 tons during the last eight years, of which the Anaconda mine alone contributed 345,006 tons. Spain, now the second copper-producing country, furnished very little until after 1860, when the copper pyrites trade commenced slowly, and only began to assume such large proportions in the decade from 1871 to 1880. Interesting notes are given on the cupreous pyrites trade, and on the three notable combinations formed to control the copper market. The first one, that of the Associated Smelters of Swansea, resulted in Chili smelting practically all her own ore and delivering the copper all ready for the copper user. Between 1856 and 1865, 40½ per cent. of the copper from Chili was imported in bars, 38 per cent. in regulus, and 21½ per cent. in ore; between 1886 and 1895 the corresponding figures were 95 per cent., 3½ per cent.,

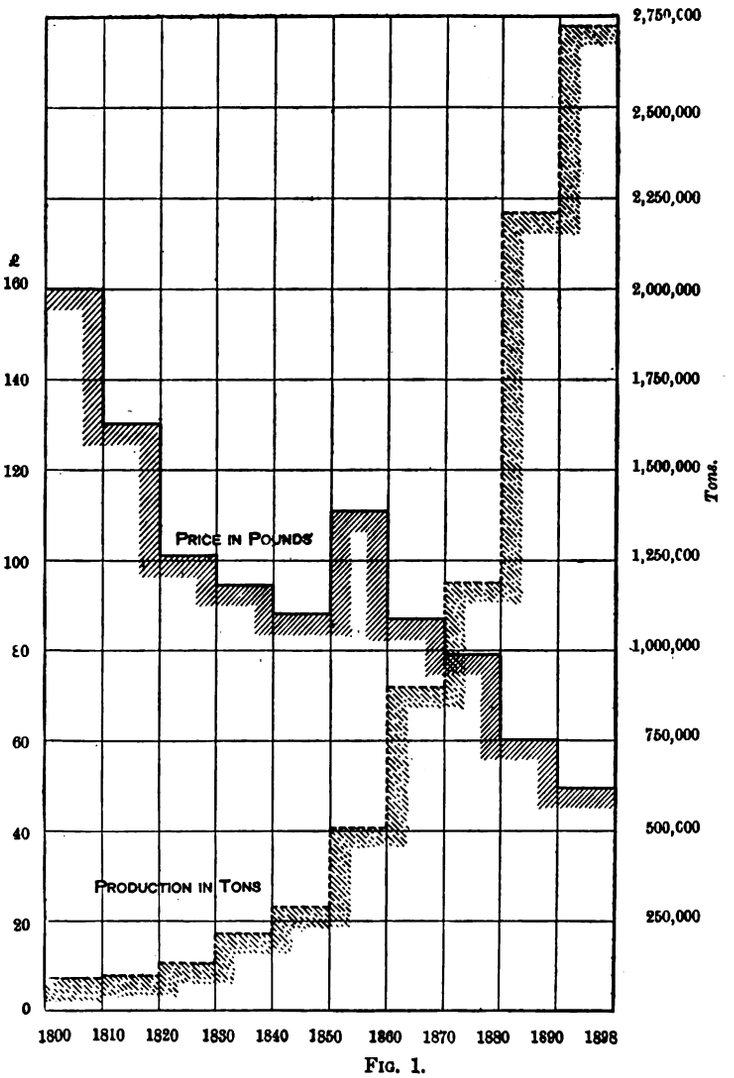

FIG. 1.

——— Average Price per ton of English Tough Copper during each decade of the century. ·-·-·-·-·- Total copper production during each decade.

and 1½ per cent. M. Secretan's attempt in 1888 and 1889, the second serious endeavour to force up the selling price of copper, will not be forgotten in financial circles—after copper had risen to over £100 per ton, it fell in one day from £70 to £35. The history of the recently-formed American "combine" and its present effect on the copper market hardly needs repetition. The last portion of the pamphlet is an admirable review of the life and exhaustion of copper mines, based entirely on statistics.

From some of the tables we have traced the above curves. Fig. 1 shows the variation in the average price of English tough copper during the present century (from a table prepared by Messrs. Vivian, Younger and Bond), and also the production during each decennial period. The last space in Fig. 1 only corresponds to the average price and production from 1890 to the end of 1898. Fig. 2 shows the variation in the price of G.M.B.s (good merchantable brands) during the past decade.

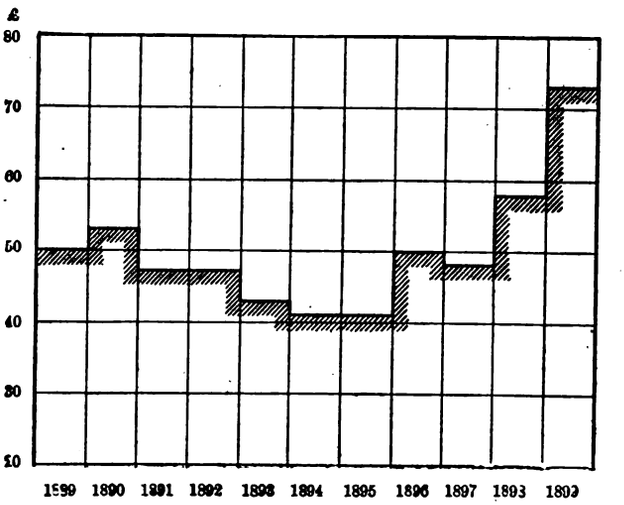

FIG. 2.

Price of G.M.B.s per ton on December 31st of each year from 1889 to 1899 (October 1st).

G.M.B.s are of 96 per cent. purity, and "tough" copper is stated to be of about 99½ per cent. purity, the latter commanding a price higher by £2 or £3 per ton.

Physikalisches Praktikum EILHARD WIEDEMANN and HERMANN EBERT. (Brunswick: Vieweg.) 10m.

The task of compressing all the most important elementary experiments of physics into a volume of 574 pages is not an easy one. It cannot be said that this has been accomplished by the authors, and probably their intention was to furnish a laboratory guide to those who have to take physics as a secondary subject in prosecuting their studies more seriously in another direction. The detailed description of experiments on the heat of solution, neutralisation, and hydration, refractive indices, absorption spectra, saccharimetry, and electrolysis make the work an admirable handbook of practical chemical physics, and the care bestowed upon this department is to a certain extent a novel feature of text-books of this class. What can hardly be too warmly praised is the number of beautiful illustrations with which the work abounds. It is not often that one finds the arrangement of an experiment made clear by half-tone cuts of the most modern type and finish. As regards the principles and details of the experiments, it is almost superfluous to say that they are on a level with the reputation of the distinguished authors. A list of apparatus required is given at the head of each experiment.

SEAT OF THE E.M.F. IN A VOLTAIC CELL.*

BY W. R. COOPER, M.A., B.SC.

The controversy caused by the contact and chemical theories died out as the doctrine of the conservation of energy sprang into existence. Since electrical energy must of necessity be obtained by the transformation of some other form of energy, it could not be produced by contact alone. But another controversy arose which has not yet been brought to a satisfactory conclusion. Admitting that contact force exists and that chemical action is also necessary, what point in the circuit may we regard as the seat of the E.M.F.?

Consider a simple element consisting of zinc and copper in dilute sulphuric acid. When the circuit is closed there are three contacts, viz., Zn/Cu, Cu/acid and acid/Zn. Owing to the comparatively large value of the contact force between copper and zinc (about 0·75 volt) and the small values of the contact force for the other two

* From a book on Primary Batteries, to be published shortly by "The Electrician" Printing and Publishing Co. All rights reserved.

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junctions, it is somewhat natural to assume that the seat of the E.M.F. is at the copper zinc junction. The value of the contact force, however, is not quite as high as the actual E.M.F. of the cell, and there is no obvious reason why the other two contacts should be left out. Possibly their exclusion is due to the idea given by Kelvin's divided disc experiment, that when zinc and copper are placed in water they are at the same potential. But it has been shown by Ayrton and Perry* that, although this may be true at the instant of immersion, the zinc soon becomes negative to the copper, and thus the E.M.F. becomes greater than the value of the contact force at the metallic junction. The same authors have shown that the E.M.F. of a cell is equal to the sum of all the contact forces in the circuit. The E.M.F. cannot depend upon the metallic junction only, for it would then be independent of the electrolyte, which is not the case. Another objection to placing the E.M.F. at this junction arises from the fact that no apparent change takes place there. It is natural to expect a change somewhere, and if we accept the

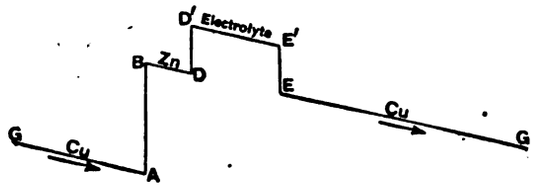

FIG. 1.—Variation of Potential in a Voltaic Circuit, according to Ayrton and Perry.

idea that energy must be transformed where an E.M.F. exists, it becomes necessary to look to some other part of the circuit.

Passing on to the two acid junctions, we find that the contact force in both cases is small. At the surface of the platinum hydrogen is evolved, but otherwise no other chemical change takes place; the platinum remains unaffected. At the surface of the zinc, on the other hand, there is a marked chemical change, the metal being dissolved, and, therefore, the zinc/acid junction is generally favoured as the seat of the E.M.F. by those who accept the definition of E.M.F. given above. It is not clear, however, why the platinum/acid junction should be left out of consideration. The ordinary solution of zinc by sulphuric acid involves the formation of zinc sulphate and the liberation of hydrogen at the same spot. But when the solution is effected electrolytically the salt is formed at one plate, whilst the hydrogen is liberated at the other,

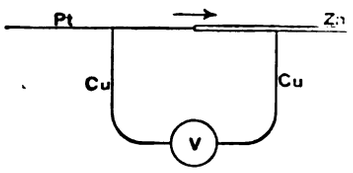

FIG. 2.

and there is no reason why the energy corresponding to the reaction should not be partly transformed at one plate and partly at the other. Taking the whole circuit into consideration it seems more reasonable to say there are three seats of E.M.F., viz., at the junctions zinc/acid, platinum/acid, and zinc/platinum, the latter being very small.

Various other views have been stated from time to time. For instance, Fleeming Jenkin† has expressed the opinion that the E.M.F. is probably due to the metallic junction, but that the current, which is maintained by it, is produced by chemical action. Ayrton and Perry‡ prefer to say that, although energy is transformed at the zinc plate, a potential difference, equal to the contact force, exists at the metallic junction. In support of this view they give a representation, which is reproduced in Fig. 1 of the variation of potential in the circuit. The broken line here given is supposed to be continuous, the two points marked G being one and the same. The current is flowing in the direction of the arrows, and potential is measured upwards. The zinc part of the circuit is represented by BD, the electrolyte by D'E', and the copper by EGA. The circuit being closed, there is a fall of potential along the conductors, and, therefore, the lines representing them are given a sloping direction. At the junction of copper and zinc there is a rise of potential indicated by AB. Similarly at the zinc/acid junction there is a rise, shown by DD', and at the acid/copper junction a fall, shown by E'E. Making use of the usual hydraulic analogy, we may imagine a pump to be working somewhere in D'E'. The water, in circulating, gains potential energy wherever it rises: thus potential energy is gained in rising from A to B and from D to D' (these parts being supposed to be vertical), although no external energy is there supplied, the pump being in D'E'. In other words, the place where energy is transformed (by the pump) is not necessarily the place where potential energy is gained.

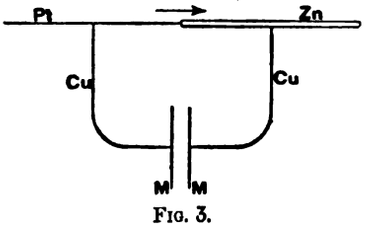

FIG. 3.

Similarly, in the actual circuit, energy is transformed at the zinc/acid junction, but there may be a rise in potential at the zinc/platinum junction. A distinction is thus drawn between E.M.F. and potential difference which is not easy to understand.

It might be thought that such a potential difference, if it really existed, could be readily detected by means of a voltmeter connected to each side of the junction, as indicated in Fig. 2. But, in such a case, the junction effect appears twice and neutralises itself. Suppose the voltmeter V to be wound with copper and to be connected up with copper; then the total potential difference acting upon the instrument is:—

P.D. due to current + Pt/Zn + Zn/Cu + Cu/Pt
= P.D. due to current + Pt/Zn + Zn/Pt
= P.D. due to current.

Hence the effect observed is due to the current only, and is independent of the junction. The same remark applies to an electrostatic instrument. Let the inductors be of some metal or alloy M, as indicated in Fig. 8. Then, beginning at the

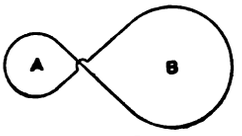

FIG. 4.

left-hand side of the instrument, we have, as the total E.M.F. acting,

M/Cu + Cu/Pt + P.D. due to current + Pt/Zn + Zn/Cu + Cu/M
= Cu/Pt + P.D. due to current + Pt/Cu
= P.D. due to current.

This difficulty, which occurs equally at a metal liquid junction, is at once overcome if we assume the definition of E.M.F. already given, and thus accept measurements of the Peltier effect. These indicate only a small E.M.F. at a metallic contact, and large values at the metal-liquid junctions. But then it is a matter of definition.

Swinburne* has made the bold assertion that there is no seat of the E.M.F., and that a coulomb of electricity in flowing round the circuit formed by a closed cell

* *Proc.* Roy. Soc., Vol. 27, p. 196, 1878.
† "Electricity and Magnetism," 7th Edition, p. 55
‡ *Phil. Mag.*, Vol. 21, p. 51, 1886.

* *See* Cantor Lectures on "Electro-Chemistry," by J. Swinburne, *Journal* of the Society of Arts, 1896.

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continually falls in potential, never regaining it. This view of the matter is best explained by considering a magnetic circuit. Suppose we have a horseshoe electromagnet, or a ring magnet with an air-gap in it. Imagine a "unit pole" at one of the magnet poles. Let it move over to the other pole. The work which it does in so moving is a measure of the difference of magnetic potential between the magnet poles. Let it move on through a small hole in the iron until it regains its first position; the additional work done is of the same sign as before. Thus each time the unit pole moves round the magnetic circuit a definite amount of work is done, which we know to be equal to $0{\cdot}4\pi nc$, where n is the number of turns in the magnet winding and c the current in amperes flowing through them. Each time the unit pole moves round this path, its circuit is interlinked with the electric circuit and the same amount of work is done. It therefore follows that the magnetic potential at any point has an infinite number of values differing by multiples of $0{\cdot}4\pi nc$.

Consider, further, a conductor in the form of an incomplete ring through which a magnetic pole is being moved. An E.M.F. is generated in the ring giving rise to a potential difference, which we may suppose equal to one volt, at its terminals. If a coulomb is allowed to flow from one terminal to the other it falls in potential and does work to the extent of one joule. If it continues to flow along the conductor, it still does work of the same sign, owing to the resistance of the conductor and consequent variation of potential. Thus, in passing round the circuit to the terminal from which it started, the coulomb does a certain amount of work, say, two joules. Every time it passes round the circuit it does work to the same extent, and so it follows, as in the case of the magnetic circuit, that each point in the conductor has an infinite number of potentials. This statement is not opposed to the usual definition of potential, viz., that the potential of a point on a conductor is equal to the work done in moving unit quantity of electricity up to that point from an infinite distance, because there is no stipulation as to the path to be followed by this unit quantity; it might follow the most direct path, or it might pass several times round the circuit under consideration, thus increasing the work done.

Now consider a cell, the external resistance of which is infinitely large compared with the internal resistance. Suppose the potential difference at the terminals to be one volt. Unit quantity of electricity in passing from the positive to the negative terminal falls one volt in potential: the work done amounts to one joule as before. If the electricity passes on through the cell to the other pole the additional work done is negligible; but, such as it is, it corresponds with a further fall of potential. People generally have the idea that the potential is again raised in passing through the cell, but Swinburne prefers to think that it still falls and that there is a cyclic difference of potential just as there is in the magnetic and electric circuits already described.

The analogy does not, however, seem altogether clear. There certainly are cases, even where the E.M.F. is due to variation of induction, in which there is what may be regarded as a seat of E.M.F.; for example, a dynamo, connected to an external circuit, is the seat of E.M.F. for that circuit. Again, suppose we have a conductor bent into the form of a figure 8, as in Fig. 4. Let a magnet move through the part A, and let B be completely shielded from induction; for example, by means of iron, which we may imagine for this purpose to be infinitely permeable. As the magnet moves, an E.M.F. is generated in the loop A, but not in B. Thus it would not be unreasonable to look upon the loop A as the seat of E.M.F. for the entire circuit. Theoretically, A might be as small as we please and thus the seat of E.M.F. would be located at one point of the circuit.

In coming to the voltaic cell it is not easy to see how a cell is strictly similar to the electric circuit with which it is compared. The latter is cutting the lines of force throughout the whole length as the magnet moves, and the E.M.F. results through the relative motion of two bodies which are entirely independent of each other. There is no reason why one point rather than any other of the conductor should be looked upon as the seat of the E.M.F. But in a cell the case is very different. The circuit is, as it were, self-contained. The E.M.F. is not in any way dependant upon a body external to the circuit, and thus it is not unnatural to place the seat of E.M.F. at one of the junctions, or points of discontinuity.

Perhaps the safest conclusion to which a consideration of the various theories lead is that the whole matter is largely a question of definition, and that it is, therefore, of relatively very small importance. It depends a great deal upon the point of view, and so we cannot say that one theory is correct and another necessarily wrong. Our ideas are naturally based upon processes most familiar to us. Being accustomed to the flow of water under the action of gravity we are struck with the similarity of electric flow, and thus we are tempted to carry the analogy too far. It is convenient to think of electricity being raised in potential at some point in the cell, just as a pump raises water to a higher level, keeping up a continuous stream and enabling the water to do work by its downward flow. But the pump is not necessarily placed where the water gains potential energy. We may, of course, define the seat of E.M.F. as the point where energy is given to the circuit, but that is only a definition, and we cannot always decide upon the position of such a point.

ON THE MASSES OF THE IONS IN GASES AT LOW PRESSURES.*

BY J. J. THOMSON, M.A., F.R.S.

In a former Paper (*Phil. Mag.*, Oct., 1897) I gave a determination of the value of the ratio of the mass m of the ion to its charge e, in the case of the stream of negative electrification which constitutes the cathode rays. The results of this determination, which are in substantial agreement with those subsequently obtained by Lenard and Kaufmann, show that the value of this ratio is very much less than that of the corresponding ratio in the electrolysis of solutions of acids and salts, and that it is independent of the gas through which the discharge passes and of the nature of the electrodes. In these experiments it was only the value of m/e which was determined, and not the values of m and e separately. It was thus possible that the smallness of the ratio might be due to e being greater than the value of the charge carried by the ion in electrolysis rather than to the mass m being very much smaller. Though there were reasons for thinking that the charge e was not greatly different from the electrolytic one, and that we had here to deal with masses smaller than the atom, yet, as these reasons were somewhat indirect, I desired if possible to get a direct measurement of either m or e as well as of m/e. In the case of cathode rays I did not see my way to do this; but another case, where negative electricity is carried by charged particles (*i.e.*, when a negatively electrified metal plate in a gas at low pressure is illuminated by ultra-violet light), seemed more hopeful, as in this case we can determine the value of e by the method I previously employed to determine the value of the charge carried by the ions produced by Röntgen-ray radiation (*Phil. Mag.*, December, 1898). The following Paper contains an account of measurements of m/e and e for the negative electrification discharged by ultra-violet light, and also of m/e for the negative electrification produced by an incandescent carbon filament in an atmosphere of hydrogen. I may be allowed to anticipate the description of these experiments by saying that they lead to the result that the value of m/e in the case of the ultra-violet light, and also in that of the carbon filament, is the same as for the cathode rays; and that in the case of the ultra-violet light, e is the same in magnitude as the charge carried by the hydrogen atom in the electrolysis of solutions. In this case, therefore, we have clear proof that the ions have a very much smaller mass than ordinary atoms; so that in the convection of negative electricity at low pressures we have something smaller even than the atom, something which involves the splitting up of the atom, inasmuch as we have taken from it a part, though only a small one, of its mass.

The method of determining the value of m/e for the ions carrying the negative electrification produced by ultra-violet light is as follows: Elster and Geitel (*Wied. Ann.*, XLI, p. 166) have shown that the rate of escape of the negative electrification at low pressures is much diminished by magnetic force if the lines of magnetic force are at right angles to the lines of electric force. Let us consider what effect a magnetic force would have on the motion of a negatively electrified particle. Let the electric force be uniform and parallel to the axis of x, while the magnetic force is also uniform and

* Communicated by the author to the December number of the *Phil. Mag.* Read at the Meeting of the British Association at Dover.

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parallel to the axis of z. Let the pressure be so low that the mean free path of the particles is long compared with the distance they move while under observation, so that we may leave out of account the effect of collisions on the movements of the particles.

If m is the mass of a particle, e its charge, X the electric force, H the magnetic force, the equations of motion are :—

$$m\frac{d^2x}{dt^2} = Xe - He\frac{dy}{dt},$$

$$m\frac{d^2y}{dt^2} = He\frac{dx}{dt}.$$

Eliminating x, we have :—

$$m\frac{d^3y}{dt^3} = \frac{He}{m}\left(Xe - He\frac{dy}{dt}\right).$$

The solutions of these equations, if x, y, dx/dt, dy/dt all vanish when $t=0$, is expressed by

$$y = \frac{Xm}{eH^2}\left\{\frac{e}{m}Ht - \sin\left(\frac{e}{m}Ht\right)\right\},$$

$$x = \frac{Xm}{eH^2}\left\{1 - \cos\left(\frac{e}{m}Ht\right)\right\}.$$

The equations show that the path of the particle is a cycloid, the generating circle of which has a diameter equal to $2Xm/eH^2$, and rolls on the line $x=0$.

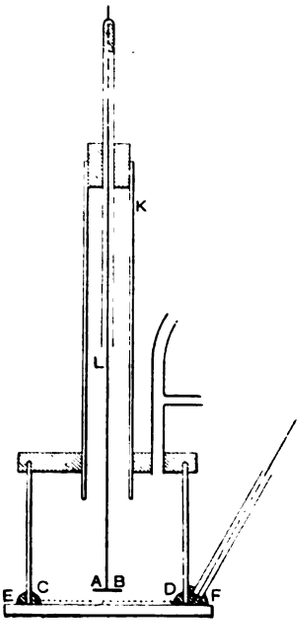

FIG. 1.

Suppose now that we have a metal plate AB exposed to ultra-violet light, placed parallel to a larger metal plate CD perforated so as to allow the light to pass through it and fall upon the plate AB. Then, if CD is at a higher electric potential than AB, all the negatively electrified particles which start from AB will reach CD if this plate is large compared with AB, the particles travelling along the lines of electric force. Let us now suppose that a uniform magnetic force equal to H, and at right angles to the electric force, acts on the particles ; these particles will now describe cycloids and will reach a distance $2Xm/eH^2$ from the place from which they start, and after reaching this distance they will again approach the plate. Thus, if the plate CD is distant from AB by less than $2Xm/eH^2$, every particle which leaves AB will reach CD provided CD stretches forward enough to prevent the particles passing by on one side. Now the distance parallel to y through which the particle has travelled when it is at the greatest distance from AB is $\pi Xm/eH^2$: hence if CD stretches beyond AB by this distance at least, all the particles will be caught by CD and the magnetic field will produce no diminution in the rate of leak between AB and CD. If, on the other hand, the distance between the plates is greater than $2Xm/eH^2$, then a particle starting from AB will turn back before it reaches CD : it will thus never reach it, and the rate at which CD acquires negative electrification will be diminished by the magnetic force. Hence, if this view of the action of the magnetic field is correct, if we begin with the plates very near together and gradually increase the distance between them, we should expect that, at first with the plates quite close together, the rate at which CD received a negative charge would not be affected by the magnetic force, but as soon as the distance between the plates was equal to $2Xm/eH^2$ the magnetic force would greatly diminish the rate at which CD received a negative charge, and would in fact reduce the rate almost to zero if all the negatively electrified particles came from the surface of AB. Hence, if we measure the distance between the plates when the magnetic force first diminishes the rate at which CD receives a negative charge, we shall determine the value of $2Xm/eH^2$; and as we can easily determine X and H, we can deduce the value of m/e.

The way in which this method was carried into practice was as follows, the apparatus being shown in Fig. 1.

AB is a carefully polished zinc plate about 1cm. in diameter while CD is a grating composed of very fine wires crossing each other at right angles, the ends being soldered into a ring of metal ; the wires formed a network with a mesh about 1mm. square. This was, placed parallel to AB on the quartz plate EF, which was about 4mm. thick. The grating was very carefully insulated. The system was enclosed in a glass tube which was kept connected with a mercury pump provided with a McLeod gauge. The ultra-violet light was supplied from an arc about 3mm. long between zinc terminals. The induction coil giving the arc was placed in a metal box, and the light passed through a window cut in the top of the box ; over this window the quartz base of the vessel was placed, a piece of wire gauze connected with the earth being placed between the quartz and the window. The plate AB was carried by the handle L, which passed through a sealing-wax stopper in the tube K. The magnet used was an electromagnet of the horseshoe type. The magnetic force due to the magnet was determined by observing the deflection of a ballistic galvanometer when an exploring coil, of approximately the same vertical dimension as the distance between the plates AB and CD, was withdrawn from between its poles. The coil was carefully placed so as to occupy the same part of the magnetic field as that occupied by the space between AB and CD when the magnet was used to affect the rate of leak of electricity between AB and CD. In this way the intensity of the magnetic field between the poles of the magnet was determined for a series of values of the current through the magnetising coils of the electromagnet ranging between 1 and 4·5 amperes, and a curve was drawn which gave the magnetic force when the magnetising current (observed by an amperemeter) was known.

The pressure of the gas in the tube containing the plate was reduced by the mercury-pump to 1/100 of a millimetre of mercury. As the mean free path of hydrogen molecules at atmospheric pressure and 0°C. is $1{\cdot}85\times10^{-5}$cm. (Emil Meyer, *Kinetische Theorie der Gase*, p. 142), and of air 10^{-5}cm , the mean free paths of these gases at the pressure of 1/100 of a millimetre of mercury are respectively 14mm. and 7·6mm., and are consequently considerably greater than the greatest distance, 4mm., through which the electrified particles have to travel in any of the experiments. These are the free paths for molecules of the gas ; if, as we shall see reason to believe, the actual carriers of the negative electrification are much smaller than the molecules, the free paths of these carriers will be larger than the numbers we have quoted.

The rate of leak of negative electricity to CD when AB was exposed to ultra-violet light was measured by a quadrant-electrometer. The zinc plate was connected with the negative pole of a battery of small storage cells, the positive pole of which was put to earth. One pair of the quadrants of the electrometer was kept permanently connected with the earth, the other pair of quadrants was connected with the wire gauze CD. Initially the two pairs of quadrants were connected together, the connection was then broken, and the ultra-violet light allowed to fall on the zinc plate ; the negative charge received by the wire gauze in a given time is proportional to the deflection of the electrometer in that time. By this method the following results were obtained : when the difference of potential between the illuminated plate and the wire gauze was greater than a certain value, depending upon the intensity of the magnetic force and the distance between AB and CD, no diminution in the deflection of the electrometer was produced by the magnetic field ; in fact, in some cases the deflection was just a little greater in the magnetic field. The theory just given indicates that the deflection ought to be the same ; the small increase (amounting to not more than 3 or 4 per cent.) may be due to the obliquity of the path of the particles in the magnetic field, causing more of them to be caught by the wires of the grating than would be the case if the paths of the particles were at right angles to the plane of the gauze. When the difference of potential is reduced below a certain value, the deflection of the electrometer is very much reduced by the magnetic field ; it is not, however, at once entirely destroyed when the potential difference passes through the critical value. The simple theory just given would indicate a very abrupt transition from the case when the magnetic force produces no effect to that in which it entirely stops the flow of negative electricity to CD. In practice, however, I find that the transition is not abrupt : after passing a certain difference of potential the diminution in the electric charge received by CD increases gradually as the potential difference is reduced, and there is not an abrupt transition from zero effect to a complete stoppage of the leak between AB and CD. I think this is due to the ionisation not being confined to the gas in contact with the illuminated plate, but extending through

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a layer of gas whose thickness at very low pressures is quite appreciable. The existence of a layer of this kind is indicated by an experiment of Stoletow's. Stoletow found that the maximum current between two plates depended at low pressures to a considerable extent upon the distance between the plates, increasing as the distance between the plates was increased. Now the maximum current is the one that in one second uses up as many ions as are produced in that time by the ultra-violet light. If all the ions are produced close to the illuminated plate, increasing the distance between the plates will not increase the number of ions available for carrying the current; if, however, the ions are produced in a layer of sensible thickness, then, until the distance between the plates exceeds the thickness of this layer, an increase in the distance between the plates will increase the number of ions, and so increase the maximum current. If this layer has a sensible thickness, then the distance d, which has to be traversed by the ions before reaching the gauze connected with the electrometer, ranges from the distance between the plates to the difference between this distance and the thickness of the layer. The first ions to be stopped by the magnetic field will be those coming from the surface of the illuminated plate, as for these d has the greatest value: hence we may use the equation

$$d=\frac{2Xm}{eH^2}, \quad \ldots\ldots\ldots \quad (1)$$

if d represents the distance between the plates, X the value of the electric field when the rate of leak first begins to be affected by the magnetic force H. Assuming that the field is uniform,

$$X=V/d,$$

where V is the potential difference between the plates; and equation (1) becomes

$$d^2=\frac{2Vm}{eH^2}.$$

The negative ions travelling between the plates will disturb to some extent the uniformity of the field between the plates; but if the intensity of the ultra-violet light is not too great, so that the rate of leak and the number of ions between the plates is not large, this want of uniformity will not be important. A calculation of the amount of variation due to this cause showed that its effect was not large enough to make it worth while correcting the observations for this effect, as the variation in the intensity of the ultra-violet light was sufficient to make the errors of experiments much larger than the correction.

The following is a specimen of the observations:—

Distance between the plates 0·29cm.

Strength of magnetic field 164. Pressure 1/100mm.

Potential difference between plates, in volts.	Deflection of electrometer in 30sec.	
	Magnet off.	Magnet on.
240	180	190
120	160	165
80	160	140
40	130	75

These observations showed that the critical value of the potential difference was about 80 volts. A series of observations were then made with potential differences increasing from 80 volts by 2 volts at a time, and it was found that 90 volts was the largest potential difference at which any effect due to the magnet could be detected. The results of a number of experiments are given in the following table:—

d (in cm.).	H.	V in absolute measure.	e/m.
0·18	170	40×10^8	$8\cdot5\times10^6$
0·19	170	30×10^8	$5\cdot8\times10^6$
0·20	181	46×10^8	$7\cdot0\times10^6$
0·29	167	84×10^8	$7\cdot1\times10^6$
0·29	164	90×10^8	$7\cdot6\times10^6$
0·30	160	86×10^8	$7\cdot4\times10^6$
0·45	100	80×10^8	$7\cdot9\times10^6$

giving a mean value for e/m equal to $7\cdot3\times10^6$. The value I found for e/m for the cathode rays was 5×10^6; the value found by Lenard was $6\cdot4\times10^6$. Thus the value of e/m in the case of the convection of electricity under the influence of ultra-violet light is of the same order as in the case of the cathode rays, and is very different from the value of e/m in the case of the hydrogen ions in ordinary electrolysis when it is equal to 10^4. As the measurements of e, the charge carried by the ions produced by ultra-violet light to be described below, show that it is the same as e for the hydrogen ion in electrolysis, it follows that the mass of the carrier in the case of the convection of negative electricity under the influence of ultra-violet light is only of the order of 1/1,000 of that of the hydrogen atom. Thus with ultra-violet light, as with cathode rays, the negative electrification at low pressures is found associated with masses which are exceedingly small fractions of the smallest mass hitherto known—that of the hydrogen atom.

(To be continued.)

ANNUAL DINNER OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

The eleventh annual dinner of the Institution of Electrical Engineers was held on Wednesday evening, at the Hotel Cecil. Although the attendance was good, some 250 being present, one missed the familiar faces of a number of members who seldom fail to take part in this social function. Perhaps this had an effect on the speeches, which as a whole seemed to lack, both in their delivery and reception, some of the enthusiasm manifested on former occasions. Mr. Crompton's speech in proposing "The Navy, Army, and Auxiliary Forces" was an exception, however. After the usual loyal toasts had been given in a few words by the President (Prof. S. P. Thompson) and duly honoured, Mr. Crompton rose. The laugh he raised when, referring to South Africa, he said he wished he were there, and he dared say many of his hearers wished the same, soon gave way to silent and sympathetic attention. After referring feelingly to the war, he said that he did not believe in volunteering out of turn, but he was convinced that the Electrical Engineers R.E. Volunteers were as ready as any others to respond to their country's call. The effect of military training on electrical engineers produced a type of soldier that was hard to beat. General Sir Richard Harrison, during the course of his reply, said that the electrical engineers' corps were doing their work zealously and well. When the day of danger came he felt sure that the corps would treble in number for the sake of defending its country.

Before Lord Kelvin rose to propose "Science," the President preceded him with a few words. Those present were to be congratulated in having such a distinguished man to propose that toast. Before Dr. Thompson was born Lord Kelvin had read Papers before the Royal Society on thermodynamics and electricity, and he was there on the present occasion as the undisputed head of the scientific and electrical engineering profession. Lord Kelvin, who was received with cheers, spoke of the debt pure science owed to electrical engineers. At the time the first Atlantic cable was laid, pure science was in a very backward state compared with its present position. Gauss and Weber gave us the foundation of electrical measurement, but its first practical use was in connection with submarine cables. He spoke of the admirable manner in which practical electricians made use of mathematics at the present day, and referred to Oliver Heaviside as one of those mathematicians who had been foremost in responding to the call made by electricians on mathematics. The engineering student of to-day was differently situated to the student of former days, when training consisted of spending many years in an engineer's office doing what he liked, chiefly playing pranks, and occasionally copying a drawing. The first professor of engineering was Gordon, at Glasgow University; and after him followed Rankine and a number of other distinguished men. In concluding, Lord Kelvin coupled the toast with the names of Sir William Roberts-Austen, to whom we owed important discoveries in connection with the diffusion of solid metals through solid metals, and Sir Henry Roscoe, who might justly claim to be a fellow-worker of the great Bunsen, who had recently left us.

Prof. Austen referred to the international nature of science. Science, he said, united all peoples. The web of copper strands that connected British electrical engineers with the rest of the world was more enduring than steel bands could ever be. To be cut off from the genius of France would be an irreparable blow to this country, he thought—for had we not communicated with France, not only through cables but through the ether?—and he was glad that the Institution was to visit Paris next year. Sir Henry Roscoe said that thanking for science was like returning thanks for his daily bread. Even our Government at last acknowledged science by decorating distinguished scientific men. But we should have loved and honoured Lord Kelvin just as much had he remained plain William Thomson. Sir Douglas Fox (President of the Institution of Civil Engineers) said, in proposing the toast of "Engineering," that practical engineers were feeling more and more that they must not

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grope in the dark, but must rely on pure science to build a proper superstructure. Yet engineering as well as science bound nations together. Although Germans and Americans were competitors of this country, yet all three countries helped one another in learning the principles necessary for the practical pursuit of our science. Sir William H. White, responding, spoke of the difficulty of saying where pure science ended and engineering began. Lord Kelvin was at the same time the greatest scientist and one of the greatest engineers of his day. And John Hopkinson, was he not as true a scientist as any man, although an engineer? In the same way, in spite of specialisation being now the order of the day, the division between different branches of the engineering profession was not clearly marked. There was no need of buffer states, for most friendly intercourse would ever continue.

The Hon. Justice Cozens-Hardy proposed the toast of the evening. Some branches of science there were, he said, in which everything had been done, but electricians of to-day were like navigators of the 15th and 16th centuries, and were discovering new worlds. Prof. Silvanus Thompson, in his response, regretted the absence of some past presidents and other distinguished men who had been expected. Major-General Webber, the only survivor of the three founders of the Institution, was absent; Sir William Preece was in Dublin, Mr. Alexander Siemens in Berlin, Mr. W. M. Mordey in Russia. Colonel Huber and Mr. C. E. L. Brown, who had been invited as representing the Institution's recent hosts in Switzerland, were also unable to be present. Dr. Thompson then referred to the success of the Institution in its latest policy—viz., the formation of local centres. Next week he hoped to attend a meeting at Newcastle for the creation of a north-eastern centre of the Institution of Electrical Engineers, where Papers will be read and discussed at the same time as—or shortly after—their reading in London. This he hoped would only be one of a number of such centres. The council had already received a petition for the formation of a similar organisation in Dublin, and there was a prospect of another soon. In Cape Town there had for some time past been informal meetings, at which advance copies of Institution Papers were read. Both Mr. Marconi's and Mrs. Ayrton's Papers had been read and keenly discussed but a few days after their presentation here, Mrs. Ayrton's, in fact, with the same illustrations on the screen as here. These were informal meetings, but they would now be recognised formally. Dr. Thompson next referred to Mr. Wilde's generous donation to the benevolent fund of the Institution, and invited others who had benefited by their profession to follow in his footsteps. He enlarged upon former services Mr. Wilde had done to the electrical industry; first by his invention or discovery of the separately excited dynamo, in which the small current of one small machine is employed to magnetise the magnets of a larger machine, from which larger currents can be drawn; and secondly, by his discovery by experiment and insight, of the synchronising property of alternators, years before Hopkinson's mathematical investigations. The President, in conclusion, called attention to the building fund, which had assumed sufficiently large proportions to justify the council in looking out for a site; and he hoped that the donations of members would soon enable the Institution to build a home of its own.

Prof. Perry proposed the health of "The Guests" in a humorous speech, to which Sir Courtenay Boyle, secretary to the Board of Trade, replied in the same vein, and the party broke up.

By Motor Car to Brighton.—An interesting experiment in motor-car traction took place on Wednesday, when a trip was made by Mr. A. Jordan, of Electrical Undertakings (Ltd.), from London to Brighton, on an electric motor-cart, with a view to demonstrating that the journey could be accomplished in one day with one battery charge. The journey was commenced at Piccadilly-circus, London, W., the destination being the Hotel Metropole, Brighton—a distance of 55 miles. The trip was, we understand, satisfactorily accomplished, the average speed attained being 11½ miles per hour. The cart was equipped with 40 Leitner cells and the voltage on arrival at Brighton is stated by the Electrical Undertakings, Ltd., to have been 84.

OPENINGS FOR MECHANICAL ENGINEERS IN CHINA.

In the course of an address delivered before the Institution of Mechanical Engineers on November 24, Lord Charles Beresford said he proposed in his paper to divide the principal openings for the mechanical engineer under three heads, and to touch upon each shortly. He classed them as follows: (1) Railways and electrical engineering; (2) mining and allied works; (3) manufactures. He classed electricity under the first heading, because he had found, since his return from China, that it was possible for the traveller to go from the railway station to the gates of Pekin by electric traction. He remembered being carried into the city in a mandarin's chair while his staff rode on Chinese ponies, and therefore, judging by the then state of the roads, to have laid and started an electric tramway so soon was very creditable to the promoters of the enterprise. The Chinese roads were perfect 2,000 years ago, and had not been repaired since. An American had recently said to him in the course of conversation: "Yes, sir, the roads are very bad; there was a mule drowned in the road outside my embassy the other day." In the European settlements electricity was already used for lighting purposes, and even at Hankow, 600 miles up the Yangtse river, some firms were laying down electrical plant. The abundance of Japanese coal would render this branch of industry—*i.e.*, electrical engineering—a very profitable one in a short time. The Chinese would no doubt prove ready consumers of electrical power for lighting and manufacturing purposes. Of course all plant must in the first instance be imported, and unless English manufacturers were much more energetic, the vast electrical plant which China will require would come from Japan and America. It was more than probable the Japanese and American engineers who accompanied the plant to China would be employed there hereafter instead of British engineers. At Kioto, in Japan, there was a great electrical plant, which in addition to lighting two-thirds of the town also supplied the motive power for the city tramways, for the pumping machinery at the waterworks, and for no less than 60 different industries in or near Kioto. The electrical energy was produced by water power from a fall of 120ft. The plant was chiefly American, but the Japanese were now beginning to make their own. At another place near Kioto there was a great trade through the Buva Lake and beyond, a total distance of 65 miles. The Japanese were more than mere copyists. They copied, but they chose the best ideas, and often combined ideas taken from widely different sources. Of course, Japan and America had great advantages over older countries like Great Britain in the fact that it is far cheaper to start with the latest products of electrical engineering than to replace steam, gas, and other expensive systems already laid down, as we in this country have to do. He referred to this, because China was in the same happy position as Japan and America; and the electrical engineer would have many openings before him if Institutions like theirs would study the immediate needs of China and assist its members to make use of their experience, industry, and ability. Telegraphs also existed all over China, and were Government property. They were badly managed. He was informed that it was even possible to go from Pekin to Tientsin and thence to Shanghai, and to arrive before a telegram dispatched at starting. By paying treble rates a better service could be obtained. Telephones existed in some settlements. All the copper wire belonging to one telephone company was stolen by the natives, so that they had to use very inefficient steel wires. In Japan he was much struck with the immense use made of the telephone. In all the small towns poles carrying 30 to 40 telephone wires were to be seen in the streets.

In connection with mining and allied works, Lord Charles Beresford referred to the great mineral wealth of China—coal, iron, gold, silver, copper, mercury, lead, and salt all existing in paying quantities, and only skilled workers and the latest machinery being needed to develop the rich resources of this marvellous country. In connection with manufactures he spoke of the abundance of the coal and iron in China making it absolutely necessary that it should some day become a great competitor with us in the industrial market. But British manufacturers need not fear this competition, for China must for many years to come be an enormous buyer of machinery and of tool steel.

The speaker told a number of stories as being quite characteristic of the Chinese. In one place he found a man boring a six-pounder gun, and the tool protesting most vigorously against the ill-treatment. He showed the men how to adjust it, and got it going properly. The workmen gathered in a corner and talked excitedly. On asking what they were saying, he was told, "They are saying that England produces the most wonderful mandarins in the world. We have many, but not one of them knows anything about any of the machinery in the shop."

In South China the current rate of wages for common coolies was 40c (9d.) a day. Fitters 75c. (1s. 5d.) a day to 1·25 (2s. 4d.) a day. Smiths got 60c. (1s. 2d.) to 1·50 (2s. 10d.) a day; carpenters 50c. (11½d.) to 80c. (1s. 6d.) a day; masons 60c. (1s. 2d.) a day; and mill and refining hands 30c. (or 7d.) a day.

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Another opening for the mechanical engineer was to establish himself as an agent for British machinery in the foreign settlements and concessions. Over and over again he had seen British machinery with the name-plates removed and German and Belgian names substituted, or where the name of the British firm was stamped in, it had been covered over by German and Belgian name-plates. The advantages of buying locally from an agent were threefold: (1) Quicker delivery, as the machinery was often in stock. (2) No trouble about the rate of exchange increasing the cost after the order was given. (3) The local agent could be held responsible for defects, and was available for repairs if anything went wrong. This was a very important point for engineering firms who were members of that Institution, and it also offered an opening for young men who were good mechanical engineers to take up the sale of British machinery, and to push it in preference to that of other countries. In connection with this matter he drew the attention of engineering firms in Great Britain to the immediate necessity of establishing an exhibition of British machinery in China, with mechanical engineers to explain and show its capabilities. The Chinese were a very practical race, and if they saw what machinery could do they would often buy it. Both the Americans and Germans were already taking steps to provide such exhibitions of their goods, and it would have a serious effect on British machinery if they were allowed to forestall us.

The best prospects for immediate openings were:—

(1) *Railways.*—He referred those seeking advice in this section to Mr. Kinder, engineer-in-chief of Chinese Imperial Railways, and applications for appointments should be made to the various syndicates financed by the Hong Kong and Shanghai Bank, particulars of which are to be found in his book, "The Break-up of China."

(2) *Mining Work.*—This was being undertaken by the Pekin syndicate and by Mr. Pritchard Morgan, M.P.'s syndicate. Electrical and hydraulic engineers should be on the look out for the prospects of employment by the municipalities in the European settlements and by large firms.

(3) *Advertisements* in Anglo-Chinese papers in Tientsin, Shanghai, Hankow, and other places should at present be the best means for securing billets for engineers wishing to enter British or Chinese firms.

CORRESPONDENCE.

THE ELECTRO-DEPOSITION OF ZINC.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have read with interest your editorial note on the work I have done in connection with the electro-deposition of zinc, where you suggest the application of a burnishing process such as is used by Elmore for copper deposition. I have experimented in this direction; but the process has limited application, being only suitable for depositing zinc on cylindrical bodies. The object in making the experiments on depositing zinc under pressure was to ascertain whether the zinc could be forced into the pores of the iron, and whether high-current densities could be used for depositing zinc on irregular objects without the formation of zinc sponge, trees, or nodules. The results obtained tend to prove that there is not the same liability of zinc sponge being formed, nor of zinc trees or nodules. I am still carrying on the experiments, and hope at a future date to communicate to you some further results.—Yours, &c.,

SHERARD COWPER-COLES.

Westminster, London, Dec. 2.

DOUBLE-CURRENT GENERATORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: There can be little doubt that in the near future double-current generators will be largely employed for the supply of electricity in extensive districts.

The articles in your last issue—one describing in detail the double-current machines and polyphase system at the Chicago Edison Co.'s works, and the other indicating some spheres of usefulness for such plant—are most opportune, and will no doubt create special interest at a time when so many combined lighting and traction works are being and about to be equipped.

The description of the Chicago plant is so minute that among those who have given but little attention to the subject of polyphase working an impression may be left that the system is exceedingly complicated, and hence undesirable. That this is not the case will be evident when the full usefulness of the combined direct-alternating system is realised. Many engineers regarded the double-current generator as a myth, or at least as nothing more than a laboratory curiosity—a status likewise accorded to the rotatory converter before Dr. Silvanus Thompson presented his Paper on the subject to the Institution of Electrical Engineers, directing attention, perhaps for the first time in this country, to its design, construction, and use. (A double-current generator is neither more nor less than a power-driven rotatory converter.) To many the information that machinery of this type has been actually working, and most successfully working, since last year will suffice to place it at once in the category of available plant.

No necessity exists for such a revolutionary departure from the still favoured bi-polar machine as appears in the 20-polar Chicago generators, for, if the alternating current is to have a frequency of 25 $\sim$ per second—a periodicity at once most suitable for the operation of rotatory converters, and that recommended by the Institution of Electrical Engineers for the lower "uniform standard frequency"—a machine with many fewer poles may be built, when driven by an engine of the high-speed type. For example: A 100 kw. machine running at 500 revolutions per minute will require 6 poles only, or a 250 kw. machine at 375 revolutions 8 poles; and while the number of poles, and therefore size and cost of the machine, is reduced, a standard type of engine, pre-eminently suited by reason of its uniform angular velocity for generating polyphase currents to be converted in rotatories, may be most economically employed.

Mr. Eustace Thomas has alluded to the value of double-current generators as intermediaries in stations where both direct and alternating-current plant is installed, when the bulk of the requirements is for currents of one class only; and for service on long traction lines by supplying the home district direct from the generators, and suitable distant points by stepping-up on the alternating-current side in transformers and supplying the line through rotatory converters. But a still wider sphere of usefulness, which while less simple yet possesses no insuperable difficulties, is open to this type of machine—namely, the simultaneous supply of both lighting and traction circuits over a scattered district from a single generator with absolute immunity from risk of short-circuits, notwithstanding that the neutral conductor of the three-wire lighting distributors and also the negative pole of the traction system is earthed.

To follow how this may be effected, let us assume that a district which in extent is beyond the economical possibilities of direct current at 480 volts pressure (this being the low-pressure limit declarable under the Board of Trade Regulations if the permissible variation of pressure is to be complied with) is to be supplied for both lighting and traction, but that a direct-current supply must be given for both purposes. The generating works will be situated so as to supply direct current to either the lighting or the traction mains close by, and one sub-station will be considered.

Two courses are open, in each case the complete isolation of the primary and secondary windings in the transformers being an important feature. Firstly, the direct-current end of the double-current generator may supply the lighting circuits, while the alternating-current end is connected through step-up transformers to supply the sub-station. The home traction circuits would be supplied by a step-down transformer and rotatory converter. At the sub-station separate groups of transformers and rotatories would supply the power for lighting and traction respectively. Secondly, the supply to both lighting and tramways might be taken from the direct-current end of the generator and one service be maintained through a one-to-one continuous-current transformer, which might conveniently be of the variable ratio type, while the sub-station is supplied as before. This plan, however, introduces a machine of which the sole function is to render possible the double earthing. But if the works are of considerable size, polyphase alternators, generating at the full line pressure, would also be provided for supplying the sub-station, in which case a third method, not employing a double-current generator, is available, which is to supply both services through separate

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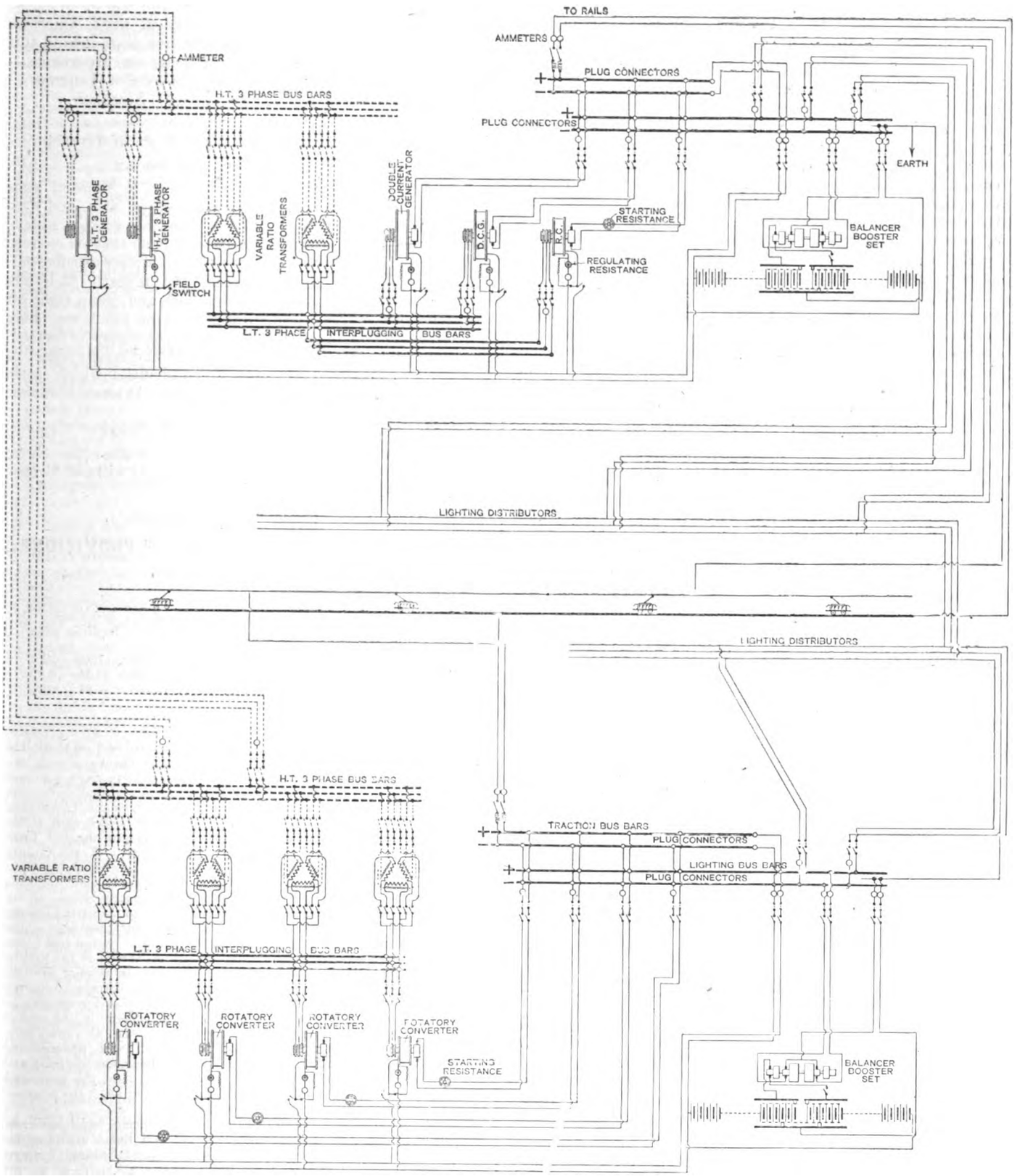
transformer and rotatory converter groups at each end of the system. The efficiency of this method is not quite so high as either of the others, and an extra transformer and rotatory group is required.

The diagram of plant and connections, herewith, for a combined lighting and traction works to generate both three-phase and direct current will serve to make the proposals clearer. For simplicity's sake the synchronising connections and some of the recording and regulating instruments have been omitted. It will be evident that the transformers and converters enable the conversion of high to low pressure and alternating current to direct current, or vice versâ, in the most flexible manner, thus rendering each type of generator available for either service. From a works thus equipped polyphase distribution could of course be effected, if for any reason it was thought desirable to prefer this system, notwithstanding the transformer losses, to one permitting the use of batteries to meet light load demands.



The combined efficiency of variable ratio transformers and rotatory converters of 100 kilowatts output is about 90 per cent. at full load and 87 per cent. at half load, while that of a 50-kw. set will be about ½ per cent. lower. It will be found that great flexibility is coupled with good efficiency in the combined direct-alternating system, and as the additional

cost of a machine constructed to give also three-phase currents is not great it is probable that many engineers will make provision for the future by installing double-current generators in place of simple direct-current machines, even if they are not immediately intending to install polyphase extensions.—Yours, &c., E. T. RUTHVEN-MURRAY.

Willesden, December 4.

FOREIGN COMPETITION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: We have seen Mr. Murphy's letter in your last issue referring to our communication to you under the above heading. Our remarks were based upon the contract actually made between the Dublin United Tramways Co. and the American Cable Co., the unusual character of which caused us much surprise when produced in court in Dublin. Our object in writing you was to show the differences between the specification as issued and the contract as made, a copy of which we appended to our letter, leaving it largely to speak for itself. These differences Mr. Murphy does not attempt to deny.

Dealing in detail with Mr. Murphy's points, he first charges us with having libelled Mr. Parshall; but this can hardly be so, as is evidenced by the fact that Mr. Parshall has taken no action in the matter. Mr. Murphy says that the variations from the conditions in the original tender were made in the interests of the Tramways Co. We would therefore ask him if he seriously contends that it was to the interests of the Tramways Co.: (1) To waive all provision of time for delivery; (2) to forego the penalty clause; (3) to take delivery of the cable in New York, instead of laid and jointed in Dublin, as originally asked for; (4) to make the guarantee of the cables less stringent than had been offered by another firm; (5) to enter into a contract in which blanks were left and still remain for prices and quantities; (6) to take plain lead-covered cables when those served with jute over the lead had been offered; (7) to enter into a contract with a foreign trading firm after being warned, as the fact was, that they could only fulfil it by infringing the patent rights of a British firm.

Mr. Murphy says that the Americans quoted lower prices than the British firms. This statement we cannot, of course, contradict, as the contract produced in court specified neither prices, quantities, nor time for delivery; but we would remind Mr. Murphy that a saving in capital cost is not always true economy, especially if, as seems to be the case here, very heavy sacrifices have to be made to attain it.

We fully accept Mr. Murphy's contradiction of our inference that Mr. Parshall was loaned to the contractors to supervise the drawing in and jointing work. Our remarks in this respect were based on the terms of the contract, which reads as follows: "The aforesaid cable shall be laid, *installed*, and connected up under the direction of the engineer, but at the cost and expense of the party of the first part" (*i.e.*, the contractors). This, coupled with the fact that delivery was to be taken of the cable by the Tramways Co. in New York, surely justified the inference that Mr. Parshall was to do the work, and not merely to supervise it. If not, we cannot even now see how the terms of the contract could be logically carried out.

We fully appreciate the £10,000 order that Mr. Murphy mentions he has given us upon Mr. Parshall's advice; but surely it is not conclusive evidence that an engineer is impartial to cite one isolated case in which his work has not gone to a particular firm. As to the American firm with whom the Tramways Co. placed their order, we have nothing to say, and have said nothing against them, and we accept Mr. Murphy's statement when he says that they carried out the work efficiently and well. They could at least afford so to do under the terms of their contract.

Mr. Murphy seems to wholly mistake the ground of our complaint in this matter. We have drawn attention to this matter, not because we were aggrieved at having lost the contract, for we are losing contracts every day, and are glad to do so in many cases in the present congested state of business. Our complaint is that a very decided preference has been shown to an individual contractor, and that the firms tendering were not all put upon an equal basis.

With regard to Mr. Murphy's last paragraph, we fear his knowledge of American electrical engineering is very limited if he attempts to set up American cable makers as models for the British firms to follow. We say, without fear of contradiction, that, owing no doubt largely to the use of overhead conductors in the earlier stages of electrical work, American underground cable makers are at least five years behind this country in methods and fully ten years in experience.—Yours, &c., THE BRITISH INSULATED WIRE CO. (LIMITED),

Dec. 5. EDWD. TRACEY, Secretary.

A THERMO-COUPLE WITHOUT JUNCTIONS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The following may be of interest to some of your readers. Take about a foot of No. 20 copper wire, and with it short-circuit the terminals of a low-resistance galvanometer; heat a portion of the wire to redness. Note that no current is produced. Now touch the hot wire with a piece of selenium, wait till the fumes have subsided, and repeat. Suddenly the needle will give a tremendous kick and jump right off the scale. Of course, although there are no junctions, there is heterogeneity in the circuit, as selenide of copper is formed. Perhaps, if this principle were adopted in the construction of thermopiles, it would get over the difficulties which arise through failure of contact at the junctions. Anyway, it makes a very pretty experiment.—Yours, &c.,

London, N.W., Dec. 3. E. BENNETT VILES.

[It appears to us extremely doubtful whether the above is really a thermo-electric effect—at all events without further particulars.—ED. *E.*]

ELECTRIC LIGHTING AND TRACTION PROVISIONAL ORDERS AND BILLS.

With our last issue we concluded the list of notices of intention to apply for Parliamentary powers for electric lighting and traction. We give below the figures for the last eight years:—

	1893	1894	1895	1896	1897	1898	1899	1900
Lighting	20	32	32	41	61	98	134	137
Traction	15	17	13	37	61	45	54	107

ELECTRIC LIGHTING.

It will be seen that, compared with last year there is an appreciable increase in the number of electric lighting applications, and of these 114 are for provisional orders and 23 for private bills. There are very few metropolitan districts for which electric lighting powers have not been obtained, and consequently only five of the proposed applications for provisional orders affect that area—viz., Battersea, Marylebone, Limehouse, Mile End, and St. George's-in-the-East. As a matter of fact, each of the above districts is already covered by an order, and in the last three cases the local authorities are attacking the position of the County of London Co. The area of the City of London is affected by three important bills—viz., (1) that of the City of London Electric Lighting Co., which seeks, *inter alia*, to relieve the company from all or any of the obligations imposed by the City of London Electric Lighting Act (1893), and by the contracts made in 1890 and 1891 between (*a*) the Brush Electrical Engineering Co. and (*b*) the Laing, Wharton and Down Construction Syndicate and the Commissioners of Sewers of the City of London. Some particulars of this bill were given in our issue of Nov. 24, p. 165. (2) The bill of the Charing Cross and Strand Electricity Supply Corporation seeks authority to purchase land in West Ham for erecting an electricity generating station for supplying electric current in the area of the City of London. (3) The City of London Corporation also propose to introduce a bill for extensive powers in connection with underground conduits for the accommodation of telegraph, telephone, electric light, and other wires, cables, and apparatus, and to amend or repeal the provisions of any existing Act of Parliament which would limit or affect the proposed powers. (See also p. 166 of our issue of Nov. 24.)

Under the North Metropolitan electric supply scheme, which embraces portions of the counties of Middlesex, Hertford and Essex, including the districts of Hendon, Barnet, Edmonton, Ware, Hertford, Hatfield, Welwyn, St. Albans, Chingford and Walthamstow, powers are sought to acquire land near the river Lea at Edmonton and at Hertford for the erection of generating stations.

The Tyneside Electric Power Co. (Ltd.) are promoting a bill in Parliament empowering them to supply electric energy throughout the whole manufacturing district on both sides of the Tyne, from Blaydon and Newburn on the west to Tynemouth and South Shields on the east. The company propose to generate electric energy on a very large scale, and to supply it both in bulk to local authorities for distribution and for motive power purposes to works, shipyards and manufactories.

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The South Wales Electrical Power Distribution Co. seek powers to incorporate a company to erect three electric generating stations at Pontypridd, Pontypool and Neath, for supplying current in bulk in the county of Glamorgan and part of the county of Monmouth, including Cardiff, Swansea, and Newport. As the company's stations are so close to the South Wales collieries, they will be able to supply energy in bulk to local authorities for distribution to the general consumers at a cheaper price than the authorities can manufacture it for themselves. The company propose to charge from 1d. to 1½d. per unit, which is equal to about £15 per horse-power per annum. The engineers for the scheme are Messrs. Bramwell and Harris, and the bill is promoted by influential commercial men and colliery owners in South Wales. The Cardiff Corporation have already taken steps to oppose the bill, and to call a meeting of representives of local authorities in the area proposed to be served by the company.

The Dublin Electric Lighting Co. (Ltd.) have given notice of a bill to authorise the supply of electricity in bulk or otherwise in the city of Dublin and neighbouring towns and districts, including Kilmainham, Drumcondra, Clonliffe, Glasnevin, Clontarf, &c.

The scheme of the Lancashire Electric Power Co. is probably the most comprehensive of the six, as powers are sought to generate and supply electric current to the whole of the county of Lancashire south of the river Ribble. As this district comprises several cities and towns already in possession of municipal electricity works, the bill is certain to encounter fierce opposition.

The Walker and Wallsend Gas Co., who last year obtained powers for supplying electricity in Walker and Wallsend, are applying for powers to carry their cables across the river to supply Jarrow and Hebburn. They have already ordered generating plant, and arrangements have been made for the erection of a station adjoining their gas works at Neptune-road, Wallsend. The company are acting in conjunction with the Newcastle Electric Supply Co., who are also seeking powers to erect works at Neptune-road and in Long Benton and Walker.

The County of Durham Electric Supply Co. have also a scheme for supplying electricity in bulk in part of the county of Durham.

The Midland Electric Corporation for Power Distribution, who already possess powers for many districts in the Midlands, are applying for a provisional order to supply electricity in various additional districts in Stafford and Worcester.

The Lymington Corporation, who propose to purchase the local gas undertaking, are also seeking powers to establish electricity works in Lymington, Boldre and Milford.

ELECTRIC TRACTION.

Judging from the great increase in these notices compared with last year (107, against 54 in 1898), the "boom" in electric traction shows no signs of abatement. Although there is no scheme for the construction of any further underground electric railways in London, there are several bills affecting the metropolis and the provinces which are of more than ordinary interest.

First there is that of the Metropolitan District Railway Co., which seeks authority to work the railways of the company electrically, and for various other powers, including an extension of time for completing the Brompton and Piccadilly-circus Railway authorised in 1897. Other metropolitan railway bills include those of the London, Walthamstow, and Epping Forest Railway Co. (for, *inter alia*, power to construct a portion of the line in tunnel instead of cutting), the City and South London Railway Co., the Baker Street and Waterloo Railway Co. (who propose to construct the line to the standard gauge), the Charing Cross, Euston and Hampstead Railway Co., and the Whitechapel and Bow Railway Co., all of which seek extensions of time, further capital powers, &c.

Among the tramway bills which affect the metropolitan area are two of the London County Council, which ask for powers to work electrically the existing tramways (north and south of the Thames), and to construct a number of additional lines; that of the South Metropolitan Tramways Co., for authority to construct a network of electric lines in Lewisham, Penge, Beckenham, Croydon, &c.; and that of the London, Barnes, and Richmond Tramways Co., to construct and operate electric tramways in Richmond, North Sheen, Kew, Mortlake, Barnes and Hammersmith. The London United Tramways (Limited) are, with commendable perseverance and energy, again seeking powers to further extend and consolidate their system of electric tramways in the western suburbs.

Out of the numerous provincial applications the following are the principal:—

The Knott End Railway Co., to acquire the Garstang and Knott End Railway, to construct new railways, and to operate the whole by electric traction.

The Mersey and Wirral Railway Co. are promoting two bills for working their lines, as well as the lines of the Mersey and Wirral Joint Committee and Wirral Railway Co. and portions of the railways of the Birkenhead joint railways of the London and North-Western and Great Western Railway Cos., electrically.

The Bray and Enniskerry (Ireland) Railway Co. wish to extend the time for constructing the light railways authorised by their Acts of 1886, 1890, 1894, and 1897, and to adopt electric traction.

A gratifying feature of the provincial notices is the number of applications by local authorities already enjoying the advantages of electric traction, for powers to carry out considerable extensions. Among these may be included the Corporations of Bradford, Hull, Liverpool, Sheffield, Halifax, Huddersfield, &c.

Lancashire seems to be well catered for, as, in addition to the Mersey and Wirral railway bills, there is the scheme for the construction of an express electric railway (on the "Behr" mono-rail system) between Manchester and Liverpool.

The South Lancashire Tramways Co. are promoting a bill to construct electric tramways of a total length of 82 miles in St. Helens, Bolton, Leigh, Eccles, Abram, Ashton-in-Makerfield, Atherton, Burtonwood, Golborne, Haydock, Hindley, Ince, Little Hulton, Newton-in-Makerfield, Pemberton, Swinton, Tyldesley-with-Shakerley, Westhoughton, Worsley, Astley, and Lowton. The idea is to construct lines in these thickly-populated and industrial districts, to connect them with the tramways of St. Helens, Manchester and Bolton. Amongst the companies interested are the St. Helens Tramway Co. and the British Insulated Wire Co. The engineers of the scheme are Messrs. Preece and Cardew and Messrs. Kincaid, Waller and Manville. The cost is estimated at £1,000,000.

Another scheme is for the construction of an electric tramway from Whitefield to Eccles, connecting with the Ship Canal at Salford Docks. It will be available for goods as well as passengers, and will be over 12 miles in length. It will pass through seven townships, with a joint population of 200,000. The estimated cost is £120,000.

In addition to the above, the Corporations of Burnley, Lancaster, Liverpool, Manchester, Oldham, Preston, and Rochdale are promoting electric traction schemes. The Rochdale Corporation scheme embraces the construction of tramways of a total length of about 18 miles, and will cost (exclusive of amount required for purchase of present tramways) about £250,000. The gauge is to be altered from 3ft. 6in. to the standard, with a view to joining up with the systems of the neighbouring authorities of Oldham and Bury.

The Shannon Water and Electric Power Co. are seeking powers to incorporate a company to take water from the Shannon and Lough Derg at Killaloe and Plassy, and to utilise the water power for the generating of electricity.

Finally, a number of local authorities, following the lead of the Glasgow Corporation, are seeking powers to attach brackets, wires, &c., to private buildings for tramway purposes.

LIGHT RAILWAYS (ELECTRIC).

During November 43 applications were lodged with the Light Railway Commissioners for powers to construct light railways in Great Britain, compared with 40 in May and 53 in November last. A notable feature is the increasing proportion of applications for electric working, and on the present occasion nearly all the big schemes and more than two-thirds of the whole seek authority to adopt electric traction. The following are some of the more important projected light railways:—

Though the London County Council are promoting two parliamentary bills for constructing new and electrically equipping their existing tramways, they are applying to the Light Railway Commission for power to construct light (electric) railways from Highgate junction, along Archway-road to the county boundary; and also in Clapham, Battersea, Wandsworth, Putney, Greenwich, Lewisham, Charlton, Kidbrooke, Woolwich, Deptford, Lewisham, Lee, and Eltham. Further particulars of this project appeared in our issue of Oct. 20.

The Herts County Council and the Metropolitan Tramways and Omnibus Co. have jointly lodged four applications for authority to construct an extensive system in the counties of Hertford, Middlesex, and Essex. The lines will be constructed to the standard gauge, and the motive power will be electricity.

The Middlesex County Council are applying for powers to construct five lines of light railway, the first line between Willesden and Wembley, the second between Wembley and Harrow-on-the-Hill, the third between Harrow-on-the-Hill, Wembley and Wealdstone, the fourth between Harrow Weald and Great Stanmore, and the fifth between Friern Barnet, Finchley and Southgate. The gauge and motive power will be the same as in the last case.

Mr. David Cook has an ambitious scheme—*i.e.*, to construct a light (electric) railway from Ramsgate through Sandwich, Deal, Walmer, to Dover (forming a connection with and having running powers over the Dover electric tramways), on to Folkestone, Hythe, Dymchurch, New Romney, to Hastings. The cost of constructing this line has been estimated at about £330,000.

The British Electric Traction Co. are seeking powers to construct new or make extensions to existing light electric railways. The districts affected are (1) Cowpen and South Blyth (Northumberland); (2) Barnsley and Worsborough (Yorks.); (3) Bradford, Dewsbury, Batley, Cleckheaton; (4) Peterborough and district; and (5) Bowness, Windermere, Ambleside and Troutbeck.

The Oldham, Ashton and Hyde Electric Tramway (Limited) are applying for powers to extend their system, and Mr. Thomas Nevins also wishes to extend the Cheltenham and Cleeve line recently sanctioned by the Board of Trade.

Other important schemes relate to Llanelly, Loughborough, Aldershot, Farnborough, Wakefield, Warrington, and Mansfield. The Bath Corporation have also decided to apply for a light railway order, presumably because the procedure is simpler and does not involve the expense and delay of a Parliamentary application.

LEGAL INTELLIGENCE.

The Queen v. The Mayor, &c., of Blackpool.

In the Queen's Bench Division, on Wednesday, Mr. Justice Darling and Mr. Justice Channell decided this case. On Aug. 11th a rule nisi for a mandamus was granted against the Mayor and Corporation of Blackpool, to show cause why they should not hear and determine an application made by Mr. James Lucas for five licences for omnibuses to ply for hire within the borough.

Sir ROBERT REID, Q.C., for the Corporation, in opposition to the rule being made absolute, said the Corporation were the authority entrusted with licensing omnibuses, and in 1898 Mr. Lucas held eight licences. This year he applied for that number, but only three were granted. He had asked

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for this rule because the Corporation, who were owners of tramways in the borough, had refused to grant the remaining five licences, as they desired to remove competition. That suggestion was, however, not true. Mr. Lucas's application for the five licences was refused in good faith. Even if the suggestion were true, he was unaware of any decision which prevented the Council from taking into consideration the interests of the borough. In an affidavit made by Mr. Lucas he referred to a statement made by Ald. Fish, chairman of the Watch committee, who in March said that the committee considered they ought to make sure of the fullest revenue being derived from the tramways, and that, while they had sympathy with interests of the omnibus proprietors, they could not be expected to place that interest before the town's interest. Ald. Grime also had said that "the omnibus trade and the cab trade must go out." In affidavits filed in answer by members of the Council it was stated that the Carriage Drive had become so congested as to be a source of danger to life and limb, and that in May last, when the applications for omnibus licences were heard by the Council, they resolved that only 14 should be granted, three of which were given to Mr. Lucas. There was no evidence to show that this vote had been carried with an improper motive.

Mr. McCALL, Q.C., argued in support of the rule. The Council had he said, an invidious duty to perform. They had control of the tramways, and they would be naturally anxious to manage them so as to throw as little burden upon the ratepayers as possible, No reason had been shown for reducing the omnibus traffic upon the routes on which Mr. Lucas's omnibuses plied, for only one of his omnibuses used to ply on the Carriage Drive, while six were on the Martin route, with regard to which there was no suggestion that it was congested. It was obvious that the Council had been swayed by the improper considerations pressed upon them by Aldermen Fish and Grimes. It was sufficient for him to show that an improper argument had been pressed upon the Council, and that they had acted as if they had accepted that argument. He cited Reg. *v.* Vestry of St. Pancras in support of this contention.

Mr, Justice DARLING said the rule must be discharged. The Council found themselves in a difficult position, owing to the conflicting interests arising from the exercise of the powers conferred on them. It was their duty to license omnibuses plying for hire in Blackpool. Further, they had, in exercise of a right conferred upon them, made tramways, and they carried on the tramways as a trading concern. In the matter of licensing it was their duty to act according to the rules of reason and justice, and if it were shown that they were actuated by wrong motives, or that their judgment was biassed, a mandamus would go, because then they would not have heard the application for the licence according to law. The difficulty arose owing to the speeches of Aldermen Fish and Grimes. That was a difficulty which was always liable to arise now that powers had been conferred on Corporations to carry on business as tramway owners, and it might be that the Legislature ought to reconsider the advisability of allowing these bodies to continue to have jurisdiction over licences for omnibuses, which might conflict with the interests of the business they carried on. It was obvious that the suspicion that had arisen in this case must be widespread. If Mr. Fish and Mr. Grimes had been the only persons deciding whether the licences should be granted, he should have come to the conclusion that they did not hear and determine the application as they ought. But the statements complained of were mere isolated statements made by members of a numerous body. Therefore, while giving full credit to the desire of the Council to carry on their tramway business so as to make a profit and not a loss, he did not think that there was enough to show that the Council had not acted according to justice and had not heard the case on its merits. Unless that were shown, the Court would not set aside their decision.

Mr. Justice CHANNELL concurred, and the rule was discharged.

Telephone Wayleaves.

A sitting of the Railway and Canal Commissioners was held on Tuesday at Edinburgh to further consider the differences which have arisen between the Postmaster-General and the Edinburgh Corporation in connection with the application of the former for consent to lay telegraph wires under certain streets in the city. The Corporation refused their consent, and the matter was remitted to the Sheriff of the Lothians, who decided in favour of the Postmaster-General ; and the Corporation now appealed from that decision to the Commissioners.

Lord STORMONTH DARLING said the case was substantially ruled by the decision of the Commissioners of July 20 last in the case between the Postmaster-General and the Glasgow Corporation. He did not propose to repeat the reasons given on that occasion, but he would shortly notice two points, viz.: (1) The argument under the Telegraph Act of 1892, which, although stated in the Glasgow case, was more urgently pressed by the present appellants, and (2) the supposed distinction between the two cases arising out of the fact that the Corporation of Edinburgh were not merely a body having control of the streets, but were owners of the solum. First, as to the Act of 1892. It was said that, by the combined effect of Secs. 5 and 9 that a company or person licensed by the Postmaster-General to exercise the powers conferred on him by the Telegraph Acts of 1863 and 1878, could not exercise these powers in a Scottish burgh without consent of the burgh road authority, which consent was not open to review. The answer to that was that the powers conferred on the Postmaster-General by the Acts of 1863 and 1878 were powers of construction, and that he had not in the present case licensed any company or person to exercise these powers. He proposed to do the work himself, and his licence to the National Telephone Co. to use some of the lines when constructed was not a licence granted under either the Act of 1863 or the Act of 1878, but under another statute. It seemed therefore that Sec. 5 of the Act of 1892 had no application. As to the ownership of the streets by the Corporation of Edinburgh, it was necessary to distinguish between their character as owners and their character as a body having control of the streets. It was only in the latter capacity that their consent was required under the Act of 1863. No doubt, under Sec. 13 of the Act, the consent of the landowner was required, in addition to the consent of the body having control, but only where such landowner was liable for the repair of the streets. And as he read Sec. 112 of the Edinburgh Municipal Act of 1879, the Corporation was liable for the repair of the streets, not as owners, but because they were vested in them, and they had the charge and superintendence of them. But really this was of little importance, because he was satisfied that Sec. 13 of the Telegraph Act of 1863, only required the consent of the owner in addition to the consent of the body having control where these were separate persons. He did not think the fact of the Corporation being owners at all affected the present question. In particular, it did not seem to the Commissioners to afford any reason for annexing pecuniary terms to the consent which they thought ought to be given to the operations of the Postmaster-General. The Corporation were a public body, and the Postmaster-General must be held to be acting in the public interest. They would therefore give consent to the proposal of the Postmaster-General as the Sheriff did, without conditions.

Stegmann v. O'Connor.

Lords Justices A. L. Smith, Collins, and Vaughan Williams, in the Court of Appeal yesterday (Thursday), delivered judgment in this case, which has been fully reported in *The Electrician*.

Lords Justices SMITH and COLLINS now upheld the judgment of the Official Referee and the Divisional Court, being of opinion that the plaintiff was certainly not liable to pay less than £50 as liquidated damages.

Lord Justice VAUGHAN WILLIAMS dissenting, said that to his mind it was clear on the findings and figures of the Official Referee that he had given the defendant liquidated damages for the time after the exclusion of the plaintiff from the work. For the defendant to do the work himself was clearly wrong. He thought the case ought to go back to the Official Referee, for him to find whether the defendant by his conduct disentitled himself to claim damages, so that it might be determined whether the facts were such as to make the plaintiff chargeable for the delay during the time preceding his exclusion from the premises.

By a majority of the Court, therefore, the appeal was dismissed with costs.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week*]

NOW READY.

"The Electrician" Electrical Trades' Directory and Handbook for 1899.—The *Second Edition* of the "Big Blue Book" for 1899 is now ready. The volume contains the large Sheet Tables of Electricity Supply Stations and Electric Railways and Tramways. The price of the Directory and Handbook is now reduced to 5s. post free 5s. 9d. ; abroad, post free, 6s. 6d. (United States 7s. 6d.).

TENDERS INVITED.

The *West Bromwich* Corporation invite tenders for the supply, delivery, and erection of the following: (*a*) Boilers and accessories (*b*) steam dynamos and condensers, (*c*) switchboard, (*d*) mains, (*e*) storage battery. An advertisement contains further particulars (including the date for completion of the various contracts), and specifications, &c., may be obtained on application to the town clerk (Mr. Alfred Caddick), Town Hall, West Bromwich. Plans and specifications may be inspected at (but not obtained from) the office of the consulting engineer (Mr. Robt. C. Quin, M.I.E.E. and M.I.Mech.E.), electricity works, Blackpool, and tenders must be in by 10 a.m. of 22nd inst.

The *Hull* Electric Lighting committee invite tenders for the supply and erection of the following plant at their Sculcoates electric lighting works: Two high-speed vertical engines, two high-tension continuous-current dynamos, and one spare armature (Eickemeyer winding). Further particulars are given in an advertisement, and specifications may be obtained at the city treasurer's office, Town Hall. Tenders to chairman of Lighting committee, Town Hall, Hull, by noon of 28th inst.

The Electric Lighting committee of the *Hackney* (London) Vestry invite tenders for accumulators. The specification, &c., can be obtained at the offices of Mr. Robert Hammond, consulting engineer to the Vestry, 64, Victoria-street, Westminster, London, S.W., on and after Dec. 4 ; and tenders must be addressed to Mr. George Grocott, Vestry clerk, Town Hall, Hackney, by 4 p.m. of Tuesday, Jan. 2, 1900. Further particulars are given in an advertisement.

The *Glasgow* Corporation invite tenders for the supply of a cast-iron cable tunnel, water storage tanks, travelling cranes for outside coal storage, mechanical stokers, coal and ash conveyors, and steel

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flues. Specifications, &c., can be obtained from the general manager of the tramways (Mr. John Young), 88, Renfield-street, and tenders must be lodged with the town clerk (Sir J. D. Marwick) not later than 1 p.m. on Saturday, Jan. 6th next. An advertisement contains further particulars.

The *Wallasey* District Council invite tenders for the construction, delivery, and fixing of a steel Lancashire boiler at the electricity supply station. Specifications can be obtained from the engineer (Mr. J. H. Crowther), Great Float, near Birkenhead, and further particulars are given in an advertisement. Tenders addressed to the clerk (Mr. H. W. Cook), Public Offices, Egremont, Cheshire, must be in by 20th inst.

The *Ilford* District Council invite tenders for the supply and erection of the following plant: (*a*) Water-tube boilers with fittings, economiser, feed pumps, &c.; (*b*) pipework, &c.; (*c*) two 200-kw. and one 100-kw. steam dynamos and motor boosters (vertical enclosed high-speed engines); (*d*) storage batteries; (*e*) main switchboard and connections; (*f*) overhead travelling crane; (*g*) underground mains, &c.; (*h*) arc lamps and posts; (*k*) station lighting. An advertisement contains further particulars, and copies of specification can be obtained of the clerk to the Council (Mr. J. W. Benton), Council offices, Ilford, after the 12th inst. Plans and specifications have been prepared by the consulting engineer (Mr. W. C. C. Hawtayne), 9, Queen-street-place, London, E.C., from whom further information can be obtained after 12th inst. Tenders (addressed chairman of Council) must be delivered before noon of 20th Jan.

The directors of the *Midland Electric Corporation for Power Distribution* (*Limited*) invite tenders for the supply and erection of plant and conductors for a power-house which, when fully equipped, will be capable of an output of 10,000 e.h.p. Tenders to the secretary (Mr. G. Carpentier), 11, Cornhill, London, E.C., before 4 p.m., Dec. 18.

The *Rathmines* and *Rathgar* (Co. Dublin) Electric Lighting committee invite tenders for additional feeding and distributing mains, including trenching, troughing, cables, joint boxes, jointing and house services. Tenders to the clerk (Mr. F. P. Fawcett), Town Hall, Rathmines, by 4 p.m. of Dec. 13.

The *Gloucester* Electricity Supply committee invite tenders for (*a*) one Lancashire boiler and accessories and mechanical stokers; (*b*) one 300-kw. steam dynamo and accessories, steam, exhaust, &c., pipes, valves, &c.; (*c*) extensions of switchboard; and (*d*) condensing plant. Tenders to the town clerk (Mr. George Sheffield Blakeway), Guildhall, Gloucester, before Dec. 28.

The *Blackburn* Corporation invite tenders for the supply and delivery of overhead line equipment. Tenders to the town clerk (Mr. Robert E. Fox), Town Hall, Blackburn, by Dec. 23.

The *Manchester* Tramways committee require tenders for the supply of steel tie bars, bolts and nuts for permanent way work. Tenders (addressed "Chairman of Committee") before 16th inst.

The *Blackpool* Corporation invite tenders for the supply, delivery, and erection of the plant detailed in our issue of Nov. 24. Tenders by 10 a.m., Dec. 15.

The *Newcastle-upon-Tyne* Tramways committee invite tenders for a 2,000 h.p. steam dynamo. Tenders to town clerk by Jan. 16.

The *St. Annes-on-Sea* District Council require mains and street arc and incandescent lighting tenders. Tenders by 21st inst.

The *Hampstead* (London) Vestry invite tenders for wiring the public baths, Finchley-road, N.W. Tenders by 14th inst.

The *Shoreditch* Vestry require tenders for the construction of two underground transformer stations. Tenders by 19th inst. to Vestry clerk.

Tenders are invited by the *Lancaster* Guardians for the electric lighting of the workhouse. Particulars from the clerk.

The *Birmingham* Corporation require a high-speed engine and dynamo for their Elan waterworks. Tenders to town clerk by noon, 20th inst.

The Municipal Council of *Almaden* (Ciudad Real), Spain, invite tenders until 15th inst. for the concession for the electric lighting of the town for 20 years. Tenders to el Secretario del Ayuntamiento.

TENDERS RECEIVED AND ACCEPTED.

The Newcastle-on-Tyne Town Council have accepted the tender of Messrs. Dick, Kerr and Co. for the supply of 5,000 tons of steel tramrails at £8. 7s. 6d. per ton, 260 tons of fishplates at £9. 17s. 6d. per ton. Mr. Cail (chairman of Tramways committee), in moving the adoption of the report said that the company was an English one with works in Germany, where the rails would be made; but they would come to this country in English ships, and the committee did not see that for a sentimental reason they should give the order to Bolckow, Vaughan and Co. at £9 per ton, with the prospect of not getting such an early delivery. The following tenders have also been accepted by the Corporation: Thomas Beeley and Son, for boilers at £7,298; Patent Nut and Bolt Co. (Ltd.), for supplying 40 tons of fishbolts with patent lock-nuts at £18. 10s. per ton, and 100 tons of cross-ties at £14 per ton.

The following tenders have been received by the Llandudno District Council for the supply of three 150 kw. high-speed engines and dynamos, motor and boosters, for their electricity works:—

India-Rubber Co. (Allen engines) (*accepted*)	£4,022	British Thomson-Houston Co.	£5,273
Sandycroft Foundry & Engineering Co.	6,606	Metcalf and Co.	5,210
P. R. Jackson and Co.	6,472	Ashton, Frost and Co.	5,206
Westinghouse Co.	6,371	Sunderland Forge Co.	5,200
Brush Co.	6,229	Mavor and Coulson	5,163
John Fowler and Co.	6,154	Crompton and Co.	5,028
D. Bruce Peebles and Co.	5,986	Smith and McMillan	4,971
Electric Construction Co.	5,662	W. H. Allen, Son and Co.	4,917
Foote and Milne	5,594	E. Scott and Mountain	4,892
Mather and Platt	5,542	J. H. Holmes and Co.	4,848
Siemens Bros. and Co.	5,400	General Electric Co.	4,427
		Thames Ironworks Co.	4,197
		Lancashire Dynamo Co.	3,632

The Leicester Corporation have placed an order for two 1,000 kw. steam alternators with the Brush Co. The dynamos will be of the inductor type, of which (we are informed) a large number, both for monophase and polyphase working, are in course of construction at the company's works at Loughborough.

The Leeds City Council have accepted the tender of Messrs. Dick, Kerr and Co. for the supply of 50 electric cars, at £28,896. These are to be delivered at the rate of 10 per month. The Council were also recommended to accept the tender of Messrs. J. Schofield, Son and Co. for the construction of seven transformer chambers at £2,298. 1s. 6d., but objection was raised as the firm did not pay the standard rate of wages; and on a vote being taken the motion to refer back was defeated, but the motion for the adoption of the minutes was also rejected (by 23 votes to 22). The subject will come up again for consideration.

The Portsmouth Corporation have accepted the tender of the Electric Railway and Tramway Carriage Works of Preston for the supply of 60 electric tramcars at £585 each.

The Liverpool Corporation have given an order to the Klein Engineering Co. for a combined condensing and water-cooling plant for engines of 3,600 h.p., for their Lister-drive power station.

The York Corporation have accepted the tender of Messrs. Venner and Co. for the supply of Hookham meters during the next 12 months, at £4. 17s. 6d. each for meters of 5 to 10 amperes capacity, and £5 each for meters above 10 and under 100 amperes capacity.

The tender of Mr. W. J. Bishop has been accepted by the Croydon Guardians for the electric lighting of the infirmary, workhouse, and union offices at £1,995. Twenty-two tenders, ranging from £1,542 to £3,434, were received.

The East Ham District Council have accepted the tender of Messrs. Dick, Kerr and Co., for the laying of tramways in the district, at £27,250.

The Leyton Town Council have accepted the tender of Messrs. Willans and Robinson for two steam engines for their electricity works, at £2,368, and that of Messrs. Mather and Platt for two dynamos, at £1,376.

The tender of the National Electric Wiring Co. has been accepted for wiring the new offices of the Willesden Council at £130. 8s.

The Bootle Corporation have accepted the tender of Messrs. R. W. Blackwell and Co. for the overhead equipment of a double line of electric tramways in Knowsley-road, and the Callender Co. have obtained the order for supplying and laying armoured cables.

APPOINTMENTS VACANT AND FILLED.

A demonstrator in physics is required for the University of Sydney, N.S.W. Salary £350 per annum. Further particulars are set out in an advertisement, and applications must be sent in to the Agent-General for New South Wales (Sir Julian Salomons), 9, Victoria-street, London, S.W., by Jan. 1.

The Plumstead (London) Vestry invite applications for the post of electrical engineer, to advise upon and design and take sole charge of the erection of the electric light plant, works, and buildings, and subsequently to undertake the sole management and control of the electric light department. Some further particulars will be found in an advertisement. The commencing salary is £400 per annum. Applications to Mr. Edwin Hughes, Vestry clerk, Plumstead, by Thursday, 21st inst.

The following positions are vacant at the Whitechapel (London) electricity works: Meter and consumers' clerk, second shift engineer, two engine and dynamo attendants, and a mains foreman. An advertisement contains further particulars, and applications must be sent to Mr. Wm. C. P. Tapper, resident engineer, 27, Osborne st., E.

The Rochdale Guardians require a clerk of works, and eventually to act as engineer-in-charge. Applications to the clerk (Mr. R. A. Leach), Union Offices, Rochdale, before 11th inst. See advertisement.

The Bury St. Edmunds Corporation invite applications for the post of resident electrical engineer. Applications to the town clerk (Mr. C. E. Salmon) by 15th inst.

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Two switchboard attendants and a meter tester are required for the Greenock electricity department. Applications to the burgh electrical engineer (Mr. S. E. Fedden), Municipal Buildings, Greenock. See advertisement.

The Chair of Engineering at University College, Bristol, is vacant, owing to the appointment of Dr. Ryan as principal of the Woolwich Polytechnic. Applications to secretary by Jan. 16.

The Bethnal Green (London) Guardians require a resident electrical engineer. Applications to clerk, Bishop's-road, Victoria Park, N.E., by 14th inst.

Mr. E. Kilburn Scott has been appointed to the position of instructor in electrical engineering and design at the Northampton Institute.

Mr. J. J. Smith, of Altrincham, has been appointed resident electrical engineer by the Stockton Town Council, at a salary of £250 per annum. There were 49 candidates. Mr. Smith is a son of Alderman G. F. Smith, J.P., of Stockton, and served his apprenticeship at Messrs. Blair and Co.'s. After a period of service on board ship he took up electrical engineering, and was engaged by Messrs. Ernest Scott and Mountain. At present he is manager of the Altrincham Electricity Works.

Mr. Charles A. Henderson, of Glasgow, has been appointed mains superintendent at the Aberdeen Corporation electricity works, in place of Mr. D. M'F. M'Leod, who has been appointed assistant engineer at Poplar.

Mr. F. E. Proctor has been appointed mains engineer by the Manchester Corporation, at a salary of £350 per annum. Mr. L. R. Lee has been appointed assistant mains engineer at £185 per annum, with an annual increase of £15.

Mr. J. G. Griffin, of Llandudno, has been appointed assistant electrical engineer at the Burnley Corporation electricity works.

BUSINESS NOTICES.

Messrs. Johnson and Phillips notify the removal of their Manchester branch to more commodious and convenient premises at Duchy-chambers, Clarence-street, Albert-square. N., Manchester, where large stocks of cables, arc lamps, meters, and other electrical apparatus will be held.

Messrs. F. H. Cerito, A. E. Edwards, and W. Shaw, trading as Cerito, Edwards and Shaw, electrical and mechanical engineers, 39, Newball-street, late 71, Temple-row, Birmingham, have dissolved partnership. Debts by Messrs. Edwards and Shaw, who have commenced business at 105, Colmore-row. Mr. F. Cerito continues at 39, Newhall-street.

BANKRUPTCIES, LIQUIDATIONS, &c.

Claims against Thomas Ford (trading as Thomas Ford and Co.), electric fittings manufacturer, &c., Victoria-street, High-street, Birmingham, must be in by 9th inst. Mr. L. J. Sharpe, 176, Corporation-street, Birmingham, is trustee.

Mr. Maurice Jenks, 6 Old Jewry, London, E.C., has been appointed trustee in the bankruptcy of J. C. Howell, electrical engineer, lately carrying on business at 24, Queen Victoria street, E.C.

A first and final dividend of 1⅞d. is payable after 13th inst., at the O.R.'s, 33, Carey-street, London, W.C., in the liquidation of Conrad Dewey and Co. (Ltd.), electric light fittings manufacturers, &c., late 24, Farringdon-avenue, London, E.C.

At a meeting of Vril Launches (Ltd.) on Nov. 13 it was resolved to wind up the company voluntarily, and Mr. A. L. Dickinson, 19, Coleman street, E.C., was appointed liquidator.

A meeting of the London and Hampstead Battery Co. (Limited) will be held at Donington House, Norfolk-street, London, W.C., on Jan. 5, to receive an account of the winding-up.

The public examination of Frederick G. William Adams, electrical engineer, lately trading in partnership with C. M. Downie, at 24, Newman-street, London, W., under the style of Downie and Adams, took place on Monday, at the London Bankruptcy Court. Debtor attributed his failure to loss on the capital contributed by him to the partnership, to bad debts, &c. He was allowed to pass upon accounts showing unsecured debts £1,000, contingent liabilities £2,142 (not expected to rank), and assets consisting of shares in the Premier Electricity Meter Co. (Limited).

On Friday last, in the Chancery Division, Dublin, the Vice-Chancellor heard two petitions for the compulsory winding-up of Dobsons and Curtis Bros. (Limited). Both petitions alleged that the company was insolvent. On Oct. 19 a receiver on behalf of the debenture holders had been put into possession of the company's assets, and after the presentation of the petitions for winding-up a resolution was passed to have it wound up voluntarily and providing for the appointment of Mr. R. Gordon as liquidator. The Vice-Chancellor said he was satisfied he was bound to make an order for the compulsory winding-up of the company. There would be an independent inquiry, and he would make an order to have the whole matter thoroughly investigated. He would take care that a person thoroughly independent of all the parties was appointed liquidator.

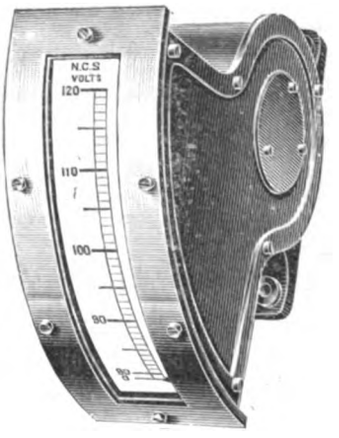
A petition has been filed at York by Henry Lionel Howard, electrical and mechanical engineer (trading as Thompson, Howard and Co., Wyverston, Dragon-parade, Harrogate, 16, Stonegate, York, and 17, Carlisle-street, Hull), and the debtor has been adjudicated bankrupt.

Plant Sale.—As announced in an advertisement, Mr. Herbert Humphries will sell by auction, on the premises of the Midland Acetylene (Parent) Syndicate (Ltd.), Corngreaves, Cradley Heath, on Monday, Tuesday, and Wednesday, 18th, 19th, and 20th inst. (commencing each day at 10 sharp), the whole of the costly electrical and steam plant recently laid down and employed in the manufacture of calcium carbide. The plant includes two Peache high-speed engines, two 150 kw. alternators, three Lancashire boilers, &c. Catalogues may be obtained from Mr. A. E. Mason, C.A., Priory-street, Dudley; Messrs. Burt and Haviland, solicitors, Bournemouth; Messrs. Homfray, Halberton and Mellor, solicitors, Brierley Hill and Cradley Heath; or from the auctioneer (Mr. Humphries), Brierley Hill and Stourbridge.

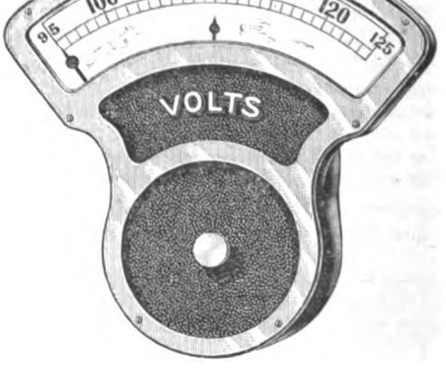
Works Sites for Sale.—An advertisement in another column gives particulars of some excellent freehold sites, suitable for electrical engineering works, &c., which are for disposal at Stapleford, Notts. The land adjoins the Midland Railway, and has in the immediate vicinity ironworks and collieries. Further information will be supplied by Mr. Joseph Wilson, solicitor, Stapleford.

Personal.—Mr. Alex. Marr has joined the St. Helens Cable Co as their superintendent.

"N.C.S." Measuring Instruments.—Messrs. Nalder Bros. and Thompson (Limited), 34, Queen-street, London, E.C., have introduced edgewise measuring instruments in varying sizes. The illustration



shows a 7in. radius instrument with an 8in. scale. These are made in larger sizes (9in. and 12in.), with illuminated dials if required. The second figure shows a sector-shaped instrument, this type being



also made with or without illuminated dial. This has a 9in radius with a 12in. scale. Both types of instrument are made for direct currents with permanent magnet moving coil and dead-beat movement, and for alternating current with electromagnetic movement.

Traction Motors and Controllers.—Messrs. Witting Bros. (Limited), of 49, Cannon-street, E.C., send us their new brochure dealing with the traction motors and controllers supplied by them. In connection with their engineering department Messrs. Witting Bros. have recently arranged to represent in Great Britain and the Colonies the well-known Belgian firm of Electricité et Hydraulique (Société anoyme), of Charleroi, who have carried out a large number of power and traction installations on the Continent. Among the more

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important of the latter may be cited Brussels, Ostend, Liège and Mons (Belgium), Koursk and Orel (Russia), Algiers, Naples, Belgrade, Sofia, &c. The line at Mons is a light railway, constructed for the Belgian State under stringent guarantees. In addition to illustrations of various motors and controllers, open and closed, Messrs. Witting's pamphlet gives typical curves of efficiency, draw-bar pull, speed, &c., with tables of weights of various sizes of motors and their parts, and taken altogether, is well worth studying by those interested in modern traction plant.

Water-Cooling Plant.—The Birmingham Electric Supply Co. have placed with the Wheeler Condenser and Engineering Co. an order for the installation of Barnard-Wheeler water-cooling towers for engines of 2,000 H.P. With the cooling towers is to be supplied a Wheeler Admiralty-pattern surface condenser of a cooling surface of 3,200 sq. ft., mounted direct on the Wheeler Co.'s open horizontal air-circulating pumps. The equipment includes a gravity filter-tank, hot well pump, and pressure filter, forming a complete condenser outfit for 2,000 H.P.

"Albert" Knife Switches.—*Correction.* An error occurred in the note in our last issue relating to the Albert switches, manufactured by the Electrical Transmission Co. (Ltd.), Albert Works, Hammersmith, London, W. The note should have read that these switches "are *not* claimed to be designed to compete with the rough and cheaper class of switches, as the company intend to supply only high-class apparatus."

Electrical Accessories and Fittings Catalogue.—Messrs. Heaton and Smith (Ltd.), Blackfriars-street, Salford, Manchester, have just issued a very complete catalogue of main switchboards and switches, accumulator switchboards and regulators, distribution boards, fuse boards, fuses, and an extensive variety of general electrical accessories and fittings.

Electric Measuring Instruments, Switchboards, Switches, &c.—A useful trade list of electric measuring instruments, switchboards, distributing-boards, switches, cut-outs, &c., is issued by Messrs. R. A. Broadhurst and Co., 184, Tottenham Court-road, London, W., copies of which can be obtained by the trade on application.

High-Voltage Lamps.—In reference to the article on high voltage lamps in the two recent issues of *The Electrician*, the Robertson Lamp Co. ask us to state that they recommend an efficiency of 3½ to 4 watts per candle for both 8 and 16 c.p. high-voltage lamps.

Exhibition.—There is to be a Gas and Allied Trades Exhibition at the Royal Aquarium, Westminster, London, from Dec. 31 to Jan 23, at which a number of the exhibits will consist of electric light and gas and electric combined fittings. Many well-known firms in the electrical fittings trade will be represented.

Cassier's Magazine.—The contents of the December issue include: "Development of Electric Stations," "Practical Limitations of Electric Power Transmission," "Electric Progress," "Direct Electric Driving in Machine Shops," "American Machine Tools and Methods," "The Need of Technical Education," and "Factory Heating."

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Nov. 29 to Dec. 5, with the ports of destination:—

Africa—Alexandria, £68 (including £51 telegraph material); Cape Town, £191; Durban, £1,090; East London, £50; Port Said, £386. *Argentina*—Buenos Ayres, £363 (including £118 telegraph material). *Australasia*—Adelaide, £19; Auckland, £20; Fremantle, £20; Greytown, £10; Melbourne, £38; Perth, £343; Sydney, £392; Wellington, £1,264. *Belgium*—Ostend, £118. *Canada*—Montreal, £116. *Chili*—Boca, £222 (telegraph material). *China*—Shanghai, £530. *Colombia*—Santos, £62. *Denmark*—Copenhagen, £180 (telegraph material). *France*—Calais, £60. *Germany*—Hamburg, £307 (including £290 telegraph material). *Holland*—Amsterdam, £60; Rotterdam, £170. *Hong Kong*—£82 (telegraph wire). *India*—Bombay, £16; Calcutta, £98 (including £47 telegraph wire). *Japan*—Kobe, £396; Tokyo, £730; Yokohama, £100. *Malta*—£118. *Portugal*—Beira, £48 (telegraph instruments). *Russia*—Libau, £35; Reval, £210. *Siam*—Bangkok, £254. *South Africa*—Chinde, £611 (telegraph material); Durban, £369; East London, £14; Port Elizabeth, £322 (telegraph material). *Straits Settlements*—Singapore, £84. *Turkey*—Constantinople, £35 (telegraph wire). Total, £9,601, against £20,807 in the corresponding week last year (Nov. 30 to Dec. 6).

MUNICIPAL, FOREIGN, AND GENERAL NOTES.

Alfreton.—The Lighting committee have sent a deputation to Pontypool to inspect the electricity works, and report.

American Electric Tramcars.—According to the special correspondent of the *Glasgow Herald*, American electric tramcar builders are at present very busy, as in addition to home orders they have in hand European contracts for nearly 1,500 trolley cars for electric tramways now constructing abroad. Nearly 1,200 cars are for municipal and privately capitalised roads in England and France. Extensive purchases of equipments have also been made for the proposed extensions of the Barcelona and Bilbao tramways. The orders will be distributed among all the principal makers in the United States, in order to facilitate delivery. The greater portion of the cars will, it is said, be of American design. The Jackson and Sharp Co., Wilmington, Del., has been awarded a contract for 100 trolley cars for roads under construction in the grounds in the vicinity of the Paris Exposition.

Bangor.—The Corporation have entered into an arrangement with the National Electric Wiring Co. for the wiring of premises in the district on easy terms.

Barnstaple.—Mr. F. W. Chanter has been appointed consulting electrical engineer to the District Council.

Bath.—The receipts for the six months ended September were £111 in excess of the corresponding half-year in 1898. The accountant calculates that under the most favourable conditions there will be a deficiency of £1,500 on the year's working, after providing for interest and sinking fund.

Bermondsey (London).—The Vestry have received a long report from their consulting engineers (Messrs. Kincaid, Waller and Manville) on the proposed electric light and dust destructor scheme. An estimate attached to the report indicates that the size of the plant to be at once installed has been doubled. The capital expenditure on the enlarged scheme (including buildings, a six-cell destructor, machinery, boiler-house plant, mains, and 20 public arc lamps), is estimated at £47,960. The anticipated revenue is taken at £6,313 and maintenance at £3,300 per annum, leaving £3,013. Interest and sinking fund for a term of 42 years is put at £1,980, leaving an estimated surplus of £1,033. With regard to these figures, the consulting engineers point out that if the Vestry decide to adopt the scheme on the larger scale they will be able to join up at least 10,500 8 c.p. lamps, which should satisfy the demands in Bermondsey for some time to come; though, judging by the progress made by other and similar parishes in London, the business obtainable is likely to exceed this estimate. After discussion the Vestry have adopted the report, and have instructed Messrs. Kincaid, Waller and Manville to prepare a specification for the erection of buildings. The Vestry have also approved a specification for the construction of the destructor, and have decided to advertise for tenders for the supply and erection of the cells.

Birkenhead.—The Electric Lighting committee recommend that application be made to borrow £3,500 for extensions of the electric lighting mains.

Birmingham.—The Public Works Loan Commisioners have decided to grant a loan of £500,000 to enable the Corporation to acquire the undertaking of the Birmingham Electric Supply Co., and Corporation Three per Cent. stock is to be issued as security for the loan.

Bristol.—An inquiry was held here on Tuesday into the application of the Corporation to borrow £15,300 for electric lighting. It was explained that the money was for purchasing land needed for new electric generating works, and the Corporation asked that the repayments should be extended over 50 years. The present electricity works were much too small for the demand. The Electrical committee had no powers under their provisional order for the compulsory purchase of land, and when they desired to increase their establishment so as to provide for additional customers they had had to buy land as and when they could get it. The Corporation felt the best thing they could do would be to acquire a considerable area of land in a part of the city where land was not so expensive, and where they could have an approach by rail as well as by water. The area of the existing works was 4,155 sq. yards, and that was practically covered. The land proposed to be acquired was more than was needed for present purposes, but it was considered best to get a piece of land which would meet the demand for some years to come. The city electrical engineer (Mr. H. Faraday Proctor) stated that between the first and second years of starting the Electrical committee added the equivalent of 9,000 8 c.p. lamps, the next year 12,000, the next 9,800, the next 16,900, whilst for the portion of the current year they had added 16,476 lamps, showing that the last year will exceed in additions any previous year. The Board had already sanctioned the purchase of additional machinery, which should be in operation as early as possible.

The question of the extension of the arc lighting system was again considered by the Sanitary committee last week. There are at present 306 arc lamps in use, and the annual charge is £23 per lamp. The annual sum debited to street lighting for these lamps was £7,038, and a list of streets was submitted in which it was proposed to erect 436 additional lamps. The borough electrical engineer stated that if the suggested extensions were carried out the cost per lamp would be reduced to £19 per lamp per annum. The addition of 486 arc lamps would cost £5,705 per annum more than the present system, or about £11. 15s. per lamp. It was decided to hold a special meeting to consider the matter.

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Cardiff.—The Royal Hotel, Cardiff, has been wired or the electric light by Messrs. Edwards and Armstrong. There are about 1,000 lights in addition to a system of telephones and electric fans.

Cheltenham.—The Local Government Board have sanctioned the borrowing of a further £16,000 for electric lighting extensions. At present there are over 350 customers connected to the mains, representing an equivalent of about 22,000 8-c.p. lamps.

Chichester.—Mr. E. Price, of Portsmouth, has reported upon the electric lighting scheme recently projected by the city surveyor (Mr. J. J. Saunders). Mr. Price recommends the adoption of the high-tension alternating-current system (generating at 2,000 and distributing at 200 volts) as the most suitable for the district. The capital expenditure involved would be about £22,000, and, according to calculations made by Mr. Price, there would be a profit of £167 after meeting all expenditure, including interest and sinking fund.

Dewsbury.—The Corporation have reduced the charge for electric current to the Co-operative Society. The matter has been under discussion for some time, and at one time the Society threatened to establish independent generating works.

Dover.—The Corporation have decided to introduce halfpenny fares on their electric tramways during portions of the day.

East London (South Africa).—According to the *British and South African Export Gazette*, the electricity supply works were recently opened, but owing to the non-arrival of the tramcars the electric tramway system has not yet been put into operation. The contract has been carried out by Messrs. Reunert and Lenz, of Johannesburg. The power station is situated near the pontoon on the Buffalo river, and is divided into boiler house and machine room. The boiler house is 46ft. by 75ft. in extent, the adjoining engine room being 75ft. by 38ft. There is also office space and electric test room, 19ft. by 15ft.; arrester house, 29ft. by 9ft. 3in.; and fitters' shop, 24ft. 6in. by 15ft. Three boilers, each of 200 h.p., have been installed, one as a stand-by. In the engine room are three continuous-current dynamos of 75 kw., one to be used for street arc lighting and another for tramway work. Two alternators are used for supplying private lighting mains and street incandescents, each capable of supplying 2,500 16-c.p. lamps, the capacity of each machine being equal to the entire light service of the town. The engines are of the Belliss enclosed type. Water-tube double drum Babcock and Wilcox boilers are installed, fitted with superheaters, said to be here used for the first time in South Africa. For the street lighting 20 2,000-c.p. arcs are employed. The lighting of the harbour works is part of the general scheme, but owing to the non arrival of the Simplex conduit fittings, which have been chosen by the Harbour Board, this has been temporarily delayed.

Eccles.—The demand for electric current is so great that the Electricity Supply committee are already considering the advisability of increasing the capacity of the generating station.

Edinburgh.—The Corporation have decided to enter into an agreement with the National Telephone Co. on the subject of the telephone service of the City in the terms set out in our last issue.

Epsom.—The Council have obtained powers for borrowing £16,100 for electric lighting.

Grantham.—The Corporation have sanctioned the application of the Urban Electric Supply Co. for a provisional electric lighting order.

Great Malvern.—The Council were recommended on Wednesday to establish electricity works, at an estimated cost of £30,000. The committee having charge of the matter has, however, been instructed to prepare an alternative and more modest scheme.

Greenock.—The Town Hall is to be wired for the electric light, and tenders are shortly to be invited.

Halifax.—The borough electrical engineer (Mr. H. F. Street) and the vice-chairman of the Tramways committee (Mr. J. H. Whitley), who recently by request of the Corporation inspected recent tramway and electrical developments in the United States, have just presented their report. Regarding car equipments, they found that in hilly districts in America a new type of motor was being used, which was less liable to failure than the smaller motors used in Halifax, and they recommend the adoption of this motor for all new cars for use on tramways with gradients of over 1 in 15. 60ft. rails were adopted in America in all new work, and special rails, with wider groove and stronger and higher check, were used on all curves over 150ft. radius. The report urges the Council to adopt similar types of rail on the Halifax lines. The deputation state that Pittsburg and Cincinnati are surrounded by hills as steep and high as those of Halifax, insurmountable by ordinary electric traction, but an ingenious system of inclines has made the hill-top as accessible as the valley, and opened up many healthy and beautiful suburbs. This system should be adopted for two places in Halifax—viz., Southowram and Salterhebble.

The Board of Trade have sanctioned the application of the Corporation to borrow £49,217 for electric tramway purposes. The period of the loan is 20 years. In his report the inspector (Mr. A. P. Trotter), who held the inquiry, referred to the fact that the employment of steam turbines is somewhat experimental for traction purposes, but he has no doubt that this method of driving can be adopted with advantage.

Hanley.—Owing to the subsidence of land near the gas works there appears a probability of a failure in the gas supply, and there should be a demand for electric wiring and fittings in this district from tradesmen taking the necessary precautions against being left in darkness.

Hereford.—The 14th inst. has been fixed for the formal opening of the electricity works.

Islington (London).—It is not surprising that the action taken by the Finance Committee of the London County Council in the matter of the application of the Islington Vestry for a loan for electric lighting extensions (regarding which, as reported in our last issue, the Committee demanded additional particulars), has formed the subject of considerable comment by the London local authorities. We learn that the Chairman of the Committee has consented to take the matter back with a view to a conference between the Committee and the Vestry authorities.

At the last meeting of the Islington Vestry a letter was read from the Shoreditch Vestry complaining of the delay on the part of the London County Council in sanctioning loans for electric lighting extensions. It was stated that the application for the loan by the Islington Vestry was sent in to the County Council as far back as Oct. 20.

Kidderminster.—The Council have approved the proposal of the British Electric Traction Co. to electrically equip the Kidderminster-Bewdley tramway.

Lectures.—The city electrical engineer (Mr. A. H. Gibbings) lectured at the Bradford Liberal Club on Saturday last on "Electrical Driving." Mr. Gibbings enumerated the various advantages which could be gained from electric driving. The speed, he said, was constant, under varying loads if required, whilst the cost in repairs was practically nil with a well-designed machine. The plant occupied a small amount of space, required practically no attention, and, because of freedom from vibration, expensive foundations were not necessary. Extensions in workshops were much more satisfactorily laid out with motors than with shafting, and electricity was the only power which could be continuously recorded and ascertained. The conditions which should be taken into consideration in substituting electrical equipment for existing shafting were the horse-power of the plant, the number of hours per annum during which the power was required, the nature of the machinery, the capital outlay on the complete plant, interest and depreciation on outlay, cost of repairs, rent, rates and taxes, wages for attendance, efficiency of gearing, and the speed of the machinery. The most suitable type of motor, the speed, voltage, &c., were items for expert advice in every individual case. The lecture was interesting to a large audience, who accorded Mr. Gibbings a hearty vote of thanks.

Mr. Robert Hammond delivered a lecture on Tuesday at the Rathmines Town Hall, Dublin, on "Electricity for Public and Domestic Uses." An exhibition of electrical apparatus in connection with the Council's electricity scheme was also held.

Leek.—The Council have before them an electric lighting scheme prepared by Messrs. Burstall and Monkhouse, estimated to cost about £13,000. The matter will come up for discussion at the next meeting of the Council.

Leith.—The Council have decided to borrow a further £10,000 for electric lighting. The capital expenditure to date amounts to £35,634.

Lewes.—The electricity supply works are to be erected on a site near the Bear Brewery, and will have a river frontage. The Council recently transferred its order to the Electrical Power Distribution Co., who propose to establish supply works at an estimated cost of £20,000.

Light Railway Orders.—The Light Railway Commissioners have submitted the Essington-Darlaston light railway order to the Board of Trade for approval. Objections must be lodged with the Board by 22nd inst.

The Board of Trade have, after modification, confirmed the Doncaster Corporation light railways order, authorising the construction of light (electric) railways in Doncaster and district by the Doncaster Corporation.

Liverpool.—On Wednesday Ald. Petrie moved the adoption of the report of the city engineer recommending the conversion during the ensuing year of the remaining 33 miles of horse tramway into electric lines, and also the construction of about 22 miles of additional electric tramway at a total estimated cost of about £350,000. During the year 33 miles had been converted, and the cost of construction had been well within the estimates. The committee found that, instead of £5,000 per mile of conversion of single track, it came out at between £3,500 and £3,700. The report was adopted.

Llanelly.—The Council have approved the electric lighting and traction scheme submitted by the British Insulated Wire Co., and an

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agreement with the company has been sealed. The estimated capital expenditure is put at £80,000. The lighting portion of the scheme is to be complete within twelve months, and the traction project within three years.

London County Council.—On Tuesday the question of the Council's approval of the plans of the London United Tramways Co. for the adoption of overhead and underground electric tramway systems on portions of the company's lines in the Uxbridge-road and in the parish of Hammersmith was again adjourned.

Manchester.—The Corporation have received the sanction of the Local Government Board to the borrowing of £22,000 for the purchase of additional land at Ardwick for workshops, stores, and offices for the electricity department.

The question of supporting the application of the Mutual Telephone Co. for a telephone licence for Manchester and district was further considered by the Manchester Corporation on Wednesday, but the subject was postponed.

Marylebone (London).—At the Vestry meeting last evening complaints were made as to the alleged insufficiency of the supply of current by the Metropolitan Electric Supply Co. in the district. Mr. Stringer, chairman of the Parliamentary committee, stated that under the penal clauses of the Metropolitan Co.'s Act and its agreement with the Vestry, a penalty was imposed of 40s. per working day for every default, and any occupier who considered he had just cause of complaint could proceed for the penalty. Under the agreement referred to the Vestry was to be supplied with a return of the pressure of supply, but the Vestry had never received any such returns. Powers were also given for the Vestry to employ an electrical inspector, who would have authority to go to the company's works and make inspections. He thought the time had come when the Vestry should appoint such an inspector. It was further decided that indicators should be installed in the Vestry Hall in order to test the pressure of supply.

Mile End (London).—A special meeting of the Vestry has decided to proceed with the application for a provisional lighting order for the district. The County of London Co. already possess an order for Mile End, and the Vestry are endeavouring to induce the Board of Trade to revoke the order, on the ground that no steps have been taken by the company to carry out its provisions.

Mills Lighting.—The order for the electric lighting of the Fibrous Manufacturing Co.'s mills has been secured by Messrs. Ellis and Ward.

Municipal Telephony. — The Beverley Council have been approached by a firm of electrical engineers as to the establishment of a municipal telephone exchange, for which the subscription would be £5 per annum.

The Grimsby Corporation have referred the question of establishing a municipal telephone service to a committee.

A meeting of representatives of the boroughs of Kent and Sussex is to be held to consider the question of applying for telephone licences.

The Grantham Corporation have appointed Maj.-General C. E. Webber consulting telephone engineer "to prepare a report and generally advise the Council on the subject of telephones, without any retaining fee, and without any remuneration unless electrical engineering works are actually carried out by the Council under his reports and estimates, but that his actual out-of-pocket expense be refunded."

The adjourned report of the Highways committee of the London County Council asking the Council to endorse resolutions passed at a conference of local authorities recommending that the Council in conjunction with the City and other local authorities should apply to the Postmaster-General for a licence to carry on a telephone service was adjourned for six months.

Newcastle-on-Tyne.—The Finance committee have negotiated a loan of £400,000 at 2¾ per cent., repayable in 30 years, for carrying out the Council's electric tramway scheme.

Northallerton.—Tenders have been submitted for the lighting of the town by the local electric light and gas companies. The electric light company's tender was as follows:—To light main street and South-parade with 27 1,000 c.p. arcs, from one hour after sunset till 10.30 p.m., for £120 per lamp per annum; for the remainder of the street lighting a 1,000 c.p. arc lamp would cost 25s. per 100 hours; for a 32 c.p. incandescent lamp, 3s. 6d., and for a 16 c.p. lamp, 1s. 9d. for 100 hours. If, however, the contract for this last did not come to £50, a bonus of £10 would be required. The General committee are considering both tenders.

Plymouth.—The Tramways committee have instructed the borough electrical engineer (Mr. John H. Rider) to prepare specifications and invite alternative tenders for the Compton tramway route: (1) For the supply of columns, cables, and materials; and (2) for supplying and erecting same. Mr. Rider is also to prepare an estimate of the cost of fixing the plant by the Corporation's workmen.

Portsmouth.—The Corporation have decided to establish a separate generating station for their projected electric tramways, on the recommendation of the sub-committee appointed to deal with the subject. The following estimates were at the same time submitted by the committee:—

Power taken from committee's station: 1,500,000 units at 1·0625d.	£6,341 15 0
Power generated at Tramway committee's own station, 1,500,000 units at 0·820d.	5,125 0 0
Difference	£1,216 15 0
Interest and sinking fund on increased cost of mains from lighting station (£4,000 at 5½ per cent.)	210 0 0
Total	£1,436 15 0

Estimate for tramway power station and plant:—

Engines and generators, switchboards, boilers, condensing plant, pumps, economisers, steam piping, &c., sundries and contingencies	£18,000
Land and buildings	6,000
Total	£24,000
Interest and sinking fund charges on above at 5½ per cent.	£1,320
Equal per unit	0·211d.

The estimated cost of generating energy by a separate tramway station is put at 0·82d. per unit, based on an output of 1½ millions of units per year.

Queenstown (Cork).—The tender of the Cork Electric Tramways and Lighting Co. for the electric lighting of the town has been accepted by the Council.

Rome.—There has been talk of late of connecting the suburban villages round Rome by a narrow-gauge electric railway, the districts to be connected being Tivoli, Frascati, Albano, Genzano, &c. The public strongly approve the proposed line, for which power will be obtained from the Tivoli waterfalls. The construction of the line has, however, so far made but small progress.

St. Helens.—Application is to be made for sanction to borrow £25,000 for electric tramway purposes. The capital expenditure on the Prescot and Denton's Green sections already amounts to £25,866, or £866 in excess of the amount authorised. Application is also to be made for the necessary moneys for providing additional electric lighting plant.

Salford.—On Wednesday the chairman of the Electricity committee (Mr. Haworth) moved a resolution approving plans and estimates for the whole of the machinery, plant, distributing mains, &c., for the new electricity generating station which the Council propose to erect. The capital expenditure involved amounts to £335,783 (including £87,200 for dynamos and boilers already applied for). Mr. Haworth said the electric tramways were expected to be running 17 months hence, and it was important to proceed simultaneously with the erection of the buildings and the plant. A suitable site in Pendleton had been obtained. The capacity of the present generating station was 660 H.P., and the new one would have a capacity of 10,000 H.P. A sum of about £95,000 had been already spent, and the expenditure contemplated was about £400,000. This included the cost of the provision of arc lamps for street lighting, but the Lighting committee had not yet decided whether they would adopt this method. The provision that was being made for traction included cables such as would be suitable for the heavy traffic on race days, and in the event of the racecourse being shifted to Broughton the cables could be removed and put in suitable conduits. The present generating station was really earning a profit at the present time, and he believed the work now in contemplation would result in a handsome profit balance to the ratepayers. The motion was unanimously adopted, as was a further resolution that application be made for power to borrow £50,000 for the erection of the necessary buildings.

Singapore.—In our issue of Aug. 19, 1898, we referred to the public lighting of Singapore. This subject has occupied the attention of the Municipal Commissioners for some time past, and in May, 1898, a special committee reported in favour of oil lighting, and further recommended that the purchase of the gas company's undertaking should not be proceeded with. Later (June, 1899) an offer of $300,000 for the plant, works, business, and goodwill of the gas company was made and rejected. The Municipal Commissioners have now adopted another report, prepared by their Lighting committee, advising a renewal for two years of the existing gas contract without alteration in price, the street lighting to be by oil lamps in the event of the gas company refusing, which is not unlikely, seeing that it is currently stated that the public gas supply is carried out at a loss, or at best at no profit. Further data is to be obtained from experts on this side as to the cost of the establishment of municipal gas works. A further recommendation is that Mr. H. R. J. Burstall (Messrs. Burstall and Monkhouse), who has already submitted a report on electric lighting, should be asked to furnish data of "a modified and less expensive scheme of electric lighting." Those on the spot are speculating as to the reason for the expenditure of all this money on reports, more

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especially as the Municipal Commissioners are anxious as to the condition of the municipal finances of Singapore. We know that one leading English electrical firm has made proposals which, if properly considered, would have led to the introduction of electricity supply being established on a considerable scale long ago, and that with little difficulty Singapore could borrow on loan in England, with the Imperial Government guarantee, at a low rate of interest. An analysis of the reports on the various schemes for the public lighting of Singapore shows that, but for the bias of the municipal engineer in favour of gas, there is only one course open to the municipal authorities, and that is the adoption of Mr. Burstall's report, either in its complete or in a modified form. It may be added that Mr. Burstall's report was, as we are informed, largely based upon information supplied by the municipal engineer, whose leaning towards gas as an illuminant for Singapore we have previously mentioned. Mr. Burstall was without any suggestions as to the standard of street lighting desired, and he therefore advised the use of arcs in the town and incandescents in the suburbs, somewhat after the plan commented upon in *The Electrician* for Oct 9, 1896. Further, Mr. Burstall had no data as to the local cost of labour, and this is a matter of supreme importance in discussing this question. Mr. Burstall's report contains English prices throughout in estimating, and we learn that when his report came before the Lighting committee a memorandum was submitted by the municipal engineer upon the estimate, in which he stated that no reduction could be made in the capital outlay except in the cost of buildings. This is, however, scarcely the correct way of regarding the matter. Labour at Singapore is 80 per cent. less than at home, and the labour items in Mr. Burstall's report should therefore have been reduced from £5,800 to about £1,200 or less. As regards the buildings, we have as an example the Singapore Dock Co.'s generating station, which has an area of over 4,000 sq. ft. and cost less than £1,000 to erect, inclusive of all foundations, and this for a building of sufficient size for the proposed municipal station if direct driven plant were installed. Since the year 1890 efforts have been made to introduce the electric light for public and private lighting in Singapore, and surely the time has come when this question should be definitely settled. The growing importance of Singapore demands that an effective system of illumination should take the place of the primitive oil lamp and the very defective gas lighting, and the public safety demands that the doubtful condition of the gas mains should be carefully investigated, more particularly if it can be proved that out of a total of 43,000,000 cubic ft. of gas manufactured in 1898, over 6,000,000 cubic ft. were unaccounted for—*i.e.*, lost in distribution. When it is remembered that as far back as 1898 a responsible English firm applied to the municipality of Singapore for maps and information which would enable them to submit a definite tender for the lighting of the town by electricity, our insistence that the municipality should bestir itself in this matter cannot be gainsaid. As an earnest that the Commissioners are beginning to feel the absurdity of the position we learn that estimates are being sought from home for the lighting by electric arc lamps of the Esplanade and some of the more important adjacent thoroughfares, but there are competent local firms who could give all this class of information without delay, although the fact that a movement is being made in the right direction is satisfactory. In justification of the strictures we have considered it necessary to pass upon the information supplied to Mr. Burstall to enable him to prepare his report, dated August 3, 1899, the following particulars will prove of interest :—

Estimate of capital cost of Scheme 1 (consisting of Central District, about 20 miles of streets). Low tension with underground mains, 10,000 8 c.p. lamps in private consumers' premises, 80 arc lamps and 350 32 c.p. lamps in public lamps provided for low-speed engines :

Plant at generating station	£19,000	
Mains, feeders, &c., joint boxes and service boxes and cables	12,890	
Meters in consumers' premises	1,800	
Public arc lamps, posts and cables	2,300	
Public incandescent lamps, posts and cables	2,400	
		£38,390
(If high-speed plant used deduct £1,500 = £36,890.)		
Allowance to be made for—		
Erection of plant at generating station	£1,100	
Supply of materials to be obtained at Singapore for mains (bricks, wood, bitumen, &c.)	4,020	
Roadwork	2,790	
Labour on jointing mains	500	
Labour on services to consumers	500	
Labour erecting and connecting public arc and incandescent lamps	900	
		9,810
Allowance made for shipping 810 tons, at 35s. per ton		1,417
		£49,671
Buildings—If high-speed plant installed		9,300
Do. If low-speed plant installed		10,200

Summary.

With high-speed plant	£57,417
With low-speed plant	59,817

(To this has to be added legal expenses, professional charges, &c.)

Following are particulars showing the cost of labour (per hour) in Singapore :—

Labourers	½d.
Fitters, turners, &c.	5d.
Carpenters	2½d.
Bricklayers and masons	2½d.
Engine drivers (native holding Government certificate)	3d.
Firemen	1d.

Doubtless the correspondence now proceeding in the local press, and the general interest excited at the present time on the subject of the lighting of Singapore, will result in a definite scheme being adopted for the introduction of the electric light on a sufficiently large scale.

Shoreditch (London).—On the subject of the dispute between the Vestry and the L.C.C. on the subject of the assessment of the combined electricity and dust destructor works, the Council's valuer has prepared a valuation based upon the accounts to March 25, 1899, in respect of the joint scheme as a commercial undertaking. After allowing 17½ per cent. interest on "tenants'" capital and £1,200 for repairs, renewals, insurance, &c., he arrives at an assessment of £4,900 gross and a rateable value of £3,700. The Vestry's Valuation committee find that an insufficient allowance has been made for establishment charges, and as the price of coal has increased, and the charge for public street lighting has been reduced, they regard the Council's valuation as excessive. The Vestry has, however, agreed to increase the assessment from £1,800 to £3,600 gross and the rateable value from £834 to £2,700.

An expenditure of £2,400 has been sanctioned for providing two motor transformers for the Worship-street sub-station. One of these, of 100 kw., will be ordered from the Electric Construction Co. of a type similar to those already supplied by the company. It has been decided to invite tenders for the construction of a new sub-station at the junction of Great Cambridge-street and Hackney-road.

Smithfield Club Show.—The 101st annual show is being held at the Agricultural Hall, London, N., this week, and has brought together a representative group of well-known firms of engine builders. Among these may be mentioned Messrs. Robey and Co., Messrs. Ransomes, Sims and Jefferies, Messrs. Ruston, Proctor and Co., and Messrs. Clayton and Shuttleworth, while, as usual, Messrs. W. H. Willcox and Co., of Southwark-street, E.C., have an excellent show of engineers' stores, lubricants, belting, &c. Messrs. Robey and Co. inform us that in consequence of the demand for their engines for electric light and general industrial and mining work they have been unable to devote time to the preparation of novelties for this show. An interesting exhibit also is that made by Messrs. Shelby and Co., of Leonard-street, Finsbury, London, including the "Warden" oil-filter and several excellent examples of labour-saving machinery.

Smoke Nuisance.—At the Westminster Police Court the Westminster Electric Supply Corporation (Ltd.) were summoned under the Public Health Act for negligently using furnaces so that smoke therefrom was not effectually consumed. The offences were not denied, and the secretary (Mr. F. Iago) urged that the Government had acquired for their transports all the available stock of Welsh smokeless coal. The magistrate (Mr. Horace Smith) said he was afraid that was no answer to the summons. Mr. Iago said they had done everything in their power, and they could not do more. They were bound by their Acts, under penalties, to supply the public with current. That was their first duty. Mr. H. Smith : No ; your first obligation is not to poison the atmosphere with foul smoke. A fine of £20 and a guinea costs was imposed.

Southport.—The Corporation have received sanction to the borrowing of £66,000 for electricity supply purposes. Terms for the purchase of so much of the undertaking of the Birkdale and Southport Tramways Co. as lies within the area of the Southport Corporation have been arranged, and the Corporation now propose to work them in conjunction with the new electric tramway system which they are constructing.

Stretford.—A provisional agreement has been entered into by the Council for leasing the existing and authorised tramways in the township for a period of 21 years to the Manchester Corporation.

Sutton Coldfield.—The Council have decided to proceed with the work of establishing electricity supply, and the Electric Lighting committee have been authorised to engage electrical assistance.

Telegraph Rates between the United Kingdom and France.—An agitation is on foot to bring about a reduction in the telegraph rates between this country and France to 1d. per word, and it is announced that the principle of the proposed reduction has received the adhesion of the French Minister of Posts and Telegraphs. The matter is now before the Duke of Norfolk, H.M. Postmaster-General.

Telephone at Glasgow.—At yesterday's meeting of the Corporation a letter from Mr. W. E. L. Gaine, manager of the National Telephone Co., was presented by the Special committee on the Telephone Service. Mr. Gaine referred to the views expressed by the Select committee of the House of Commons as to the reasonableness of the company's non-limit service, and in reference to the

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expression of opinion by the committee that the company did not cater for a large section of the public requiring a limited service at a cheaper rate, pointed out that the National Co., whatever view it might entertain on this subject, has loyally accepted the committee's view, and has decided, in order to meet the wants of small users, to adopt a system by which, by payment of £3. 10s. per annum (£3. 3s. for the company and 7s. for Government duty) and 1d. per call for local calls, the telephone service shall be more generally available. This new system will come into operation on Jan. 1st, and is to apply to existing subscribers, at their option, under suitable conditions. For the purposes of the 1d. call it is proposed to group together and treat as one all the company's central exchanges in the Glasgow area. Mr. Gaine further points out that it will be impossible for the company to give the Glasgow public the full benefit of these cheap rates unless the Corporation will afford facilities for placing their wires underground. If an arrangement of this kind can be come to, it will not only enable the company to connect up a large number of new subscribers at the cheaper rates, but also to put the whole of its Glasgow service on the twin-wire system, which the company has long been desirous of doing. Mr. Gaine asks the Corporation to reopen negotiations with the company. The Special committee recommend that this letter be remitted back, giving them power if considered expedient to treat with the company.

Telephone Tariffs in Paris.—The rate for a three minutes conversation on the Paris telephones is to be reduced from 25 centimes to 15 centimes, and on Jan. 1, 1902, the telephone subscription rate in Paris is to be reduced from 400f. to 300f. per annum.

Torquay.—The Council's consulting engineer (Mr. W. H. Trentham) has now supplied the necessary particulars for the excess expenditure at the electricity supply works, and the Local Government Board has been requested to sanction the borrowing of the £2,865 which was recently refused. At present the equivalent of 11,000 8-c.p. lamps has been connected to the mains and the engineer has been instructed to consider and report as to the necessity of making extensions to the generating plant.

Vienna.—The work of converting the tramways into electric lines is proceeding rapidly. Current will be supplied by the Allgemeine Oesterreichische Electricitäts Gesellschaft until the municipality has erected its own works.

Walsall.—The Corporation have entered into an agreement with the South Staffordshire Tramways Co., the British Electric Traction Co., and the South Staffordshire Tramways (lessee) Co., under which the Corporation are to purchase the whole of the tramway undertaking in the borough (except the James Bridge generating station) as from Dec. 31, 1900, at £18,500, and the Corporation are to grant a lease to the lessee company of certain of the lines for 21 years from Jan. 1, 1901, and of the remaining portion of the tramways in the borough for three years from the same date, at such a rent as will indemnify the Corporation from all loss in regard to the undertaking and relieve the rates of any additional burden in respect of the purchase.

Wigan.—The electrical engineer (Mr. H. Collings Bishop) has been instructed to report upon the advisability of electrically lighting the municipal buildings.

Worcester.—On Tuesday the Streets and Electricity committees recommended the Council to purchase and extend the local tramways and to introduce electric traction. After discussion an amendment that the lines be leased to a company for the purpose of effecting improvements and introducing electric traction was carried.

Workmen's Compensation.—On the subject of workmen's compensation Mr. J. Chamberlain, M.P., in the course of a brief review of the work of the present Government, made the following remarks:—

At the date of the introduction of the Workmen's Compensation Act it was said that the charges would be so great that business would be disorganised, and no doubt certain colour was given to this impression by the exorbitant demands made by insurance companies. But what has happened? I know cases—I could give them by the score—in which insurance companies asked 25s. per cent. as the rate of insurance, and have now come down to 7s. 6d., to 5s., and in one case 1s. 6d.; and I am quite certain that, as greater knowledge is gained of the working of the Act, it will be found that the cost in each business is but a very moderate proportion of the working expense of the business, and after a very short time will, as a matter of course, like other working expenditure, be spread over the general consumers of the country. The Government have never said that it was a final measure; on the contrary, I believe the time is shortly coming when it will be applied to all other trades.

Workhouse Lighting.—The South Shields Guardians have had before them a report from their consulting engineer (Mr. Fairweather) for lighting the workhouse premises at an estimated cost of £2,200, and the Finance committee recommend that this sum be borrowed. The report has, however, been referred back.

York.—To encourage large consumers of electric current the Electric Light committee have adopted the following tariff for consumers of more than 5,000 units per annum: under 10,000 units, 7d. per unit for the first hour's maximum demand and 2½d. after; under 15,000, 7d. and 2d; and over 15,000, 7d. and 1½d., respectively

COMPANIES' MEETINGS AND REPORTS.

Kalgoorlie Electric Power and Lighting Corporation (Limited).

The statutory meeting of this Company was held on Monday, under the presidency of Mr. ROGER W. WALLACE, Q.C., who said that the whole of the issue of £150,000 Six per Cent. Preferred Cumulative shares had been allotted. The amount called up was 5s. per share, and calls had practically all been paid. They had 547 shareholders, chiefly interested in mines in the Kalgoorlie (Westralia) district. Nearly the whole of the mining properties in Kalgoorlie were situated within a radius of a mile and a half from the Company's central station, and this was an exceedingly favourable feature from the point of view of distribution. Some of the companies supplying electric light in London go a much greater distance than that. Theirs was a different business from the supply of electric light pure and simple. The supply of electric light from an ordinary station only takes place for a very few hours a day, except in times of fog, and yet the whole plant must be available, so that a portion of that plant remained idle for a large proportion of the 24 hours. In the case of a supply to the mining industry, such as they were undertaking, power was required for practically the whole 24 hours, and their plant was consequently working continuously. What was required in mining was continuity in the supply of power. If from any cause either the pumps or the stamps ceased working, the output fell considerably short. For this reason a combination of the kind contemplated by their Company was manifestly a great advantage, inasmuch as keeping one unit of spare plant enabled the whole of the consumers who took current from the Company to be sure that they would not fail from reason of loss of power. When the Directors took charge of affairs they had to deal with the reports of various electrical engineers, in whose estimates there was a great deal of difference, and also a very great divergence of view as to the best means of carrying out their work. They therefore decided not to fix upon any system in detail until they had consulted those acquainted with the requirements of the district. One of these was Mr. Callahan, of the Lake View Mining Co., and then Mr. Cooke, the engineer who had been superintending the erection of the Perth electric tramways. When he (the Chairman) first read the reports from the electrical engineers they had employed, he came to the conclusion that ultimately the power would be produced by means of gas engines; but in work of this kind one must not try experiments, and when they came to look into the matter, although manifestly it will ultimately be the cheapest means of producing the power, still they had not had sufficient experience at present of the working of large gas engines. They have been at work at Brunner Mond's and also in the Westinghouse Co.'s own works, but gas engines of large horse-power had not yet been sufficiently experimented upon to warrant their using that source of supply for power. They were, however, having experiments made there. The reason that gas would be cheaper than steam power was found in the nature of the water at Kalgoorlie, which was very largely impregnated with salt, and when they came to use this for condensing engines the result was that they had a very large expenditure in getting the water for the purpose. Now, in cooling gas engines they could use the salt water without condensation and get a very much more economical rate of working. He believed that by the use of gas engines they could save on the existing annual expenditure something like £30,000 a year; so that he thought the board were justified in making—not at their own expense, because others were willing to make the expenditure for them—efforts to see that this system was thoroughly investigated for the future units of plant which they would put down. At present they were contemplating putting down 4,000 H.P., and hoped that plant would be at work in the course of a year. Details of the plans had, however, to be considerably modified from those that were set before them by the engineers. In the early stages of the company's working he did not think it of much benefit to give full information as to what they were doing, because it very often interfered with the contracts that were being made and with the prices which they were charged. One thing had, however, been decided, and that was not only to supply electricity, but also to supply compressed air. They found from inquiries that electric drills were not yet in a perfect state for use, and that drills must be driven by means of compressed air, so that they would put down a compressed air plant. With regard to the quantity of electric current they were likely to sell, there was not the slightest doubt that that would very largely exceed their expectations and calculations, as the mine managers were very anxious to get the power. With regard to their staff, they had been making inquiries both in America and in Germany, and the board had before them the names of three or four gentlemen from whom they could select one or two who would answer all their requirements as managers. They had not yet actually come to any decision, but would do so in the course of a very short time.

A SHAREHOLDER asked if the Directors had altered their plans and not invited tenders?

The CHAIRMAN said the Directors wanted to have their hands perfectly free, and in order to get proper tenders it was actually essential that the details of the plans should be finished before the tenders were invited. The delay that had occurred would save the shareholders a great deal of money.

A SHAREHOLDER: Will the Company manufacture its own gas?

The CHAIRMAN said that one of the difficulties which they were now investigating was the question of producing the gas, as it would be impossible to put down a large gas works with a view to supplying coal gas. They

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would have to use one of the cheaper forms of gas. There was the Dowson system of making gas, and there was also Brunner Mond's system. One of the difficulties was that the coal they found in Western Australia was not considered suitable coal for the making of gas. They were making investigations with regard to Collie coal, and hoped the result would be that they would be able to use gas from that coal for the purpose of generating power. The other source of supply would be gas on the Dowson system, for which they would have to use anthracite coal, and, even taking anthracite coal at 40s. or 45s. a ton, according to the investigation he had made they would be able to effect a saving as over steam on the 4,000 H.P. of about £30,000 a year, and the making of that gas on the Dowson principle would not be a very costly thing in the way of putting up gas works. The Dowson system was a well-known system, and was generally used in this country for making heat for furnaces and so forth, and he had no doubt that it would very soon be more largely used.

A vote of thanks to the Chairman brought the proceedings to a close.

India Rubber, Gutta Percha, and Telegraph Works Co. (Limited).

The report of the directors for the nine months ended Sept. 30th shows, after provision for doubtful debts, a net profit of £43,616. 5s. 7d. Adding £25,395. 3s. 3d. brought forward, and deducting £12,500 interim dividend paid in July, there remains a disposable balance of £56,511. 8s. 10d. The directors recommend a further dividend of 10s. a share, free of tax, amounting to £25,000, making a total payment at the rate of 10 per cent. per annum, and leaving £31,511. 8s. 10d. to be carried forward.

The general business of the company has been fairly profitable, the selling prices of goods having been increased to meet the advance in the cost of the raw materials.

The company's cable vessels have been moderately employed. The "Dacia" completed the laying of a short cable manufactured by the company for the International Ocean Telegraph Co. of New York. As the period under review was closing the company concluded a contract with the Commercial Cable Co. for the making and laying of a cable to connect Canso, N.S., with New York. This cable is to be laid by the "Silvertown" next year.

The works at Silvertown and Persan (France) have been maintained in their usual state of high efficiency.

Mr. Robert Kaye Gray has been elected a director of the company.

RICHARD HORNSBY AND SONS (LTD.).—The ordinary general meeting of this company was held on Monday. The chairman (Mr. H. Simpson Gee), in moving the adoption of the report, congratulated the shareholders on the satisfactory result of last year's working. They were at the present time doing a much larger business than last year. The net profits for the year were £47,932. 5s. 3d., against £37,827. 8s. 7d. in 1898. After taking into consideration the balance brought forward from last year, a sum of £50,069. 16s. 7d. was available for distribution. They proposed to pay a dividend at the rate of 6 per cent. on the Preference stock to September 30, at 8s. per share on the Ordinary shares, to carry £25,000 to reserve and £7,069. 16s. 3d. forward. They were about to erect further buildings at Grantham for the purpose of reorganising the works on the most approved plan possible, so that no labour might be expended unnecessarily. They proposed in future to pay the dividend on Preference stock half-yearly.

SOUTHERN ELECTRICAL INSTALLATION AND FREE WIRING CO. (LTD.).—The statutory meeting of this company was held last week at Hastings. The chairman (Col. Colville, J.P.) said the business was progressing satisfactorily, and they had a number of wiring orders on hand.

VOLENITE (LTD.).—At the first meeting of this company, held on Tuesday, at Dublin, Lord Lurgan, who presided, referred to the progress made in the establishment of the company's works, regarding which a good deal of ill-natured scepticism has been expressed by some of the financial papers. Lord Lurgan explained that the works, which are of an extensive character, had occupied a longer time in erection than the directors had anticipated. The chairman stated that the large orders which the company had received for volenite for a variety of purposes had justified the directors in greatly extending the original scheme of the works. He announced that during the past few weeks orders representing over a quarter of a million sterling had been received for the ordinary manufactured materials made from volenite, and that orders representing nearly half a million of money had had to be refused for the present. On the subject of "electrical" volenite Lord Lurgan stated that if this was to be dealt with on a large scale a considerable increase of the company's capital would have to be provided for. As to the rumours which had been spread that a large percentage of rubber was used in the preparation of volenite, Lord Lurgan stated that this was not the case; and this statement was confirmed by the managing director of the company and inventor of volenite, Mr. Lamplough, the actual statement being that "the original volenite has not a particle of rubber in it." The company had an unlimited amount of raw material to work upon. Negotiations (continued the chairman) were going on in connection with the sale of the American rights, as well as those for Russia and Italy. They had received orders (Mr. Lamplough stated) from France, Hungary, Italy and America, and they had received repeated orders from electrical firms for the company's manufactures. Some of the largest accumulator makers in England were ordering volenite.

NEW COMPANIES, STATUTORY RETURNS, &c.

COUNTY OF SUSSEX ELECTRICAL POWER DISTRIBUTION CO. (LTD.).—This company was registered on Nov. 28, with a capital of £50,000 in £20 shares, to manufacture and deal in electrical apparatus, to supply electricity for all purposes, and to carry on the business of mechanical, electrical, and chemical engineers, tramway and light railway proprietors, &c. The subscribers are: J. Renwick; M. E. Sheerboom; C. Walmsley; E. Hopwood; W. L. Madgen, electrical engineer; R. P. Sellon, electrical engineer; J. S. Raworth, civil engineer.

ENGLISH ELECTRIC MANUFACTURING CO. (LTD.).—This company was registered on Nov. 21, with a capital of £385,000 in £5 shares (37,000 Preference), to adopt an agreement with the Equipment Syndicate (Ltd.), and to carry on the business of electricians, generators and distributors of electricity, manufacturers of electrical apparatus and machinery, &c. The subscribers are: R. H. Prestwich, B. Sykes, T. D. Lingard, S. H. Short (electrical engineer), T. S Turnbull, G. Flett, and F. O. Mott. The first directors are: G. Flett, J. Kerr, T. D. Lingard, R. H. Prestwich, G. Richardson, and S. H. Short.

GARSTON AND DISTRICT TRAMWAYS CO. (LTD.).—This company was registered on Nov. 21, with a capital of £5,000 in £1 shares, to construct, maintain, acquire and work by electricity or other mechanical power any tramways, and to carry on the business of electrical and mechanical engineers, wire and cable manufacturers, &c. The subscribers are: Jacob Atherton, George H. Nisbett (electrical engineer), A. E. Haptie, C. O. Grindrod, F. W. Lintern, A. Buckley, and H. J. Russell.

LLANELLY AND DISTRICT ELECTRIC LIGHTING AND TRACTION CO. (LTD.).—This company was registered on Nov. 23, with a capital of £50,000 in £1 shares, to construct, lay down, establish, and maintain cables, wires, lines, accumulators, lamps, and works; to generate and supply electricity for the purposes of light, heat, and motive power, and to carry on the business of an electric light company in all its branches. The subscribers are: W. M. M. Forwood, C. O. Grindrod, A. E. Haptie, F. W. Lintern, A. Buckley, H. J. Russell, and J. Hayes.

NEWHAVEN AND SEAFORD ELECTRIC LIGHTING CO. (LTD.).—This company was registered on Nov. 25, with a capital of £20,000 in £1 shares, to carry on the business of electrical and mechanical engineers, suppliers of electricity for light, heat, and motive power, or other purposes, manufacturers of wires, cables, and apparatus, &c. The subscribers (each with 50 shares) are A. J. Jack, J. F. Plaister, J. A. M. Bannister, Dr. A. G. Mossop, E. J. Gorringe, Dr. W. P. Morgan, Rev. H. H. Goodwin, and E. Towner.

CITY NOTES.

MEMORANDA.—Bank rate 6 per cent. (since Nov. 30, 1899). Price of silver 27 1/16d. per oz. (Dec. 7). Consols (2¾ per cent.) 102—102¼ for money, 102⅛—102⅜ for account; 2½ per cent. 99¼–99¾ (Dec. 7). Stock Exchange Settling Days: Consols, Jan. 4; Stocks and Shares Continuation Days, Dec. 12 and 27; Ticket Days, Dec. 13 and 28; Pay Days, Dec. 14 and 29; Mining Share Carry-over Days, Dec. 11 and 23.

BERLINER ELECTRICITATS-WERKE.—This company has decided to issue, about Jan. 11, Four-and-a-Half per Cent. bonds to the amount of £300,000 to £350,000. The total capital of the company is now about £1,360,000, and the last dividend was 13 per cent.

BRAZILIAN SUBMARINE TELEGRAPH CO. (LIMITED).—An interim dividend of 3s. per share (at the rate of 6 per cent. per annum), free of tax, for the quarter to Sept. 30, has been declared, payable on 21st inst. The transfer books are closed from 14th to 20th inst. inclusive.

BRITISH COLUMBIA ELECTRIC RAILWAY CO. (LTD.).—An interim dividend at the rate of £4 per cent. free of tax, for the six months to Sept. 30, on the Ordinary shares has been declared, payable 20th inst.

ELMORE'S GERMAN AND AUSTRO-HUNGARIAN METAL CO.—Mr. H. Ellis has been appointed to a seat on the board vice Gen. Fraser, deceased. Mr. Ellis will continue to act as secretary.

ELECTRIC AND GENERAL INVESTMENT CO. (LTD.).—An interim dividend of 10 per cent. on the capital paid up on the Ordinary shares of this company (2s. per share), less tax, has been declared for the six months to 30th ult., payable 20th inst.

ENGLISH ELECTRIC MANUFACTURING CO. (LTD.).—Subscriptions have been invited for an issue of £310,000—£125 000 Four-and-a-Half per Cent. First Mortgage Debenture stock and £185,000 Six per Cent. Cumulative Preference shares of £5 each in this company, which has been formed to manufacture every description of electrical machinery, and especially apparatus for the equipment of electric railways and tramways. The company will acquire works now in course of construction at Preston, Lancs., belonging to the Equipment Syndicate (Limited) of Manchester. These works, it is expected, will be ready for occupation and operation about April next. Agreements have been entered into between Mr. Sidney H. Short and the Equipment Syndicate, whereby the Short patents for motors, controllers, generators, and other electrical apparatus for the United Kingdom, India, and British colonies and possessions, except Canada, and with rights to all improvements made therein for a period of 10 years are acquired. Mr. Short becomes a director of the new company, which also acquires the benefit of certain orders for electrical equipments given by Messrs. Dick, Kerr and Co. (Ltd.), booked by the vendors, who guarantee that the net profits of the company to March 31, 1902, shall be sufficient to pay the dividends on the £185,000 Six per Cent. Cumulative Preference shares now issued. The list of applications closed yesterday (Thursday).

HAMPSTEAD ELECTRIC SUPPLY CO. (LTD.).—Investors interested in the progress of this company may be referred to the *Financial Times* for Dec. 7.

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COMMERCIAL CABLE CO.—A quarterly dividend of 1¾ per cent. and a bonus of 1 per cent. has been declared, payable on Jan. 2 out of the net earnings of this company, and the transfer books will be closed from 22nd inst. to Jan 1 inclusive. The transfer books of the Sterling Four per Cent. 500-year Debenture stock will be closed from 23rd to 30th inst. inclusive.

HALIFAX AND BERMUDAS CABLE CO. (LTD.).—The trustees for the debenture holders will receive offers of debentures for purchase at noon on 15th inst., at the offices, 33, Old Broad-street, London, E.C. In the event of the number offered not being sufficient to absorb the amount to be applied, a drawing will take place to absorb the balance on the same day.

MUTUAL TELEPHONE CO.—At Manchester, on Monday, a small gathering of sympathisers with the Mutual Telephone Co. was held to discuss a petition which was presented to the Corporation on Wednesday. The petition points out "that one of the conditions on which the shares of this company were allotted is that the payments made on application should be returned if a licence were not obtained before Dec. 31, 1899." The one condition now necessary to secure a licence for the company is that the City Council should reconfirm the resolution passed on April 14, 1897. The memorialists asked the Council to comply with the requirements of the Postmaster-General by reconfirming this resolution. The chairman (Mr. W. Thomson) said it was urged that the Council, if they allowed the Mutual Co. to get a licence, would lose their power to give the National Co. six months' notice to leave. The Council had the power, theoretically, to give the six months' notice, but it was, he desired to point out, theoretical and nothing more. The power was of no use to them at all unless they had a competing company in existence. If the Council did not grant them a licence now, the Mutual Co. would on Dec. 31 cease to exist as a company. That would be hard, for the company had spent a good deal of money during the last four years. Mr. F. Scott (secretary of the company) explained that as soon as their system was completed they would hand it over to the Corporation should the Corporation wish to buy it. This would leave the company with plenty of work to do in connection with the telephoning of other towns, the Corporation going on with its own centre of Manchester.

At a meeting of the General Purposes committee of the Salford Corporation a recommendation of the Finance committee in favour of the application of the Mutual Co., with certain restrictions, was approved.

ROLLER BEARINGS CO. (LTD.).—Mr. W. Bayley Marshall, of Birmingham, has joined the board of this company, and Mr. Thomas W. How has been appointed manager and secretary.

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee has appointed 20th inst. as a special settling day in the further issue of 20,000 £5 fully-paid 5 per cent. cumulative preference shares (Nos. 54,001 to 74,000) of the *New General Traction Co. (Ltd.)*. The Committee has been asked to appoint a settling day in and grant a quotation to £150,000 4½ per cent. First Mortage Debenture Stock of the *Castner-Kellner Alkali Co. (Ltd.)*.

VENEZUELA TELEPHONE AND ELECTRICAL APPLIANCES CO. (LTD).—The ordinary general meeting was held last week. Sir Douglas Fox presided, and remarked that fair progress had been made by the company during the past year, and he thought that they might hope to do better in the future. The accounts showed a profit of £9,079, to which was added £699 brought forward after payment of dividend on the Preference and Ordinary shares. In addition to the payment of debenture interest and the preference dividend up to June 30, it was now proposed to pay a dividend on the Ordinary shares at the rate of 2 per cent. per annum, which would absorb £1,400. It was further recommended that the expenses in relation to the new contract, amounting to £1,103, should be written off, that £1,500 should be carried to reserve, and £531 be carried forward. Good relations had been maintained with the central Government and the municipalities of the various towns with which the company was connected, and there had been very few complaints as to the working of the company's system. The company's property had been well maintained.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	1899	£	£		£	£
*Birmingham Tramways.	Dec. 2	4,439	+ 522	22	91,864	+ 9,545
Blackpool Corporation...	Nov. 30	148	+ 25	35	20,171	+ 4,355
Blackpool and Fleetwood	Dec 2	161	+ 18	22	19,737	+ 5,887
Bradford Corporation ...	,, 3	356	+ 117	68	22,633	...
Brisbane Trams	Oct. 18	1,529	+ 456	3	4,619	+ 1,725
*Bristol Trams & Carriage	Dec. 1	2,697	+ 218	22	69,449	+ 8,466
*Buenos Ayres & Belgrano	Nov. 5	2,454	+ 750	44	94,867	+42,960
City & South London Ry.	Dec. 3	1,053	− 66	23	22,540	− 96
Dover Corporation	,, 2	154	+ 14	35	7,617	...
Dublin United	,, 1	2,926	+ 536	...	...	...
Dublin Southern Dist....	,, 1	665	+ 168	...	...	...
*Glasgow Corporation ...	,, 2	8,892	+1,002	...	...	...
*Liverpool Corporation...	,, 25	6,902	+1,402	47	324,114	+38,917
Liverpool Overhead Rly.	,, 3	1,747	+ 430	22	37,485	+ 1,813
*Sheffield Tramways	,, 3	1,906	+ 742	49	69,572	+20,667
*South Staffs. Trams.....	,, 1	701	+ 91	48	31,981	+ 1,631

* Partly electrical.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	NAME.	Previous Week's Price, Nov. 29.	Price Wednesday, Dec. 6.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Dec. 6. Highest	Lowest
			TELEGRAPHS.			£ s. d.			
£110,900	100	4%	*African Direct Telegraph 4% Mort. Deb. (red.)	100 104	100 104	3 16 11	January and July	...	...
25,000	10	...	Amazon Telegraph	3 4	3 4	...	June and December	...	...
£125,000	100	5%	Do. 5 per Cent. Debentures	85 90	85 90	5 11 1		...	...
£875,520	Stock	15/0	Anglo-American	66 69	65 68	5 2 3	Feb., May, Aug., Nov.	66¾	...
£3,062,240	Stock	30/0	Do. Preferred	117 118	115½ 116½	5 3 11	,, ,,	117⅜	116½
£3,062,240	Stock	18/0	Do. Deferred	17½ 18	17 17½	5 2 10	...	17½	17½
205,993	10	5/0	Brazilian Submarine	15 15½	15 15½	4 11 0	Mar., June, Oct., Dec.	15½	15
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1900)	107 111	107 111	4 11 6	June and December	...	...
$10,000,000	$100	$1½	Commercial Cable Capital Stock	198 202	198 202	3 19 9	Jan., Apr., July, Oct.	...	...
£1,382,823	Stock	4%	* Do. 4 per Cent. Debenture Stock	103 105	103 105	3 16 6	,, ,,	104½	104½
16,000	10	8/0	Cuba Submarine Ordinary	9 10	9 10	8 0 0	February and August	...	...
6,000	10	10/0	Do. Preference 10 per Cent.	19 20	19 20	5 0 0	,, ,,	...	...
12,931	5	2/0	Direct Spanish Ordinary	4 5	4 5	4 0 0	April and October	...	...
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference	9 10	9 10	5 0 0	,, ,,	...	...
£20,000	50	4½%	Do. 4½ per Cent. Debentures	103⅞ 107⅞	103⅞ 107⅞	4 4 1	January and July	...	...
60,710	20	3 0	Direct United States Cable	11½ 12½	11½ 12½	5 14 3	Jan., Apr., July, Oct.	12½	12
£120,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red.)	101 104	101 104	4 7 10	June and December	...	...
£4,000,000	Stock	5%	Eastern Ordinary	156 161	154 159	4 8 8	Jan., Apr., July, Oct.	157½	154
£1,795,000	Stock	3½%	Do. 3½ per Cent. Preference Stock	99 102	98 101	3 9 8	,, ,,	99½	99½
£1,432,268	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.)	117 122	116 121	3 6 5	May and November	119½	117½
250,000	10	2/6	Eastern Extension	15½ 16	15½ 15¾	4 8 11	Jan., Apr., July, Oct.	15 3/16	15¼
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	118 123	117 122	3 6 3	February and August	...	...
£16,200	100	5%	* Do. 5% (Austln. Gov. Sub.) Deb., 1900 (reg.)	99 103	99 103	4 17 4	January and July	...	...
£64,400	100	5%	Do. (Bearer)	100 103	100 103	4 17 1	,, ,,	...	...
£17,400	100	5%	*Eastern and S. African 5% Mort. Deb., 1900 (reg.)	99 103	99 103	4 17 1	,, ,,	...	...
£24,500	100	5%	Do. (Bearer)	100 103	100 103	4 17 1	,, ,,	...	...
£300,000	100	4%	* Do. 4 per Cent. Mortgage Debentures, 1909	101 104	101 104	3 16 11	February and August	102½	...
£200,000	25	4%	Do. 4 per Cent. Mauritius Sub. Debs. (red.)	101⅞ 104⅞	101⅞ 104⅞	3 16 10	May and November	...	...
180,227	10	1/9	Globe Telegraph and Trust	11¼ 11¾	11¼ 11¾	4 9 4	Jan., Apr., July, Oct.	11¼	11 7/16
180,042	10	3/0	Do. 6 per Cent. Preference	15½ 16	15½ 16	3 15 0	,, ,,	15⅝	15½
150,000	10	5/0	Great Northern of Copenhagen	31 33	31 33	3 15 9	January and July	...	...
£89,500	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb. (red.)	100 103	100 103	4 7 5	...	...	...
17,000	25	12/6	Indo-European	48 52	48 52	4 16 2	May and November	49	...
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904	106 109	106 109	5 10 1	March and September	...	...
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.)	103 106	102 105	3 17 6	June and December	103	102
11,839	8	4/0	Reuter's	7 8	7 8	5 0 0	April and October	7⅞	...
3,381	£100 Cert.	6%	Submarine Cables Trust	128 133	127 132	4 11 7	,, ,,	...	...
15,609	10	...	West African Telegraph	2½ 3½	2½ 3½	4 9 3	December and July	...	...
£100,000	100	5%	* Do. 5 per Cent. Debentures (red.)	99 103	99 102	4 18 0	March and September	101¼	...
30,008	2½	...	West Coast of America	½ 1	½ 1	...	...	...	...
£150,000	100	4%	* Do. 4 per Cent. Debentures	102 105	102 105	3 16 8	January and July	...	...
88,321	10	2/6	West India and Panama xd	1 1½	¾ 1⅛	...	May and November	1 7/16	1
34,563	10	6/0	Do. 6 per Cent. 1st Preference xd	10 10½	9½ 10	6 0 0	,, ,,	9 1/16	...
4,669	10	6/0	Do. 6 per Cent. 2nd Preference xd	8 9	7½ 8½	7 1 2	,, ,,	...	...
£80,000	100	5%	* Do. 5 per Cent. Debentures	106 109	106 109	4 13 7	January and July	...	...
£389,731	Stock	4%	Western & Brazilian 4 per Cent. Debenture Stock	104 107	104 107	3 15 0	June and December	...	...
£159,100	100	6%	*Western Union 6 per Cent. Sterling Bonds (red.)	98 103	98 103	5 16	March and September	...	...

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Nov. 29.	Price Wednesday, Dec. 6.	Rate per Cent. Yielded. £ s. d.	Dividend Due.	Business Done During Week Ending Dec. 6. Highest	Lowest
			TELEPHONES.						
44,000	£5	3/0	Chili Telephone (fully paid)	2 3	2 3	6 13 4	August	...	...
224,850	10s.	0/1½	Consolidated Telephone Const. & Manufacturing	¼ ¼	¼ ¼	4 15 3	July	...	...
72,680	1	0/6	Monte Video Telephone Ordinary	½ ½	½ ½	5 0 0	October	...	...
86,492	1	1 0	Do. 5 per Cent. Preference	¾ 1	¾ 1	5 0 0		...	...
490,000	5	3/0	National	5 5½	5 5½	5 14 3	February and August	5 7/16	5 1/16
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Preference	14 15	14 15	4 0 0	,, ,,	...	...
15,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference	14 15	14 15	4 0 0	,, ,,	14½	14
250,000	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref.	5½ 5½	5½ 5½	4 10 11	,, ,,	5 1/16	...
1,329,471	Stock	3½%	* Do. Debenture Stock 3½ per Cent. (red.)	100 102	100 102	3 8 8	June and December	101½	100
171,504	1	0/4	Oriental	¾ 1	¾ 1	5 0 0	April and October	...	...
58,000	5	6/0	United River Plate	4¾ 5¼	4¾ 5¼	5 14 3	July	...	...
16,639	5	...	Do. 5% Cumulative Preference (£3. 10s. paid)	3¾ 3¾	3¾ 3¾	...		...	...
£179,947	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	105 108	105 108	4 13 9	June and December	105¼	...
			ELECTRICITY SUPPLY COMPANIES.						
100,000	1	...	Bl'ckh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.)	¾ 1	¾ 1	...		...	...
6,000	10	7/9⅗	Bournemouth and Poole Electricity Supply Ord.	12¾ 13¼	12¾ 13¼	2 18 10		...	...
6,000	10	4/6	Do. 4½ per Cent. Cumulative Preference	10 11	10 11	4 1 10		...	...
19,661	5	2/6	Brompton & Kensington Electricity Supply Ord.	7⅞ 8	7½ 8¼	3 10 7		...	...
12,000	5	3/6	Do. 7 per Cent. Preference	9 10	9 10	3 10 0	March and September	...	...
20,000	5	...	Calcutta Elec. Supply Ordinary (£4 paid)	6½ 7	6½ 7	...		...	...
30,000	5	4/0	Charing Cross & Strand Electricity Supply Corp.	10 11	10 11	4 1 10	February & August	10	...
20,000	5	...	Do. (Nos. 3,001 to 50,000)	9⅛ 10⅛	9⅛ 10⅛	...		...	...
20,000	5	2/3	Do. 4½ per Cent. Preference	5⅝ 6¼	5⅝ 6¼	3 12 0	,, ,,	...	...
34,000	5	2/6	Chelsea Electricity Supply Ordinary	8 9	8 9	3 6 8	March	...	...
£100,000	Stock	4½%	* Do. 4½ per Cent. Debenture Stock (red.)	111 113	111 113	4 0 9	June and December	...	...
$1,200,000	$1,000	5%	Chicago Edison 1st Mort. 5% 30 year Gold Bonds (red.)	100 110	100 110	4 10 11	April and October	...	...
60,000	10	7/0	City of London Electric Lighting Ordinary	11⅛ 12⅛	11⅛ 12⅛	4 16 0	February and August	11¼	...
40,000	10	6%	Do. 6 per Cent. Cumulative Preference	13 14	13 14	4 5 9	January and July	...	...
£400,000	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	125 130	125 130	3 17 5	June and December	127½	...
40,000	10	...	County of London and Brush Prov. Ordinary	10⅛ 11⅛	10⅛ 11⅛	...		11	10⅛
20,000	10	6/0	Do. 6 per Cent. Cumulative Preference	13 14	13 14	4 5 9	March and September	13½	...
£200,000	Stock	7/8	Do. 4½% Deb. Stock Certs. (all pd.) (red.)	111 114	111 114	...		112½	111½
15,000	5	10%	Kensington and Knightsbridge Ordinary	11½ 12½	12½ 13½	4 1 6		...	...
10,000	5	6%	Do. 6 per Cent. 1st Preference	7½ 7¾	7½ 7¾	3 17 5	January and July	...	...
110,000	3	...	London Electric Supply Ordinary	2⅞ 3¼	2¾ 3¼	...		3	...
48,050	5	3/0	Do. 6 per Cent. Preference	6 6½	6 6½	4 12 2		6⅝	...
£100,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures	104 106	104 106	3 16 4	Mar., June, Sept., Dec.	...	...
62,500	10	5/0	Metropolitan Elec. Supply Ord. (Nos. 1 to 62,500)	14⅝ 15⅛	14 15	3 6 8	April and October	14⅞	14
22,500	10	3/7½	Do. (Nos. 62,501 to 85,000)	14⅝ 15⅛	13½ 14½	3 6 0		...	...
£220,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage	117 119	117 119	3 15 7	June and December	...	...
6,452	10	6/0	Notting Hill Electric Ordinary	15½ 16½	15½ 16½	3 15 0	March	...	...
10,000	5	5/0	Oxford Electric Ordinary	6⅞ 7⅛	6⅞ 7⅛	3 9 0	,,	...	...
300,000	1	8%	Rand Electric	⅞ 1	⅞ 1	10 13 4		...	...
£130,070	Stock	5%	River Plate El. Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb.	80 90	80 90	5 11 1		...	...
150,000	$100	$2	Royal Electric Company of Montreal Shares	160 180	160 180	4 8 11		...	...
£123,200	100	4½%	* Do. 4½ per Cent. 1st Mortgage Debentures	104 106	104 106	4 5 6	April and October	104½	...
31,980	5	5/0	St. James's and Pall Mall Electric Ordinary	15½ 16⅜	15½ 16⅜	4 7 11	February and August	16⅜	...
20,000	5	3/6	Do. 7 per Cent. Preference	9 9½	9 9½	3 13 8	,, ,,	...	...
65,000	5	...	South London Electric Supply Ordinary (fully paid)	3½ 3¾	4¼ 4½	...		4⅝	...
79,900	5	5/0	Westminster Electric Supply Ordinary	14 15	14 15	4 0 0	March and September	14½	13⅞
			ELECTRIC MANUFACTURING, &c., COMPANIES.						
125,000	1	7½d.	Aron Electricity Meter 6 per Cent. Cum. Pref.	1⅛ 1⅛	1⅛ 1⅛	...		...	...
40,000	5	5/0	British Insulated Wire Ordinary	11¼ 12¼	11¼ 12¼	4 0 0		...	...
27,500	5	3/0	Do. Preference	6½ 6¾	6½ 6¾	4 8 11		...	...
90,000	2	2/0	Brush Electrical Engineering	1⅞ 2⅛	1⅞ 2⅛	4 14 1	September	...	...
90,000	2	1/2½	Do. 6 per Cent. Pref. Non-Cumulative	2⅛ 2⅜	2⅛ 2⅜	5 1 1	,,	...	...
£125,000	Stock	4½%	Do 4½ per Cent. Perpetual Deb. Stock	110 115	110 115	3 18 5	February and August	...	...
£50,000	Stock	4½%	* Do. 2nd Debenture Stock (red.)	104 107	104 107	4 4 11	June and December	...	...
20,000	5	5/0	Callender's Cable Construction Ordinary	13 14	13 14	5 7 2	,, ,,	...	...
20,000	5	...	Do. 5 per Cent. Cumulative Preference	5½ 6	5½ 6	...		...	...
£90,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb. (red.)	113 116	113 116	3 18 7	November and May	...	...
300,000	1	0/9⅗	Castner-Kellner Alkali Co. (fully paid)	1½ 1⅝	1½ 1⅝	5 6 8		...	...
60,000	1	0/7⅕	Chadburn's Ship Telegraph Ordinary	1 1⅛	1 1⅛	...		...	...
60,000	1	0/7⅕	Do. 6 per Cent. Cumulative Preference	1 1⅛	1 1⅛	4 16 0		...	...
32,098	3	2/1⅗	Crompton and Co. (Nos. 1 to 32,098)	3¾ 4	3¾ 4	4 10 9	January and July	...	...
£100,000	100	5%	* Do. 5 per Cent. First Mortgage Deb. (red.)	100 103	100 103	4 17 10	,, ,,	...	...
60,000	1	0/3	Davis and Timmins 6 per Cent. Cum. Pref.	¾ 1	¾ 1	...		...	...
99,261	5	1/9⅗	Edison and Swan United ("A" Shares) (£3 paid)	2 2¼	2 2¼	7 4 0	February and August	...	...
17,139	5	2/9⅗	Do. (£5 paid)	3¾ 4⅛	3¾ 4⅛	6 13 4	,, ,,	...	...
£314,023	Stock	4%	Do. 4 per Cent. Mortgage Deb. Stock (red.)	95 97	95 97	4 2 6	June and December	...	...
26,100	5	5/11½	Edmundson's Electric Corporation Ord. (fully pd.)	5 5⅛	5 5⅛	5 9 1	Half-yearly	...	...
112,100	2	1/2½	Electric Construction Co. (Limited)	2 2¼	2 2¼	5 2 3	January and July	2 1/16	2 1/16
25,000	2	2/9⅗	Do. 7 per Cent. Cumulative Preference	2⅞ 3¼	2¾ 3¼	4 6 2	July	...	...
182,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	104 107	104 107	3 15 8	January and July	...	...
91,195	1	...	Elmore's Patent Copper Depositing	¼ ⅜	⅜ ½	...		...	...
30,000	5	...	Henley's Telegraph Works Ordinary	13 14	12½ 13½	...	February and August	...	...
15,000	£5	...	Do. 4½ per Cent. Preference	5½ 5¾	5½ 5¾	3 18 3	,, ,,	5 5/16	...
£50,000	Stock	4½%	Do. 4½ per Cent. Mortgage Deb. Stock (red.)	111 114	111 114	3 19 6	,, ,,	...	...
50,000	10	5/0	India Rubber, Gutta Percha, &c., Works	21 22	21 22	4 8 11	,, ,,	21⅞	21⅝
£300,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	100 104	100 104	3 16 11	March and September	...	...
37,350	12	12/0	Telegraph Construction and Maintenance	37 41	36 40	4 10 1	March and July	36	...
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909	103 106	103 106	3 15 6		...	...
20,000	5	3/0	Do. Manufacturing Ordinary xd	9 10	9 10	3 10 0		...	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5½ 6	5½ 6	4 3 4		5¾	...
30,000	5	5/0	Willans and Robinson Ordinary	10⅝ 11	10⅝ 11	4 1 10	April and October	...	...
30,000	5	3/0	Do. 6 per Cent. Cumulative Preference	7 7⅛	7 7⅛	4 0 0	,, ,,	...	...
£100,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Debentures xd	106 108	104 106	4 0 2	May and November	...	...
			ELECTRIC RAILWAYS, TRAMWAYS, &c.						
12,000	10	6/0	Blackpool and Fleetwood Tramways	18 20	17 19	3 13 8		...	...
£167,900	100	5%	Brisbane Tramway 5 per Cent. Debentures	104 106	104 106	4 14 4		...	...
50,000	10	7%	Bristol Tramways and Carriage Ordinary	23 24	23 24	2 17 2	February and August	...	...
25,000	10	...	Do. Cumulative Preference (£4 paid)	4⅜ 4⅝	4⅜ 4⅝	...		...	...
£100,000	Stock	4%	Do. 4 per Cent. Debentures	118 119	118 119	3 7 3		...	...
30,000	10	9/0	British Electric Traction Ordinary	16⅛ 17	16⅛ 17	3 10 7		17	16 13/16
30,000	10	6/0	Do. 6% Cum. Pref. (Nos. 30,001 to 60,000)	13 13½	12¾ 13¼	4 10 7		13⅜	13
£200,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures	126 129	126 129	3 17 10		...	...
40,000	5	1/9	Buenos Ayres & Belgrano 6% "A" Cum. Pref.	5⅛ 5⅜	5⅛ 5⅜	5 11 7		5 5/16	5 1/16
27,500	5	...	Do. "B"	4⅜ 5⅛	4⅜ 5⅛	...		...	...
265,585	Stock	5%	Do. 5 per Cent. Debentures	108 111	108 111	4 10 1		...	...
35,250	10	3/0	Central London Ordinary	10¼ 10⅝	10¼ 10⅝	2 15 10	June and December	10½	...
178,303	10	2/4 1/10	Do.	... ...	... ...	...	,, ,,	...	...
£265,000	Stock	2½%	City and South London Railway Con. Ordinary	63 66	61 64	3 7 2	January and July	63	62⅜
37,000	10	...	Do. (Nos. 22,501 to 60,000) (£4. 10s. paid)	3⅜ 4⅜	3⅜ 4⅜	...		...	...
£150,000	Stock	5%	Do. 5 per Cent. Perpetual Preference (1891)	143 148	143 148	3 8 0	January and July	...	...
£200,000	Stock	5%	Do. (1896)	135 140	135 140	3 11 11		...	...
£187,701	Stock	4%	Do. 4 per Cent. Perpetual Debenture	132 134	127 133	3 3 0	May and November	...	...
20,000	10	7½%	†Imperial Tramways Ordinary	23 24	23 24	...	March and September	...	...
10,000	10	6%	† Do. 6 per Cent. Preference	15½ 15¾	15½ 15¾	3 13 10	,, ,,	...	...
£200,000	Stock	4½%	† Do. 4½ per Cent. Debenture	115 116	115½ 116½	3 18 0	January and July	...	...
30,000	10	1/3	Kidd'rm'nst'r & Dist. E.L. & Tr'ct'n 5% Pref. (£6 pd.)	5¼	6 6¼	4 10 11	May and November	6⅛	6
37,500	10	2½%	Liverpool Overhead Railway Ordinary	8⅜ 9	8⅛ 9 1/16	3 11 8	February and August	...	...
10,000	10	5%	Do. 5 per Cent. Preference	13¼ 13⅜	13¼ 13¼	3 12 9	,, ,,	...	...
125,000	Stock	4%	Do. 4 per Cent. Debenture	104 106	104 106	3 16 3	January and July	...	...
24,000	5	...	New General Traction Ordinary	3¾ 4¼	3¾ 4¼	...		...	...
30,000	5	6/0	Do. 6 per Cent. Cumulative Preference	5 5¼	5 5¼	5 9 1	May	...	...
4,000	10	...	Oldham, Ashton and Hyde Elec. Tramway Ord.	19 19½	19 19½	...	February and August	19½	19
4,000	10	5/0	Do. 5 per Cent. Preference	10¾ 10⅞	10¾ 10⅞	4 11 11	,, ,,	10⅞	10¾
13,334	10	...	Potteries Electric Traction Ordinary	13 14	12¾ 13¼	...		...	...
20,000	10	5/10	Do. 5 per Cent. Cumulative Preference	10¼ 11	10 11	4 10 11		10½	10
£540,000	Stock	3%	Waterloo and City Ordinary	101 104	101 104	2 18 0	June and December	102½	...

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THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,126. [No. 8. Vol. XLIV.] FRIDAY, DECEMBER 15, 1899. PRICE SIXPENCE (by post, 6½d.), Abroad, 8d., or 16 cents. or 80fr., or 70pf.

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NOTES.

THERE are several supply stations, both in the provinces and in London, which, had they been erected to-day, would have been built for the continuous-current three-wire system instead of the single-phase alternating-current system, or at all events would have been designed to supply continuous current in the central part of their supply area. Some of these, notably the Metropolitan Electric Supply Co. and the City of London Electric Lighting Co., are gradually altering their system in accordance with this more modern practice, others are thinking of doing so, and a third category are still putting in their extensions on the old single-phase system. Sheffield has been one of these last-mentioned instances, having recently erected a new Mordey inductor single-phase alternator (described a few weeks ago in our columns), and having ordered another single-phase machine from Messrs. FERRANTI, which will be put in during next year. Interesting reports from Mr. ROBERT HAMMOND, the consulting engineer, and from Mr. W. JOHNSON, the resident engineer, will be found in another part of this issue. Mr. HAMMOND recommends that the Sheffield Corporation should forthwith proceed to convert their central area from the two-wire alternating to the three-wire continuous-current system, and Mr. JOHNSON replies that it will not pay to do so, at all events at present. No doubt Mr. JOHNSON will win the day on this occasion, as the funds to be spent on extensions during 1900 have already been allocated to the new Ferranti alternator (the labour clause being happily omitted from the contract, we may venture to remark *en passant*). As Mr. JOHNSON truly remarks, the question of the conversion of the system is one entirely dependent on local conditions, butit is also one that should now be raised in connection with every single-phase alternating-current system when large extensions become necessary.

LEADING articles in the *Engineer* of last Friday and in *The Times* of last Wednesday discuss at great length the shortcomings of some of the London electric lighting companies, being chiefly directed to the recent failure of the Metropolitan Electric Supply Co. to supply all its consumers at the hours of maximum load during the past few weeks. Our engineering contemporary commences by blaming the companies for having been too quick in adopting new and untried engines merely in order to secure greater economy; but surely the excellent results obtained with the modern high-speed engine leave little room for censure. However, the real cause of complaint is admitted both by *The Times* and the *Engineer* to be overloading, and it is pointed out, as has been done over and over again in our columns, that electric supply companies are too anxious to connect up new consumers before the machinery necessary for supplying them all the year round has been erected.

OUR leading daily contemporary has little to offer in the way of suggestions of a remedy for the evil, but the *Engineer* concludes:—

> The legal remedies likely to meet the case in the future would probably take such a form that no company could undertake to light a district until a certificate had been obtained from the Board of Trade that the plant was in all respects sufficient and efficient, very much in the same way that a Board of Trade certificate must be obtained before a railway company can open a line. Against this it may be urged that the repeal of an existing clause in the Companies Acts, by which they are compelled to supply current to anyone asking for it in a district where the mains are available, would be necessary. Furthermore, no matter how efficient plant might be to begin with, deterioration takes place; and to throw on the Board of Trade the responsibility of seeing that the plant was always kept up to a proper standard of efficiency would be extremely unwise. As we have said, so we repeat, that a little patience on the part of consumers will probably have its full reward. It should not be forgotten that parliamentary interference in the past, by stifling enterprise, is largely responsible for the troubles now experienced.

The above suggestion of a Board of Trade certificate to the effect that the plant was "in all respects sufficient and efficient" is open to an objection which our contemporary overlooks. No company can be expected to wait before supplying

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any consumers until sufficient plant has been erected to meet all the demands which may eventually be made for the supply of electrical energy. The compulsory supply penalty clause in provisional orders is happily seldom put into operation. What with the above conditions and the regulations for continuous supply and maximum pressure variation, were supply invariably insisted on by intending new consumers, in accordance with the provisions in the model provisional order, the supply undertaker would often find himself in a predicament impossible of solution. Should supply undertakings ever find themselves in such a corner, we would advise them to take the opinion of the Board of Trade as to what is a "reasonable" date for the commencement of supply to a new consumer, and what is a "reasonable" maximum demand of such consumer, when the supply station plant is already loaded to considerably beyond its normal capacity. The employment of this word "reasonable" in the penalty clause in question leads to the conclusion that it was purposely intended to allow the undertaker some latitude in this respect.

As mentioned in another column, the Marylebone and Paddington Vestries are threatening to take proceedings against the Metropolitan Electric Supply Co., under another clause of the electric lighting order, for not maintaining a continuous supply at constant pressure, the latter Vestry taking as a test case the arc lamps in the particul arly well-lighted thoroughfare of Westbourne-terrace. This is certainly not a well-advised move. A more sensible thing to do would be to authorise the partial extinction of the arc lights in this street (which is illuminated now to a far greater extent than was deemed necessary a few years ago), and thus enable the company to give better service to its remaining consumers. The Paddington Vestry should be intelligent enough to understand that the company is doing its best to cope with the present load, but that it is at the moment only in a position to supply a certain amount of electrical power. If some can be spared from street lighting, this would doubtless be employed in other parts of the parish.

The Grantham Highways committee have passed the following resolution and directed it to be submitted to the Council for confirmation: "That Major-General Webber be and he is hereby appointed electrical engineer to advise the Council on the subject of telephones, without any retaining fee, and without any remuneration unless electrical engineering works are actually carried out by the Council under his reports and estimates, but that his actual out-of-pocket expenses be refunded." This is very generous of Major-General Webber—but one looks for a more dignified attitude from a past-President and founder of the Institution of Electrical Engineers.

An interesting decision is reported in another column—viz., that the line of the City and South London Railway is not liable to be rated, at all events at present. This is because the line does not pass under any site previously occupied by a building, and therefore it cannot be rated, at any rate until the next quinquennial valuation. This will be pleasant news for the builders of other deep-level underground railways in London.

We referred in our last issue to recent incidents at Cardiff in connection with which the resident engineer, who is continually being interfered with by the Electric Lighting committee in the engagement and control of his staff, disclaimed responsibility for an interruption in the service. The following reports from this gentleman and two of his assistants indicate clearly the ridiculous state of affairs engendered when the committee insists on intervening with regard to details over which its engineer should have sole control and take all responsibility. The engineer-in-chief reports as follows:—

> The failure of the arc lights was due to the condition of the mains and not to the rectifiers. The mains were defective in that water had found its way into six or seven of the joint boxes, the presence of which was not revealed by the daily test as to their condition. The responsibility for the presence of this water must be divided between Mr. Teasdel [the Assistant Engineer] and Mr. Pengelly [the Mains Superintendent]. The former, because during Pengelly's holidays he had men working on some of these boxes who did not rejoint them, and the latter because water was found in one box where he had omitted to have all the fixing screws replaced at some time in the past. I consider the conduct of Pengelly in going home to tea as he did on the 10th inst., while the lamps were still out, and for not keeping in touch with Mr. Teasdel over these repairs, is open to severe criticism. It is very doubtful to my mind as to what time the lights would have been on again had not Mr. Teasdel late in the afternoon taken up the work of finding the faults, while Pengelly was at tea, and restoring the service.

Mr. Teasdel gives the following explanation:—

> As no message was sent, he knew nothing of the arc circuit being out until the next morning, when he saw a report in the log book, and it stated that the outside department were at work on the arc mains. On the following day he found that only four or five lamps had struck up at 4.45 in the afternoon. He heard that Mr. Pengelly had gone to get something to eat, and the men employed under him expressed their intention of doing the same, as they did not think they could do anything further that day. Mr. Teasdel then set to work, and got all except two lamps alight.

Finally, Mr. Pengelly reports:—

> Shortly after six o'clock on October 9th all the lamps except two on "A" circuit went out. He found several faults, but apparently could not rectify them, and went home at 9.15. On October 10th he started to take the faults off, but at 5.30 could only get two lamps lit up. He then went home to tea, and told the men to get theirs. He returned at 6.45, and at 7.20 all the lamps except one in Mill-lane and another in Park-place were alight. On the following day he put those right.

We only give in full the above extracts from the *Western Mail* to show the absurdity of the situation. That the assistant engineer omitted to make certain joints, or that the mains superintendent placed tea before duty, are surely not matters which should be investigated by a committee and form subjects for reports printed in the local newspapers. Yet there are other Electric Lighting committees which, even if they have not yet held themselves and their staff up to ridicule in such a manner as the Cardiff committee has done, equally prevent the exercise of proper authority and discipline by the engineers appointed to manage their undertakings. As we have emphasised on previous occasions, it rests with the engineers themselves to refuse posts in which they are placed in such an undignified position. In other places than Cardiff there are engineers-in-chief who must appeal to the Electric Lighting committee for permission to dismiss an insubordinate workman, the further possibility existing that the committee, having sanctioned the dismissal, might be called upon to reinstate the man at a subsequent Vestry or Council meeting.

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Cable Interruptions.	Date of Interruption.
Latakia—Cyprus	June 21, 1899
Cayenne – Pinhieros	Oct. 11, 1899
Zanzibar—Mombassa	Oct. 27, 1899
San Thomé – Loanda	Dec. 11, 1899

Personal.—Mr. Charles Pratt Sparks, M.I.E.E., electrical engineer, late director of Messrs. S. Z. de Ferranti (Limited), has been appointed chief engineer and manager of the County of London and Brush Provincial Electric Lighting Co. (Limited).

Royal Society.—Among the Papers down for reading yesterday were "A Note on the Electrical Resistivity of Electrolytic Nickel," by Prof. J. A. Fleming, F.R.S.; and "Investigations on Platinum Thermometry at Kew Observatory," by Dr. C. Chree, F.R.S.

Prize Distributions.—The prizes were distributed at the Northampton Institute, Clerkenwell, on Friday night last (December 8th), by Sir Henry Roscoe, F.R.S, and at the Chelsea Polytechnic, Manresa-road, S.W., on Wednesday evening, by Mr. R. C. Antrobus (in the absence of the Bishop of London).

Scientific Degrees at Oxford University.—A new statute is to be promulgated for the institution of degrees of Doctor of Letters and Doctor of Science. It is proposed that candidates shall submit published Papers or books containing an original contribution to learning or science.

University College, Liverpool.—Mr. A. W. W. Dale, fellow and tutor of Trinity Hall, Cambridge, has been appointed principal of University College, Liverpool, in succession to Mr. R. T. Glazebrook, F.R.S., whose appointment to the directorship of the new National Physical Laboratory we announced some weeks ago.

The Berlin Academy of Science.—The Berlin Academy of Science will celebrate the 200th anniversary of its foundation on March 19 and 20, 1900. Both the Royal Society and the French Académie des Sciences have been invited to send representatives, and the Royal Society has already appointed delegates.

Nunc Dimittis.—On New Year's Day, 1900, the Eastbourne Corporation will take over the undertaking of the Eastbourne Electric Light Co. (Ltd.). It is interesting to note that this company, which then ceases to exist, was the pioneer company in the United Kingdom for the supply of electric lighting from a central station.

"Science Abstracts."—This useful little publication contemplates an addition to the subject-matter of its contents which will widen its sphere of usefulness. Commencing with the January, 1900, number, a section will be added dealing with steam plant, gas and oil engines, and abstracts concerning motor cars of all kinds (not merely electrical as hitherto) will be included. Future numbers are to be issued on the 25th of each month, instead of the 1st as heretofore.

Fire in Boiler Foundations.—A peculiar accident has taken place at the Chester electric supply station. The concrete foundations of two boilers having ignited, the whole block became red-hot. The concrete consisted of one part in seven of boiler ashes, and the trouble seems to have arisen owing to the brick lining having been omitted under the boilers in one place, with the result that the red-hot soot lay in contact with the concrete. It has been found necessary to pull down the brickwork of the boilers and to remove the whole of the concrete block.

Marconi's Patent in America.—Suit has been brought against Mr. Marconi in the United States Circuit Court, by Lyman C. Larned, of Boston, for infringement of the patent granted October 5, 1886, to Prof. A. E. Dolbear, of Tufts College. The bill of complaint was filed in the United States Circuit Court on October 5th last. The *Electrical World* of New York says that the suit is spoken of with contempt by Mr. Marconi's representatives in the newly-formed American company referred to by our New York correspondent in another column.

Stand-by Supply.—Whilst some of our municipal electrical engineers are much perturbed that there is no law absolving them from allowing the public supply from being used as a stand-by in the case of a consumer who has his own generating plant, it appears that a case of this sort has been decided in Germany in favour of an electric lighting company. The Deutsche Bank in Hamburg has its own installation, and the Hamburg Electric Lighting Co. refused to supply it with current. The case was decided in favour of the company, the decision being sustained on appeal.

Royal Institution.—The following are among the lecture arrangements at the Royal Institution before Easter: Mr. C. Vernon Boys, six Christmas lectures (specially adapted for young people) on "Fluids in Motion and at Rest;" the Right Hon. Lord Rayleigh, six lectures on "Polarised Light." The Friday evening meetings will begin on January 19th, when a discourse will be given by the Right Hon. Lord Rayleigh, on "Flight." Succeeding discourses will probably be given by the Hon. C. A. Parsons, Prof. J. H. Poynting, Prof. Frank Clowes, Sir A. Noble, Prof. Dewar, and other gentlemen.

Electricity Supply at Northwich.—On account of the subsidences of the ground, for which Northwich is famous, the Northwich Electric Supply Co. has unusual difficulties to contend with. It is, however, especially important that interruptions in the supply should be avoided as far as possible, as the motors which operate the swing bridge over the river Weaver are supplied from the company's mains. On December 2nd, notwithstanding all precautions, an interruption of about one hour's duration occurred, during which time it was fortunately only necessary to turn the swing bridge once by hand. Owing to a subsidence, a short-circuit took place within a house service box, causing the main fuse at the generating station to blow and interrupt the supply until the faulty section was found and cut out. In circumstances such as at Northwich a station engineer would be quite justified in dividing up his distributing network by means of fuse links to a far greater extent than would be advisable on an ordinary town distributing system.

International Telephony.—The Vienna correspondent of the *Daily Chronicle* writes that telephonic communication between Vienna and Constantinople will soon be established. The Hungarian and Servian Governments have just arranged for a telephone wire between Budapest and Belgrade, which is expected to be ready at the end of January. From Belgrade the Servian Government has granted two more telephone wires, one to Sofia and another *viâ* Uskub to Constantinople. There is a telephone already working between Budapest, Vienna, and Berlin, and hence it may be expected that the German capital will soon have telephonic communication with Constantinople. Our contemporary's Brussels correspondent telegraphs that recent experiments, with the view of connecting Brussels and London by telephone, have been so successful that the negotiations have entered upon a practical stage, and a convention on the matter is about to be signed by the respective Governments. The wire will be carried through Lille, Calais, and Dover.

The Birmingham University.—Mr. Andrew Carnegie, when he made his donation of £50,000 for a Birmingham University, suggested that some of the features of American universities should be incorporated in the new establishment. Mr. G. H. Kenrick, Prof. Poynting (professor of physics at Mason's College), and Prof. Burstall (professor of engineering at Mason's College) were therefore deputed to visit certain universities in America. They left Birmingham on November 1st, and visited Cornell University, the Massachusetts Institute of Technology at Boston, the McGill University at Montreal, and others of the leading colleges and schools in the United States generally. Having now returned from their travels, they will report to the University committee, Prof. Burstall is reported to have told a Press representative that we had much to learn from the United States on education generally, although, on the other hand, we had points that the Americans lack. But, he added, our Transatlantic cousins have had an immense advantage over us in regard to superiority of endowments.

The Proposed Volunteer Reserve.—As a number of our readers and their employés are retired volunteers, we are glad to give publicity to the following letter received from Lord Wemyss:—

SIR: In a recently published letter I said I was in communication with the War Office *re* a volunteer reserve, but that if they took no action in

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the matter we must do so ourselves, and present the nation with a Christmas gift of 500,000 volunteer reservists. Well, I have received an official "tip" that it would be well that the volunteers should themselves take the thing in hand. This, therefore, is what we now have to do; and I would, through the Press, urge immediate action on the part of all *emeriti* volunteers who hold, as so many of us do, that such splendid fighting material as we have in our midst should no longer be allowed to run to waste, but be at once organised and made available for home defence. What, then, I humbly but confidently suggest is that all *emeriti* volunteers of fighting age—say from 20 to 45—should at once send in their names to the commanding officers of their respective regiments and corps as being willing to rejoin and serve when required in any time of national need. Having done this, nothing more should in ordinary times be expected of them, save that they should appear once a year in plain clothes at the inspection of their regiment and march past the inspecting officer. This would show foreign nations that such a reserve of trained volunteers is not a myth, but a substantial potential fact. Further, it would be well if reservists had free access to their regimental butts, and that a sufficient number of rifles, now in Government stores, should be supplied for their use and kept at their headquarters. Thus it would be seen how readily a volunteer reserve can be formed, entailing little or no trouble on the reservists, and at no cost to the Government; while all the machinery needed to bring it into substantial life would be a personal call at headquarters or a halfpenny postcard intimating readiness to serve when needed.—Yours faithfully, WEMYSS.

P.S.—What I have said regarding a volunteer reserve should apply equally to our splendid force of yeomanry. They are now, I think, 14,000 strong, and from those who have passed through their ranks, and are still of fighting age, a large reserve ought readily to be formed.

The Metropolitan Electric Supply Co.—The troubles of this company are not yet over. Consumers' circuits are still being switched off at the hours of maximum demand, and complaints are numerous. In reply to a number of letters in *The Times*, the secretary of the company explains that the delay in the delivery of the ironwork for the new station at Willesden was the prime cause of the defective supply. Until a short time ago, assistance was afforded from the London Electric Supply Corporation, who supplied the Metropolitan Co. with a certain amount of high-pressure electrical energy "in bulk," but this corporation are now unable to continue this supply. One of the three 1,500 kw. sets is now running on load every evening, but the others are not yet in complete working order. The company is also troubled with difficulties in obtaining Welsh coal for their London stations. In addition to this, we understand that the Manchester-square station is shut down at present for repairs rendered necessary by the constant overloading. At last week's meeting of the Marylebone Vestry it was decided to inform the company that, on failure recurring, the Vestry will proceed against them under the penal clauses of the electric lighting order. The Paddington Vestry last week threatened a similar step. A recommendation of the Electric, Gas, and Water committee was adopted to the effect that a copy of the surveyor's report relating to the intermittent lighting of Westbourne-terrace be forwarded to the Metropolitan Electric Supply Co., with an intimation that, should the arc lamps stationed there still continue to go out, the committee will have no alternative but to recommend the Vestry to put in force the penal clauses of the Paddington Electric Lighting Order—with a rider authorising the committee, at their discretion, to take proceedings against the company.

Conduit Explosion in Westminster.—An unfortunate explosion took place on the mains of the Westminster Electric Supply Corporation at a quarter to five on Tuesday evening. It occurred in the culvert in Great Smith-street, Westminster, and blew up the pavement for several yards. The paving stones falling into the culvert caused the short-circuiting of all the copper conductors, these unhappily being several of the main feeders from the company's Millbank-street generating station. Workmen were sent to the spot immediately, and the short-circuited mains disconnected as quickly as possible. In the meantime, however, owing to the excessive current which had to be carried by the feeders running to Parliament-street, these caught fire; but there was no explosion in this case and no boxes were blown up there, as stated in some of the daily papers. As soon as the company's engineers heard that smoke was issuing from the ventilators, men were sent round to remove the covers, and the fire from the burning insulation was extinguished as quickly as possible. As might be expected, the above incidents resulted in considerable interruption to the supply in the Westminster district. New mains were run to take the place of the injured ones, and between eight and nine o'clock on Tuesday night the supply was resumed, but only at about 160 volts. At eleven o'clock, however, the voltage was up to 200, with the exception of the district in Parliament-street and Great George-street, where the repairs could not be completed until about eleven o'clock on Wednesday morning. Owing to the damage caused to the three-wire connection, there were still, at the time of our going to press a few 100 volt consumers unable to obtain a supply. It should be added that it was only the Westminster district that was so seriously affected, as shortly after the breakdown the network supplying this area was separated from the remainder. This is the first occasion since the company commenced supply that it has had an accident so serious as practically to extinguish all the lights. While sympathising with the company in their misfortune, we congratulate the engineers on the prompt manner in which they have been able to put matters straight again.

Röntgen Society.—A particularly interesting meeting of the Röntgen Society was held on Thursday week, at the rooms of the Medico-Chirurgical Society in Hanover-square. Upon that occasion Mr. Mackensie Davidson, a well-known practical worker with X-rays, exhibited a number of useful appliances suitable for enabling a medical practitioner to determine with great accuracy the whereabouts of a foreign body embedded in the tissues. It must be admitted, however, that the appliances shown were scarcely suitable for work with the rays requiring a portable form of apparatus, although Mr. Mackensie Davidson has certainly not neglected to consider that aspect of the case. While it is true that everything is made to pack and fold easily, and great ingenuity is displayed in the design of the various parts, it is too much to expect that the average X-ray worker who uses the rays for surgical purposes can employ such elaborate apparatus. But for hospital work, where the pressure of cases awaiting operation may not be heavy and where large and costly appliances can be permanently established, it is difficult to conceive that Mr. Mackensie Davidson's method of localisation will be improved upon. A distinct feature of the apparatus is a special focus tube in which the anticathode is faced with osmium, thus enabling a more powerful and more sharply focussed beam of cathode rays to be utilised for the purpose of obtaining good definition. Some interesting stereoscopic radiographs were on view, and numerous results in connection with the application of Mr. Mackensie Davidson's localisation method to ophthalmic surgery were exhibited. Mr. T. Moore brought a curious case before the members of the Society, and demonstrated practically, by means of a fluorescing screen and Röntgen lamp, the presence of a bullet situated in one of the frontal lobes of the brain of a living subject. The patient appeared unconcerned and unaffected by the presence of such an unpleasant addition to the contents of his skull, and only complained because the X-rays had burned almost all the hair off his head.

MEETINGS OF SCIENTIFIC AND ENGINEERING SOCIETIES, &c.

TUESDAY, December 19th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Paper to be further discussed: "Combined Refuse Destructors and Power Plants." By C. Newton Russell.

WEDNESDAY, December 20th.

ROYAL METEOROLOGICAL SOCIETY.

7:30 p.m. Ordinary Meeting at the Institution of Civil Engineers, 25, Great George-street, S.W.

ROYAL MICROSCOPICAL SOCIETY.

8 p.m. Meeting at 20, Hanover-square, W.

THURSDAY, December 21st.

INSTITUTION OF CIVIL ENGINEERS.

2 p.m. Students' Visit to the Generating Station of the Westminster Electricity Corporation, and subsequently to the Works of the Shingleton Ice Co., Eccleston-place, S.W. Meet at Generating Station, Eccleston-place.

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CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

Transition Cell.—A new kind of transition cell is described by E. Cohen. Its electrodes are of the same metal, in two different modifications, and the electrolyte consists of a solution of a salt of the same metal. Up to the present no metal was known which, at suitable temperatures, occurs in two modifications. But it has been found that metallic tin has a transition point at 20°C. Below this temperature the so called grey tin is the stable form, above it the so-called white tin. Since the white modification may be considerably supercooled, we may put together a cell of the form: Grey tin—solution of tin salt—white tin. The E.M.F. of the element is simply a function of the electrolytic solution pressures of the two modifications of tin. This function is of course very small, and there is no likelihood of the new cell displacing any of the others as sources of current. But the new cell has a considerable value for the chemical physicist, inasmuch as it enables him to determine accurately the point of transition from the grey to the white variety by heating the element until the E.M.F. becomes zero. A number of delicate investigations can thus be carried out, as, for instance, that concerning the displacement of the transition point by external pressure.

[E. Cohen, *Proc. Roy. Akad. Amsterdam*, Oct. 28, 1899.]

Periodicity of Wehnelt's Interrupter.—According to Simon, the periodic time T of Wehnelt's interrupter is given by the equation

$$T = \frac{3L}{2r} + \frac{C_1 r}{E^2} + C_2,$$

where L is the self-induction in the circuit, r the resistance within the interrupter, E the E.M.F., and C_1 and C_2 constants. Simon showed that the equation held good in a certain sense by making r and L constant and varying E. Since then E. Ruhmer has verified the formula in another way by keeping r and E constant and varying the self-induction L. If the same interrupter is used, and the length of the platinum bit and the temperature are kept constant, only T and L are variable in the above formula, and it may be written

$$T = AL + B.$$

To vary the self-induction within wide limits the author constructed two coils, one of which could be inserted in the other. They could be connected in two different ways, with the windings aiding or opposing each other, so that by varying the degree of insertion any value of the self-induction between a low minimum and a high maximum could be obtained. The law specified was found to be true within a maximum error of 2 per cent.

[E. Ruhmer, *Elektrotechn. Zeitschr.*, Nov. 9, 1899.]

Magnetic Spasms.—Since the great development of seismology the instruments which record the earth's magnetic elements have also rendered good service as seismographs in the researches on the propagation of earth-waves. W. van Bemmelen has, during half-a-year, had the opportunity of tracing the seismic disturbances in the magnetograms at Batavia. When an earthquake is taking place the magnetic curve shows a discontinuity, the needle suddenly starting vibrating, and continuing to do so for several minutes. When the earthquake is distant there is only a broadening of the curve. In certain circumstances it is difficult to distinguish between these seismic disturbances and those periodic variations of the magnetic force of small amplitude and duration which the author calls "spasms." To prove the existence of the latter the author used Eschenhagen's micro-variometer for horizontal intensity, in which a light magnet is held perpendicular to the magnetic meridian by the torsion of a German-silver wire. The author, after several nights' continuous observation, was successful in observing at least one case of purely magnetic spasms, with a periodicity of about three per minute. The spasms appear to occur only in the horizontal intensity, and not in the declination.

[W. van Bemmelen, *Proc. Roy. Acad. Amsterdam*, Oct. 28, 1899.]

Absorption of Röntgen Rays.—If the absorption of X-rays by salts were atomic—that is, if the absorption were not produced so much by the nature of the absorbing molecule as by its constituents—there ought to be some simple relation between the absorbing powers of salts having the same acid radicle. To discover such a relation Lord Blythswood and E. W. Marchant used two photographic methods of comparison, the second being a null-method, and therefore not subject to the errors introduced by duration of development. The solutions were poured into wedge-shaped cells and compared with cells containing pure water. A large number of chlorides, bromides, iodides, acetates, nitrates, and sulphates were examined. As regards the acid radicles, no relation could be found between their absorptivity and their atomic weights or molecular densities, the order of increasing absorption being nitrate, chloride, and sulphate. As regards the bases, there is a rough correspondence between absorption and atomic weight, but the salts of the alkali metals are less absorptive than they should be. A 6 per cent. solution of common salt is 10 per cent. more absorptive than pure water. It is very doubtful whether the great difference of absorptivity evinced by different persons to the rays can be attributed to a difference of the amount of inorganic salts dissolved in their blood.

[Blythswood and Marchant, *Proc. Roy. Soc.*, No. 421, 1899.]

A Practical Thermometric Standard.—H. L. Callendar advances an imposing array of reasons for adopting the platinum-resistance thermometer as the practical standard for high temperatures. The preamble to the draft proposals submitted to the British Association at Dover, and provisionally adopted, states that the gas thermometer, which has long been adopted as the theoretical standard, has given results so discordant in the hands of different observers at high temperatures as greatly to retard the progress of research. The author further adds that the backward state of the science of heat at the present time, our comparative ignorance of the fundamental laws of radiation and dissociation, and of many other phenomena as dependent upon temperature, are principally due to discrepancies of gas thermometry. The platinum-resistance thermometer has distinct advantages over the thermo-couple, on account of its greater accuracy and simplicity. It is sufficient to send a few grammes of the standard wire in an ordinary letter to reproduce the scale with the utmost accuracy in any part of the world. The author deals at length with the selection of the platinum sample and the standardisation of the instrument. The latter must of course be based ultimately upon the gas thermometer.

[H. L. Callendar, *Phil. Mag.*, Dec., 1899.]

AN ELECTROLYTIC COPPER REFINING PLANT.

The Boston and Montana Copper and Silver Mining Co., at Great Falls, Montana, have one of the largest and best equipped copper refining plants in the world. Power is obtained from the river, across which a dam has been constructed, giving 50ft. head. The power plant is situated on the river bank, about three miles above the town of Great Falls.

Within the power house is a twin turbine, supplied by the Dayton Globe Iron Works, developing 2,900 H.P. at 130 revs. per min. Directly connected to the shaft, on either end, are two Westinghouse electrolytic generators running in parallel, each nominally of 810 kw., but guaranteed to develop 1,210 kw. The generators are regularly operated at this overload, running continuously seven days in the week, day and night. These machines have a normal rating of 4,500 amperes at 180 volts, but are guaranteed to carry 5,500 amperes at 220 volts continuously. One of these generators is seen in the view of the machine room shown in Fig. 1. The field casting of each generator is divided vertically, opening upon ways in a horizontal direction. This vertical division affords excellent facilities for inspection or removal of the armature or field coils without the necessity of removing the out-board bearings.

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This arrangement is of great convenience where head room is limited and cranes for handling heavy weights are not available.

shaft, and may be drawn off without in any way interfering with the permanent arrangement of the commutator and windings. The fields are separately excited, the current for

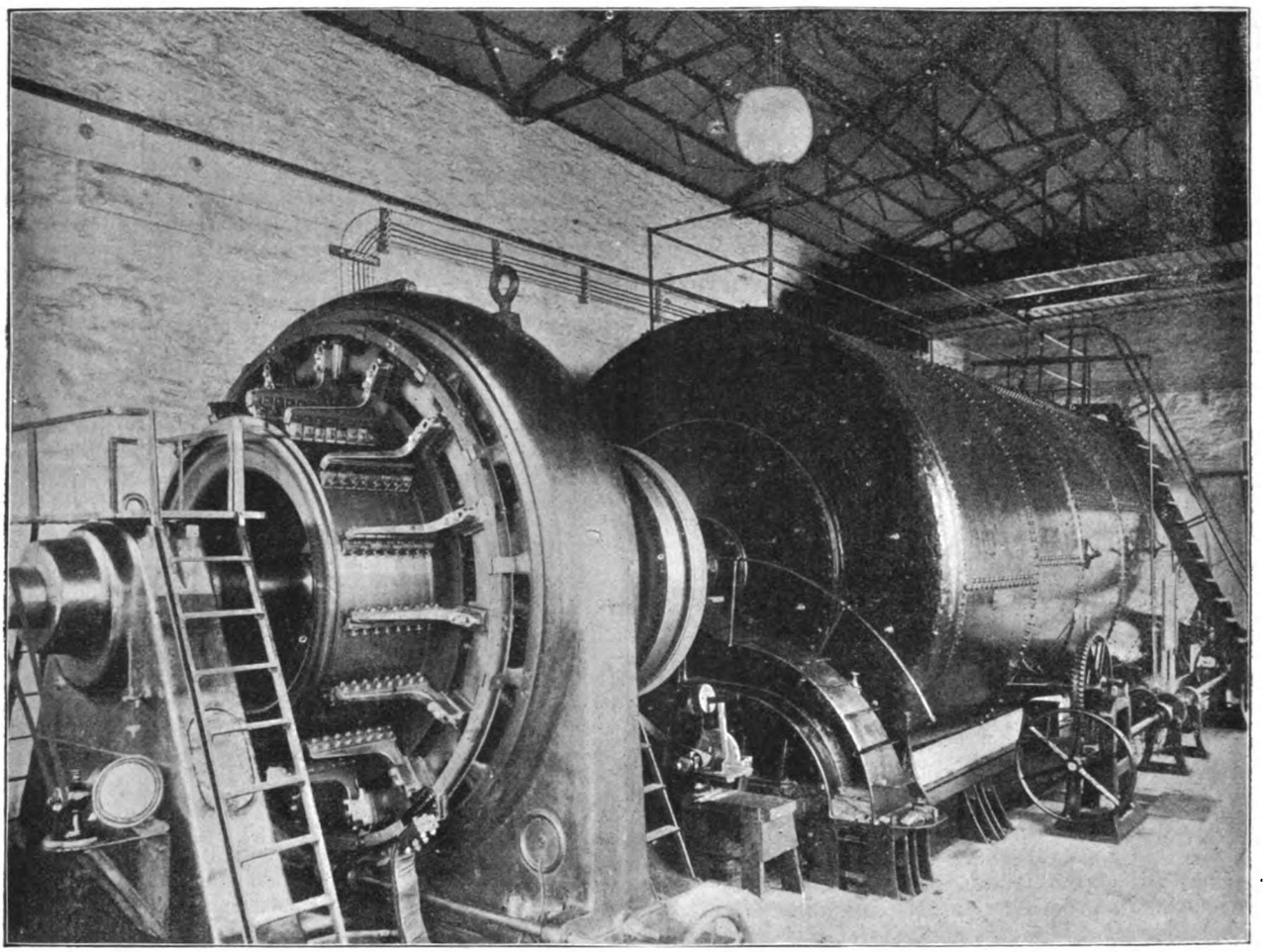

FIG. 1.—WESTINGHOUSE 810 K W. ELECTROLYTIC GENERATOR, AT THE WORKS OF THE BOSTON AND MONTANO COPPER AND SILVER MINING CO.

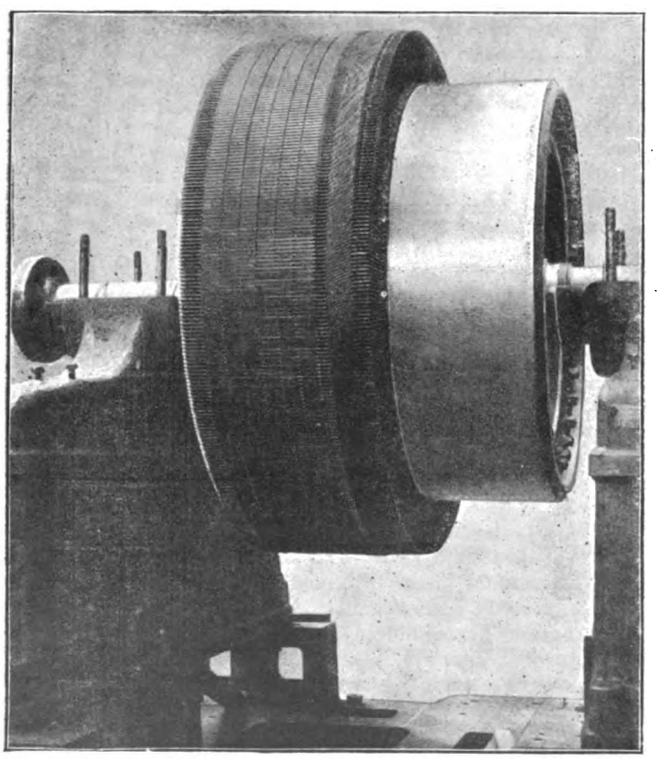

FIG. 2.—ARMATURE OF 810 K.W. WESTINGHOUSE ELECTROLYTIC GENERATOR.

The armature core, Fig. 2, is composed of punched steel discs, and is built upon an iron spider, which also carries the commutator. This spider is pressed and keyed upon the

this purpose being supplied from two 125 volt Westinghouse generators. The Westinghouse generators are connected to the turbine shaft by a flexible coupling composed of two steel discs carrying projecting pins set at different radii. The coupling

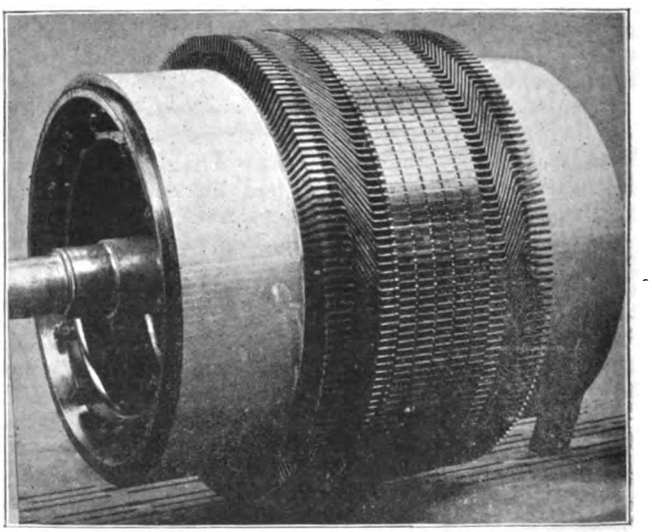

FIG. 4.—ARMATURE WITH TWO COMMUTATORS FOR WESTINGHOUSE ELECTROLYTIC GENERATOR.

is effected by heavy links of leather, each link passing over a pair of pins, one on each disc. The brush holders are carried by brackets projecting from a ring, concentric with and supported by the field frame. By means of the hand wheel worm, which engages with a gear on the rim of this ring, adjustment of all the brushes is accomplished simultaneously.

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The ring carrying the brush holder brackets lies close to the field, and does not project over the commutator; the commutator and brushes are therefore clear of obstructions, and may be easily inspected at any time. Fig. 5 shows the switchboard. The instruments mounted on the right-hand panel are used in connection with the two 22½ kw. 125 volt exciters. The other four panels contain the necessary switches and instruments for controlling the two 810 kw. generators. The board is 7ft. 6in. in height and 10ft. long. The four single-pole switches mounted thereon are of 6,000 amperes capacity each.

The copper ore in its crude state is first ground and put through concentrators to remove the refuse. This operation takes place where the copper ore is mined. From the concentrators the metal is carried to the smelting department and cast into pigs, about 2in. in thickness and 2ft. square, which makes it extremely important that the supply of current should be uninterrupted.

The refining works are half-a-mile distant from the power plant, situated upon the summit of a hill rising abruptly from the river. On account of the heavy electric current and its low voltage, an exceptionally large conductor had to be devised. This is of copper, 12in. wide by 2in. in thickness, having the appearance of a continuous plank, raised on rough scaffolding about 12ft. from the ground, and is seen mounting the hill from the power house. The business of electrolytic copper refining is an extremely profitable one, and is finding extensions in the eastern and western States. The published annual report of the Boston and Montana Co. for the year 1898 gives the sales of copper, gold, and silver at nearly £1,500,000, and the amount applicable to dividends, after payment of all expenses, £700,000.

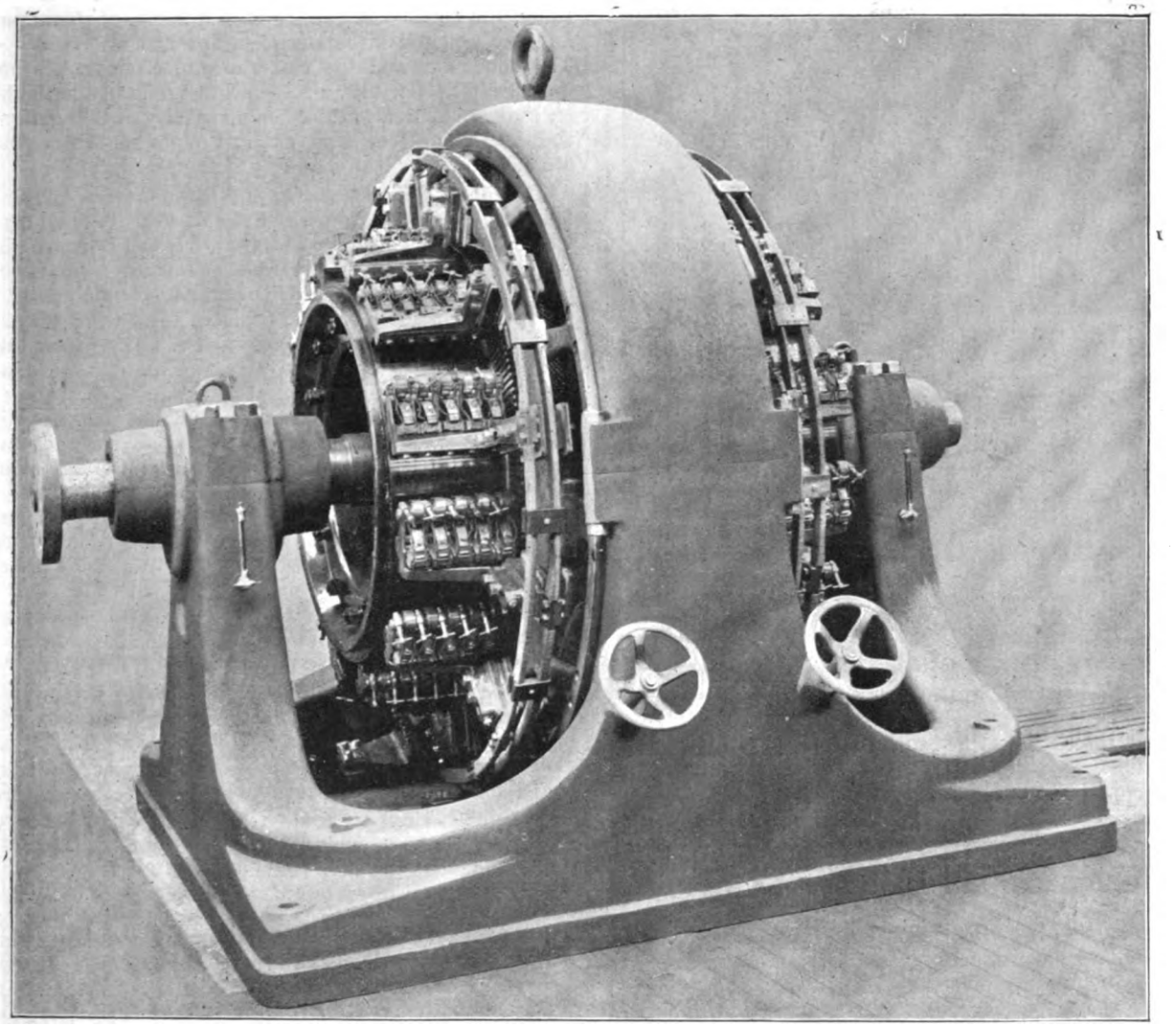

FIG. 3.—WESTINGHOUSE ELECTROLYTIC GENERATOR WITH TWO COMMUTATORS, EMPLOYED BY THE ANACONDA COPPER MINING CO.

having projecting shoulders at one end. The electrolytic process is carried on by a number of tanks, arranged side by side, which are filled with solution, consisting chiefly of copper sulphate. The pigs of crude metal are arranged in rows in the tanks, hanging by the shoulders on the brackets. Thin sheets of copper are placed between each pair of pigs. Electric current is passed through the series of tanks, decomposing the copper of the pigs and depositing the refined copper on the thin sheets, while the residue containing gold, silver, and lead drops to the bottom of the tanks. It is said that this residue is worth $2,500 a ton, the gold, silver, and lead extracted from it being sufficient to reimburse the cost of the whole electrolytic process. In the electrolytic process, work is carried on continuously without any break,

The Anaconda Copper Mining Co., at Anaconda, Montana, has also been electrically equipped by the Westinghouse Electric and Manufacturing Co. This refinery was described in *The Electrician* three years ago (Vol. XXXVIII., p. 144), but the plant has been considerably added to since then. It now includes nine Westinghouse electrolytic generators. Three of these generators are of 270 kw., or 3,600 amperes at 75 volts, being belt-driven by steam engines at a speed of 360 revs. per min. Four other Westinghouse generators of 270 kw. each, or 3,600 amperes at 75 volts, are directly connected to their engines, and there are also two directly-connected Westinghouse electrolytic generators of 360 kw., which, together with the three directly-connected generators of 270 kw., have a novel feature in carrying two commutators

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one mounted at each end of the armature. Fig. 3 shows one of these generators. Two commutators are used on these machines, on account of the large current generated by them. The two commutators provide sufficiently enlarged surface to carry off the current from the armature coils to the brushes, thus avoiding excessive heating. This arrangement of two commutators also distributes the weight more evenly on the frame bearings, and secures better commutation, with a firmer contact of the brushes. The armature of one of the generators carrying two commutators is shown in Fig. 4. The generators are connected directly to the engine by means of flanges

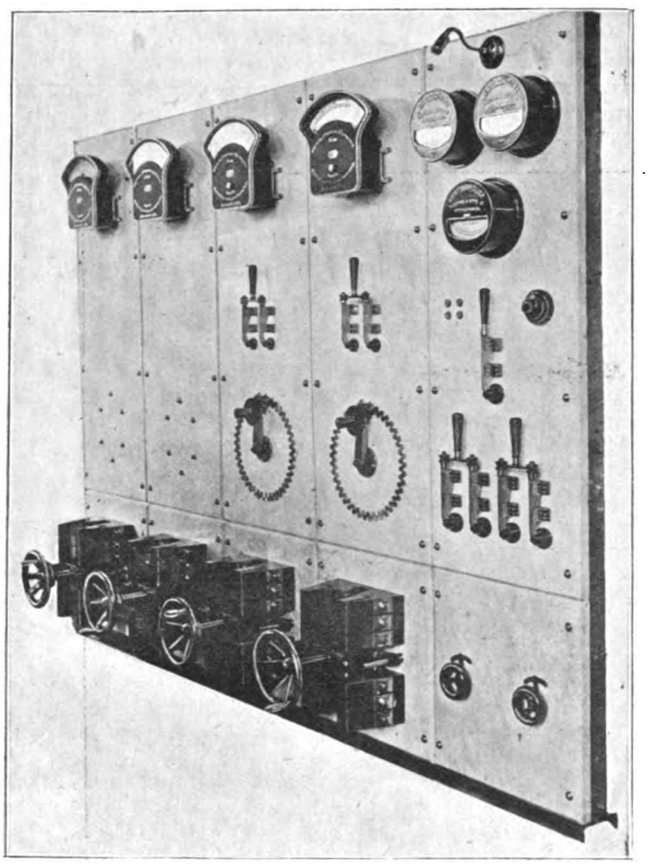

FIG. 5.—WESTINGHOUSE SWITCHBOARD FOR ELECTROLYTIC WORK.

forged upon the shafts. The brush holders can all be adjusted simultaneously by a hand wheel, and are supported from the field casting, the latter being divided horizontally.

THE HEREFORD ELECTRIC SUPPLY WORKS.

The small supply station opened at Hereford yesterday is on the three-wire continuous current system at 2×220 volts which is now almost universally adopted in towns of small size where the electricity works can be placed in a central position. The following is a description of the plant, for the details of which we are indebted to the chief contractors—the India-Rubber, Gutta Percha and Telegraphs Works Co., and some of the sub-contractors.

The boilers, supplied by Messrs. R. Taylor and Sons, are of the Lancashire type and two in number, their dimensions being 30ft. by 7ft. 6in. They are constructed for a working pressure of 150lb. per sq. in., and work in conjunction with a Green's economiser of 96 tubes, each boiler being capable of evaporating 7,000lb. of water per hour. They are fitted with Meldrum's forced draught furnaces. The feed-water is obtained through two three-throw pumps driven by Silvertown motors, and in addition one injector is provided. A self-acting triple-scraper economiser is driven by an electric motor through worm gearing.

In the engine-room are two Belliss-Silvertown direct-coupled fast-speed sets. The engines are of the two-crank type, each rated at 150 B.H.P., with a steam pressure of 150lb. at the stop valve when exhausting into the condenser or atmosphere, and at a speed of 450 revs. per min. The dynamos, made by the Silvertown Co., are of their usual two-pole undertype pattern with drum armatures, giving an output of 200 amperes at 440 to 500 volts, with the normal engine speed. They are, of course, shunt-wound. When tested after a six hours' run on full load, the makers inform us that the machines showed no signs of sparking at the brushes, and that the maximum temperature was found to have risen considerably less than the specified 70°F. The steam consumption per electrical horse-power of each of the combined sets running, condensing, and on full load did not exceed 22lb. The main steam piping is of lap-welded steel with flanges forged on solid, the subsidiary steam piping being of wrought iron, and the last bends to the engine of solid-drawn copper. Cast-iron exhaust pipes run from each engine below the floor level to a 10in. exhaust. The condenser is of the Ledward type with 160 tubes, and capable of dealing with 6,000lb. of steam per hour, and its air and circulating pumps are electrically driven. The condenser and the cast-iron collecting tank—the latter measuring 25ft. × 13ft. × 2ft.—are erected outside the building on girders. The feed tank has a capacity of 600 gallons. All the steam, hot-feed, and exhaust pipes in the engine room are covered with sectional Magnesia covering.

The motor-driven boosters and balancer are combined, the four machines being on the same shaft. The two machines, which are to work either as motor or generator, are placed in the middle of the group and the boosters outside. One booster and one of the other machines are mounted together on the same bedplate, the bedplates measuring 8ft. $0\frac{7}{8}$in. by 2ft. 4in., and being placed 13in. apart. The larger machines are single-horseshoe, drum-armature, undertype machines, each capable, when working as a balancer, of dealing with a balancing current of 100 amperes. The boosters are likewise Silvertown single horseshoe, drum-armature, undertype machines, and each of them can raise the pressure from 20 to 90 volts with a current of 90 amperes. The speed of the set is about 800 revs. per min. For starting the balancer and booster a double pole switch is provided on the switchboard with suitable starting resistances; and four shunt resistances, one for each balancing machine and one for each of the boosters, are fixed with their switches on to the switchboard handrail, a separate switch for breaking the exciting circuit of each booster being also provided.

The switchboard, arranged for the three-wire system at a pressure of from 440 to 500 volts between the outers, is erected on an iron frame 14ft. by 8ft., with three enamelled slate double panels. On the two outer panels are mounted the dynamo cut-outs with double-pole fuses, ammeter 'bus-bars, feeder ammeters, and fuses with two-way switches, and on the middle panel are the battery regulating switches, the balancer, double-pole starting switches, and the usual throw-over switches, ammeters, voltmeters, &c. Four-feeder circuits leave the 'bus-bars, and on each pole of these circuits is an ammeter and a double fuse with a two-way switch. A middle 'bus-bar, provided with terminals for the battery, feeder, and balancer, is fitted, and also an ammeter to indicate the amount of current flowing in the middle wire. An arrangement is also made for connecting the middle wire to earth through an ammeter reading up to 50 amperes. Weston voltmeters are provided on the feeder circuits and Kelvin multicellular instruments for the dynamo, battery and booster terminals. The accumulators are of the Chloride R type, and the battery consists of 270 cells. Each cell has 23 plates, and the guaranteed capacity is 660 amperes hours at a 9-hour discharge rate, the battery being capable of discharging at 250 amperes without injury. The stands are arranged in two tiers and are made of pitch-pine painted with three coats of acid resisting varnish. Forty cells in each half battery are connected to 21-way regulating switches on the switchboard, so that the cells are cut in or out two at a time.

The present network of mains has a capacity of about 10,000 8 c.p. lamps, and there are three feeding points. The cables are insulated with vulcanised india-rubber taped over all, and are laid in a tarred wooden trough filled in with

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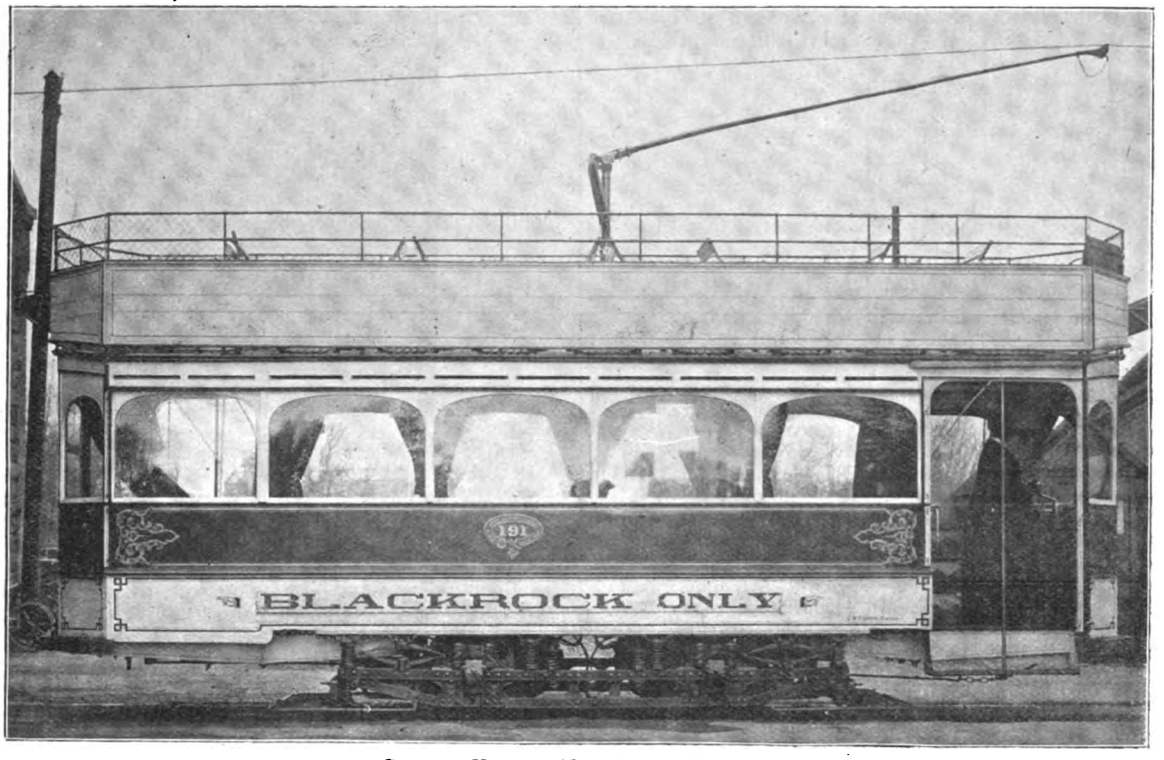
compound. The feeders are run separately from the distributing mains, and the latter, in nearly all cases, are on both sides of the road.

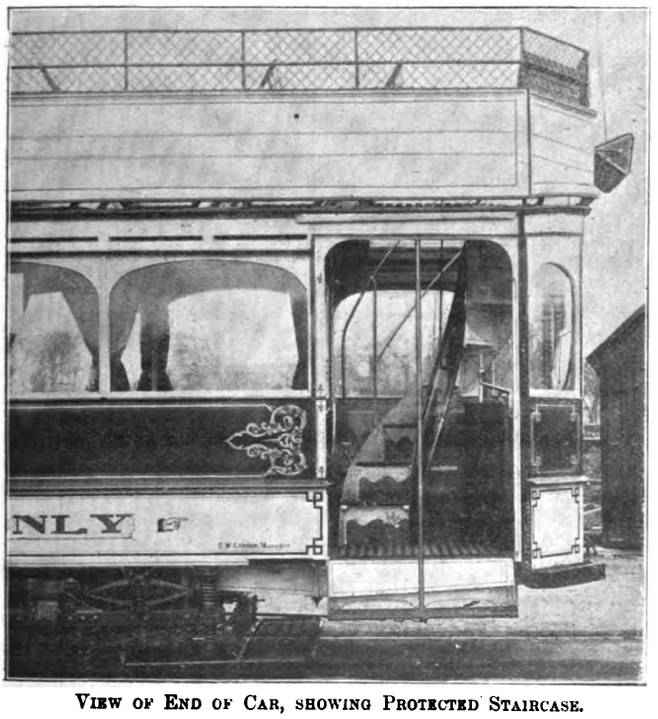
With the exception of the buildings and excavations, all the work has been carried out by the Silvertown Co. under the supervision of Mr. Stuart Russell. Their local representatives—Messrs. Ely and Whitmee—and all the other contractors are to be congratulated on the speed with which the work was carried out, for it was only 7½ months ago that the sanction of the Local Government Board was obtained for the loans. Mr. John Parker, the borough engineer and surveyor has been supervising the work for the Electricity Committee, whose able and energetic chairman is now Mayor of Hereford. Mr. Parker has also been filling the duties of resident engineer unaided until the recent appointment of Mr. Poulton to assist him.

A NEW TRAMCAR.

The Dublin United Tramways Co. have just made a novel addition to their rolling stock in the shape of a vestibule motor car of a new type. It will be seen from the illustrations (reproduced from photographs taken by Mr. R. S. Tresilian, secretary to the company) that the staircases ascending to the roof are enclosed within the vestibules, obviating any fear of passengers falling off on to the roadway. Access to the roof is made through a "hatchway" above the vestibules, and on alighting on top the passenger finds himself securely railed in, the rails of the roof completely encircling the car. Complete protection from inclement weather is afforded to motorman and conductor alike, and the platform area is increased so that it leaves ample accommodation for parcels, &c. The seating capacity of the roof is also increased so as to allow of eight additional passengers. The seats on the top are provided with a cover (the patent of Mr. Edgar Anderson, son of the managing director of the company) which will at all times afford a dry seat for passengers. The principal dimensions are :—



General View of New Dublin Tramcar.



View of End of Car, showing Protected Staircase.

Length of body	16ft. 8in.
Length of platform	5ft. 3in.
Length over platforms	27ft. 2in.
Length over buffer rims	28ft. 2in.
Width over side panels	6ft. 7in.
Extreme width	7ft. 1½in.
Clear height inside saloon	6ft. 4in.
Length of wheel base	6ft. 0in.

Seating capacity : inside, 25 ; outside, 37.

A New Electric Brake.—The Hubbard Brake Co., of Chester (U.S.A.), has brought out a new electric brake. It consists of an electromagnetic device arranged to operate the ordinary wheel-brake shoes by means of a large solenoid, which takes the place of the cylinder in the usual air-brake equipment. The brake is operated from independent controllers, about one-third the size of the car controller, placed on each platform and so connected as to change the motor terminals when desired, converting the motors into generators. This is done independently of the position of the car controllers, whether on or off, as the instant the brake controller is set the car controller is dead. The device works whether the trolley wheel is in contact with the wire or not, and will, it is claimed, entirely prevent flat wheels.

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METHODS OF SUPPRESSING ARCS IN SWITCHES, FUSES, &c.*

BY ERNEST KILBURN SCOTT, A.M.INST.C.E.

(*Continued from page 221.*)

The Garton-Daniels Arrester is shown in Fig. 8. The lightning discharge enters at the lower end of the graphite resistance (shaded black), and from there passes through the flexible cable to a soft-iron plunger, which normally rests on the top of the upper discharger. It then jumps the spark gap and goes to earth, but if current follows, the drop across the graphite resistance, with which the solenoid is in shunt, sends current through the solenoid, and the resulting magnetism draws up the soft-iron plunger several inches, thus breaking the arc inside the tube.

Wood Arrester.—The Wood arrester, as made by the Fort Wayne Corporation, also depends on a mechanical movement to break the arc. Fig 9 shows the device. Both line and machine terminals are

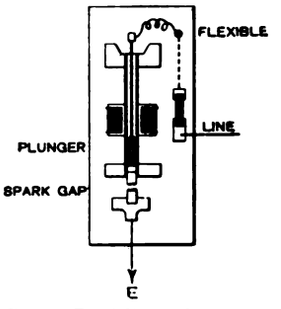

FIG. 8.—Garton-Daniel's Lightning Arrester.

connected to the lower part of the arrester. Earth is connected at the top, and the lever thus forms the path for the lightning discharge, there being a spark gap at either end. In its normal position the lever is vertical, but when a discharge occurs a dynamo current, momentarily following the discharge, energises the coils, thus drawing the plungers and tilting the lever into the position shown in the figure. Directly the arc is broken the coils lose their magnetism, and the lever falls by gravity into its normal position again, ready for the next discharge. The Brush Electrical Engineering Co. supply a somewhat similar apparatus.

Sentinel Circuit-Breaker.—An interesting if somewhat complicated automatic circuit-breaker is made by the Sentinel Electric Co., of Wilmington, Delaware, U.S.A. The arrangement is indicated in Fig. 10, which shows the triple-pole type. A bar of brittle metal

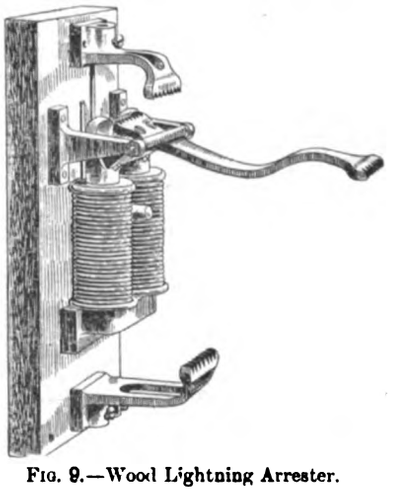

FIG. 9.—Wood Lightning Arrester.

is mechanically broken out by a spring released by a trigger, this latter being actuated magnetically, as in the I.T.E. and other circuit-breakers. Unlike a fuse which first melts at the centre and gradually burns away towards the terminals, the piece of metal in this case is removed mechanically in its entirety, and there is thus exceedingly little arcing. There are no moving electrical contacts, the apparatus is not affected by electrolytic action and does not become jammed, which is sometimes the case with the ordinary circuit-breaker. Fig. 11 shows the idea applied to a switch, E and K being the pieces of metal placed ready for breaking out.

Choking Coil on Alternate-Current Switches.—Regulating switches for alternating-current have not been required to any great extent hitherto, but the introduction of the regulating booster transformer, and of traction by multiphase motors, has shown the necessity for protecting alternating-current switch contacts from excessive arcing. The method of reducing arcing by a double brush and small resistance on continuous-current accumulator charge and discharge switches is well known. In much the same way alternating-current regulating switches may be easily and cheaply fitted with a small choking coil, which automatically comes into circuit by means of a double brush at each jump from contact to contact, annihilating arcing as effectively as does the magnetic blow-out. The small resistance used in continuous-current regulating switches is not nearly so effective as the choking coil in the alternating-current switch,

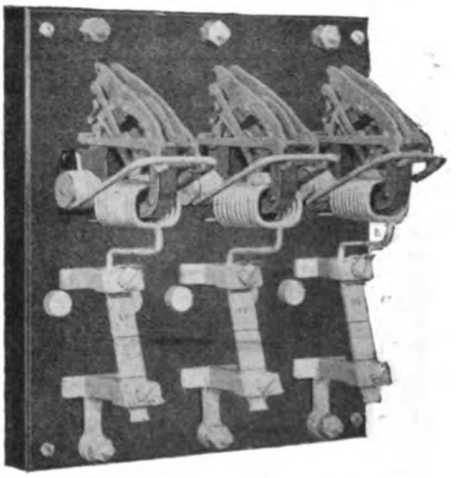

FIG. 10.—Sentinel Automatic Circuit Breaker.

because of the latter having a mass of soft iron entering into its construction. Fig. 12 shows the arrangement of such a switch for a booster transformer.

Use of Electrolytic Cells.—It is interesting to note that part of an alternating-current wave may be suppressed by the employment of electrolytic cells. M. Adolph Müller, of Hagen, Germany, has been carrying out some work on these lines, and he advocates a method of preventing sparking on making and breaking circuits by the employment of electrolytic or polarisation cells. As arranged for continuous-current circuits, say for switching off arc lamps, a number of elements consisting of aluminium plates immersed in an alum solution are

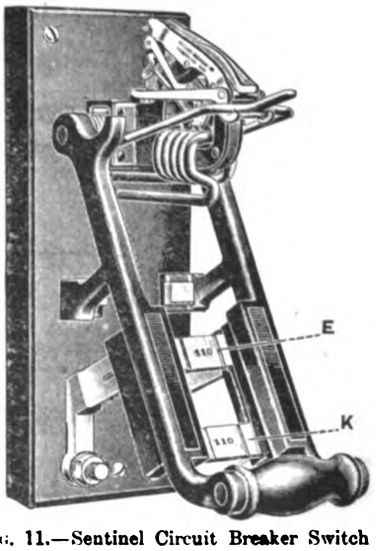

FIG. 11.—Sentinel Circuit Breaker Switch

first switched into current (see Fig. 12A) by moving the switch lever H in the direction of the arrow, so as to connect up the two contacts C_1 and C_2. As soon as the lever touches contact C_2 the battery P is polarised to the terminal tension of the current source D. Current is thereby reduced to zero, thus permitting the circuit to be broken *without* sparking.* The arrangement can be used for interrupting or breaking alternating currents, the polarisation batteries being made of small capacity, so that the condition of their charge can follow

* Paper read before the Northern Society of Electrical Engineers, Dec. 5.

* Some few years ago Prof. Perry suggested the use of lead plates in dilute sulphuric acid in connection with two parts of a brush to prevent sparking on dynamo commutators. He also informs the writer that he made a sparkless switch on this principle. Something of the same sort was suggested in connection with the experimental line at Wolverhampton on the Wynne surface-contact system of traction.

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the change in the E.M.F. of the current source quickly enough to at any moment bring the sum of the latter and of the opposing E.M.F. of the consumption apparatus to zero, thereby stopping flow of current. The idea can be applied to stop sparking on a commutator operating synchronously with an alternating current as in the Ferranti rectifier. In alternating-current work the polarisation battery could be replaced by a condenser, but it would hardly be as mechanically reliable as the battery. The cells may be made up of steel plates immersed in potash lye, or simply lead plates in sulphuric acid. This, and to some extent the choking coil method just mentioned, are especially interesting, because the idea is to prevent an arc *forming*, whereas in all other cases which we are considering the arc first forms and is then suppressed.

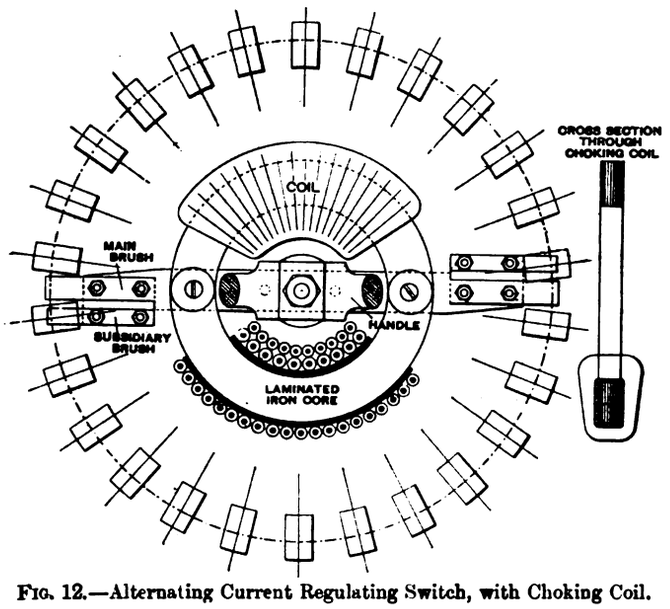

FIG. 12.—Alternating Current Regulating Switch, with Choking Coil.

In this connection it may be of interest to briefly refer to several methods of preventing arcing in continuous-current circuits which surround an iron core. When a dynamo or alternator field winding is switched off the magnetisation at once begins to weaken and the change in the number of magnetic lines induces an E.M.F. tending to maintain the current in the same direction and at the same strength as before. This induced E.M.F may be many times greater than the working pressure, and so be liable to pierce the insulation ; it is therefore the practice, in such wound dynamos particularly, to short-circuit the field winding through a resistance (sometimes only the armature or a group of lamps) when shutting down. In this way current continues to flow through the coil in the same direction, and the demagnetisation being thus delayed, the induced E.M.F. is reduced within safe limits. The flash, on opening a full magnet circuit, may be much reduced by building the coil on a sheet copper former, the

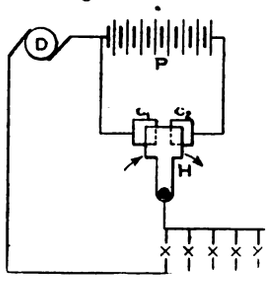

FIG. 12A.—Müller Method of Switching by Polarisation Battery.

copper making electrical connection all round the pole. This was on some of the first brush arc lighting machines built in this country.

Another most effective method of preventing arcing under such circumstances has been recently introduced by Messrs. C. L. Buckingham and E. Germann (see U.S A. Patent 634,198, 1899). They merely wind on the various layers of the coil in one direction only—that is to say, each layer starts from the same end of the formers. In telegraphy it has been known for some time that sparking at the key of a local telegraph circuit can be lessened by winding the electromagnet with *two* wires connected in parallel. Buckingham and Germann's method is a development of this idea, and the beneficial result is most probably due to a condenser action between adjacent layers at different potentials, the electrostatic charges from which balance to a certain extent the self-induction. Destructive arcing being prevented by this means, it follows that there is much less liability of the insulation being pierced, a point which dynamo makers would do well to note.

PART II.—FUSES.

Mordey Dust Fuse.—It is an axiom in the construction of high-tension fuses that, both from the point of view of safety in handling, and also in order to ensure blowing at the right moment, the wire must be enclosed. It is obvious, however, that the mere enclosing of the wire in a straight tube with a terminal at either end is not going to destroy the arc unless made of unreasonable length ; and, principally with the idea of reducing this length, Mr. Mordey in 1890 suggested his well-known *dust fuse*. In this fuse the wire is completely enclosed in a glass tube, and passes through a marble dust and sand, cement at each end, this refractory insulating filling preventing the arc travelling outwards to the contacts and absorbing the volatilised metal. For large currents it is used as a shunt to an ordinary fuse, the arrangement being such that the final break occurs between the two pallets of marble dust.

The Berend Smith Fuse consists of a long papier-mâché tube about 1⅛in. in diameter, ⅛in. thick, and 12in. long for 4,000 volts. It is fitted at each end with gun-metal hatchet contact pieces, to which the fuse wire is soldered. Before placing in position the tube is filled

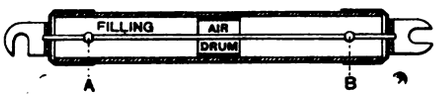

FIG. 13.—D. and W. Switch Fuse.

up with sand, the papier-mâché tube being perforated in several places and the holes covered with tissue paper, so that when the fuse blows the paper is charred and serves to draw the attention of the attendant. To re-fuse, the metal ends are unscrewed and a new wire soldered to them. When the fuse blows, it is probable that, as the vaporised metal is many times greater than the volume of the fuse, there is a powerful tendency for the vapour to rush out from the space originally occupied by the fuse wire. The sand being porous, the vapour therefore easily penetrates it, and dividing up into numerous small streams of vaporised metal, the desired effect of breaking up the vapour is effected. The reliability of the fuse would probably be increased if it had an air space round the wire at the centre as in the Mordey fuse. Being closely surrounded along its whole length, its maximum carrying capacity is liable to change according to the length of time the fuse is in circuit, gradually becoming less as the surrounding material is heated. Obviously, a fuse which when hot would be a protection is not so efficient a protection when cold. The use of an air chamber modifies this defect, because the confined air is so much less a conductor of heat than is the sand filling.

The D. and W. Fuse—a similar arrangement to Mordey's—is a good deal used in America, and has recently been adopted on the

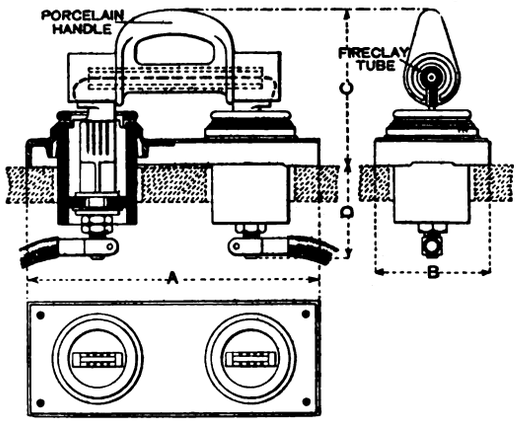

FIG. 14.—Bates Switch Fuse.

Central London Railway plant. It is shown in Fig. 13. The wire is soldered to copper terminals at A and B, and an air space is formed in the centre by a little paper drum or capsule, which thus ensures the fuse wire first going at the centre, the confined air being a much poorer conductor of heat than the filling. The makers have accumulated a large amount of practical data showing the connection which the rise in temperature bears to the current value, and thus, although the fuse can hardly be called novel, they undoubtedly turn out a properly rated and reliable piece of apparatus.

The Bates High-Tension Switch Fuse has the fusible wire passing through an open-ended fireclay tube about ⅜in. inside diameter, carried in a porcelain handle fitted with hatchet contacts as shown in Fig. 14. When the wire melts the heated air escapes with considerable velocity at either end, and so splits the arc in two. A Mr. G. F. Curtis suggested using an open-ended fuse in America as early as March, 1891, and those who visited Switzerland recently will have noticed that the same idea is very extensively employed there.

(To be concluded.)

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ON THE MASSES OF THE IONS IN GASES AT LOW PRESSURES.*

BY J. J. THOMSON, M.A., F.R.S.

(*Continued from page 230.*)

I have examined another case in which we have convection of electricity at low pressures by means of negatively electrified particles —that of the discharge of electricity produced by an incandescent carbon filament in an atmosphere of hydrogen. In this case, as Elster and Geitel (*Wied. Ann.*, XXXVIII., p. 27) have shown, we have negative ions produced in the neighbourhood of the filament, and a charge on a positively electrified body in the neighbourhood of the filament is discharged by these ions, while if the body is negatively electrified it is not discharged. If the filament is negatively, and a neighbouring body positively electrified, there will be a current of electricity between the filament and the body, while there will be no leak if the filament is positively and the body negatively electrified. Elster and Geitel (*Wied. Ann.*, XXXVIII., p. 27) showed that the rate of leak from a negatively electrified filament was at low pressures diminished by the action of the magnetic field. On the theory of charged ions, the effect of the magnet in diminishing the rate of leak could be explained in the same way as the effect on the convection due to ultra-violet light. A series of experiments were made which showed that the effects due to the magnetic field were consistent with this explanation, and led to a determination of e/m for the carriers of the negative electricity.

The apparatus was of the same type as that used in the preceding experiments. The wire gauze and the zinc plate were replaced by two parallel aluminium discs about 1·75cm. in diameter; between these discs, and quite close to the upper disc, there was a small semicircular carbon filament which was raised to a red heat by the current from four storage cells. The carbon filament was placed close to the axis of the discs; the object of the upper disc was to make the electric field between the discs more uniform. The lower plate was connected with the electrometer The plates and filaments were enclosed in a glass tube which was connected with a mercury pump, by means of which the pressure, after the vessel had been repeatedly filled with hydrogen, was reduced to 0·01mm. of mercury. Great difficulty was found at first in getting any consistent results with the incandescent carbon filament: sometimes the filament would discharge positive as well as negative electricity; indeed, sometimes it would discharge positive and not negative. Most of these irregularities were traced to gas given out by the incandescent filament; and it was found that by keeping the filament almost white hot for several hours, and continually pumping and refilling with hydrogen, and then using the filament at a much lower temperature than that to which it had been raised in this preliminary heating, the irregularities were nearly eliminated, and nothing but negative electrification was discharged from the filament. When this state was attained, the effect of magnetic force showed the same characteristics as in the case of ultra-violet light. When the difference of potential between the filament and the lower plate was small, the effect of the magnetic force was very great, so much so as almost to destroy the leak entirely; when, however, the potential difference exceeded a certain value, the magnetic force produced little or no effect upon the leak. An example of this is shown by the results of the following experiment:—

The distance between the carbon filament and the plate connected with the electrometer was 3·5mm., the strength of the magnetic field 170 C.G.S. units.

Difference of potential between wire and plate, in volts.	Leak in 5 seconds.		Ratio of leaks.
	Without magnetic field.	With magnetic field.	
40	43	1	0·023
80	170	50	0·29
120	300	250	0·83
140	345	345	1·0
160	400	430	1·07

Taking 140 volts as the critical value of the potential difference, we find by equation (1) that

$$\frac{e}{m} = 7{\cdot}8 \times 10^6.$$

The results of this and similar experiments are given in the following table; V denoting the critical potential difference in C.G.S. units, and H the magnetic force:—

d.	V.	H.	e/m.
0·35	140×10^8	170	$7{\cdot}8 \times 10^6$
0·35	220×10^8	220	$7{\cdot}5 \times 10^6$
0·35	170×10^8	170	$9{\cdot}6 \times 10^6$
0·35	130×10^8	170	$7{\cdot}2 \times 10^6$
0·35	120×10^8	120	$11{\cdot}3 \times 10^6$

* Communicated by the author to the December number of the *Phil. Mag.* Read at the Meeting of the British Association at Dover.

giving $8{\cdot}7 \times 10^6$ as the mean value of e/m. This value does not differ much from that found in the case of ultra-violet light. In the case of the incandescent filament the ions are only produced at a small part of the plate, and not over the whole surface as in the case of ultra-violet light, so the conditions do not approximate so closely to those assumed in the theory. We conclude that the particles which carry the negative electrification in this case are of the same nature as those which carry it in the cathode rays and in the electrification arising from the action of ultra-violet light.

The unipolar positive leak which occurs from an incandescent platinum wire in air or oxygen, and in which the moving bodies are positively electrified, was found not to be affected by a magnetic field of the order of that used in the experiments on the negative leak. This had already been observed by Elster and Geitel (*Wied. Ann.*, XXXVIII., p. 27).

On the theory of the effect given in this Paper, the absence of magnetic effect on the positively charged carriers indicates that e/m is much smaller or m/e much larger for the positive ions than it is for the negative. I am engaged with some experiments on the effect of the magnetic field on the convection of electricity by positive ions, using very strong magnetic fields produced by a powerful electromagnet kindly lent to me by Prof. Ewing. From the results I have already got it is clear that m/e for the positive ions produced by an incandescent wire must be at least 1,000 times the value for the negative ions, and this is only an inferior limit.

The positive and negative ions produced by incandescent solids show the same disproportion of mass as is shown by the positive and negative ions in a vacuum tube at low pressures.

W. Wien (*Wied. Ann.*, LXV., p. 440) and Ewers (*Wied. Ann.*, LXIX., p. 187) have measured the ratio of m/e for the positive ions in such a tube, and found that it is of the same order as the value of m/e in ordinary electrolysis; Ewers has shown that it depends on the metal of which the cathode is made. Thus the carriers of positive electricity at low pressures seem to be ordinary molecules, while the carriers of negative electricity are very much smaller.

Measurement of the Charge on the Ion produced by the Action of Ultra-Violet Light on a Zinc Plate.

This charge was determined by the method used by me to measure the charge on the ions produced by the action of Röntgen rays on a gas (*Phil. Mag.*, December, 1898); for the details of the method I shall refer to my former Paper, and here give only an outline of the principle on which the method is based. Mr. C. T. R. Wilson (*Phil. Trans.*, 1898) discovered that the ions produced by ultra-violet light act like those produced by Röntgen rays, in forming nuclei around which water will condense from dust-free air when the supersaturation exceeds a certain definite value.

Suppose, then, we wish to find the number of ions produced by ultra-violet light in a cubic centimetre of air. We cool the air by a sudden expansion until the supersaturation produced by the cooling is sufficient to form a cloud round the ions: the problem of finding the number of ions per cubic centimetre is now reduced to finding the number of drops per cubic centimetre in this cloud. We can do this in the following way: If we know the amount of the expansion we can calculate the amount of water deposited per cubic centimetre of the cloud; this water is deposited as drops, and if the drops are of equal size the number of drops per cubic centimetre will be equal to the volume of water per cubic centimetre divided by the volume of one of the drops. Hence, if we know the size of the drops, we can calculate the number. The size of the drops in the cloud was determined by observing v, the velocity with which they fall under gravity, and then deducing a, the radius of the drop, by means of the equation

$$v = \frac{2}{9}\frac{ga^2}{\mu},$$

where μ is the coefficient of viscosity of the gas through which the drop falls.

In this way we can determine n the number of ions per cubic centimetre: if e is the charge on an ion, u the velocity with which it moves under a known electric force, the quantity of electricity which crosses unit area in unit time under this force is equal to neu. We can determine this quantity if we allow the negative ions to fall on a plate connected with a condenser of known capacity and measure the rate at which the potential falls. We thus determine the product neu, and we already know n; u has been determined by Mr. Rutherford (*Proc. Camb. Phil. Soc.*, IX., p. 401); for air at atmospheric pressure u is proportional to the potential gradient, and when this is one volt per centimetre, u is 1·5cm. per second; for hydrogen at atmospheric pressure u is 4·5cm. per second for the same potential gradient. Hence, as in the known product neu we know n and u, we can deduce the value of e the charge on the ion.

There are some features in the condensation of clouds by ultra-violet light which are not present in the clouds formed by the Röntgen rays. In the first place, the cloud due to the ultra-violet light is only formed in an electric field. When there is no electric field, the ions remain close to the surface of the illuminated plate, and are not diffused through the region in which the cloud has to be

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formed ; to get the negative ions into this region we must electrify the plate negatively ; when this is done, expansion produces a cloud. Again, if the ultra-violet light is very strong, Mr. C. T. R. Wilson has shown (*Phil. Trans.*, 1899) that large nuclei are produced in the gas through which the light passes ; these are distinct from those produced near a metal plate on which the light falls, and they can produce a cloud with very little supersaturation ; these nuclei are not ions, for they do not move in an electric field, and the drops formed round these nuclei ought therefore not to be counted in estimating the number of negative ions. For this reason it is necessary to use ultra-violet light of small intensity, and there are in addition other reasons which make it impossible to work with strong light. I found, when working with the ions produced by Röntgen rays, that it was impossible to get good results unless the rays were weak and the clouds therefore thin. If the rays were strong, one expansion was not sufficient to bring down all the ions by the cloud ; sometimes as many as five or six expansions were required to remove the ions from the vessel. Another reason why the strong rays do not give good results is that there are slight convection currents in the vessel after the expansion, for the walls of the vessel are warmer than the gas ; this gives rise to convection currents in the gas, the gas going up the sides and down the middle of the vessel. The velocity of the convection current is added on to the velocity of the ions due to gravity ; and if the velocity of the ions is very small, as it is when the rays are strong and the drops numerous, a very small convection current will be sufficient to make the actual rate of fall of the drops very different from that of a drop of the same size falling through air at rest. All the reasons are operative in the case of ultra-violet light, and it is only when the intensity of the light is small that I have got consistent results.

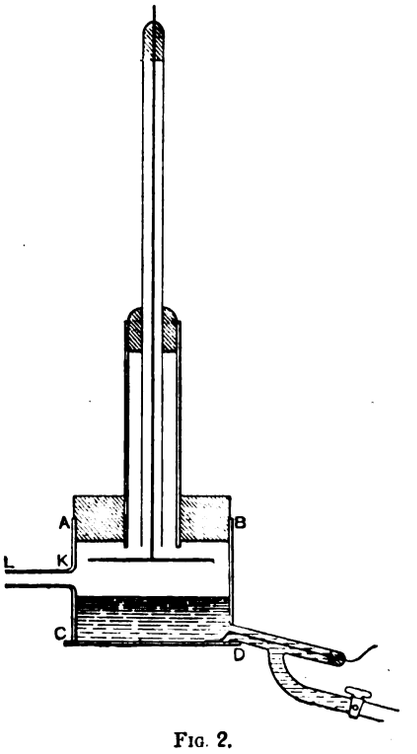

FIG. 2.

The vessel in which the expansion took place is shown in Fig. 2. AB is a glass tube about 3·6cm. in diameter ; the base CD is a quartz plate about 0·5cm. thick ; on the top of this there is a layer of water in electrical connection with the earth about 1cm. in thickness ; the illuminated zinc plate was 3·2cm. in diameter, and was 1·2cm. above the surface of the water. The ultra-violet light was produced by an arc about 0·3cm. long, between zinc terminals connected with an induction coil ; the arc was about 40cm. below the lower face of the quartz plate. The space between the zinc plate and the water surface was illuminated by an arc light so as to allow the rate of fall of the drops to be accurately measured. The tube LK connected this vessel with the apparatus used in the previous experiments ; a figure of this is given in the *Phil. Mag.*, December, 1898.

To observe the current of electricity through the gas, the illuminated plate was connected with one pair of quadrants of an electrometer, the other pair of quadrants being kept connected with the earth. The capacity C of the system, consisting of the plate, connecting wires, and quadrants of the electrometer, was determined. The plate was then charged to a negative potential, and the deflection of the electrometer needles observed. The induction coil was now set in action, and the ultra-violet light allowed to fall on the zinc plate: the deflection of the electrometer needle immediately began to decrease ; the rate at which it decreased was determined by measuring the diminution of the deflection in 30 seconds.

Let D be the original deflection of the electrometer, let this correspond to a potential difference equal to aD between the plate and the earth. If b is the distance between the zinc plate and the surface of the water, the potential gradient is aD/b. If A is the area of the plate, n the number of ions per cubic centimetre, e the charge on an ion, u_0 the velocity of the ion under unit potential gradient, then the quantity of negative electricity lost by the plate in one second is

$$Ane u_0 a\mathrm{D}/b.$$

But the plate is observed to fall in potential by ab per second, and the capacity of the system attached to the plate is C ; hence the loss of electricity by the plate per second is

$$\mathrm{C}ad.$$

Equating these two expressions for the loss of electricity, we get

$$Ane u_0 a\mathrm{D}/b = \mathrm{C}ad,$$

or

$$e = \frac{b}{nu_0}\frac{\mathrm{C}}{\mathrm{A}}\frac{d}{\mathrm{D}}.$$

Hence, knowing b, C, A, and u_0, if we measure n and d/D we can determine e.

(To be concluded.)

COMBINED REFUSE DESTRUCTORS AND POWER PLANTS.

At the meeting of the Institution of Civil Engineers, on Tuesday last, Sir Douglas Fox (President) in the chair, the Paper read was on "Combined Refuse Destructors and Power Plants," by Mr. C. Newton Russell, Assoc.M.Inst.C.E. The Paper dealt with the subject of refuse destruction, particularly in reference to its employment for raising steam ; and gave details of ten combined plants, the data of which all tended to prove that a considerable amount of energy in the form of heat was to be obtained from the burning of ordinary domestic refuse. The results obtained from eight combined plants in England and two abroad were given, the Shoreditch plant being dealt with in considerable detail, as being the largest of its kind in operation.

The total amount of refuse destroyed during a period of twelve months was about 26,000 tons, of which 92 per cent. was ordinary domestic refuse and 8 per cent. trade refuse, consisting of straw, paper, &c., &c. The latter was practically useless for steam raising. The plant consisted of six Babcock-Wilcox water-tube boilers and 12 refuse furnaces of the Manlove-Alliott type, each boiler being placed between two refuse furnaces, the hot gases from which were led into the boiler tubes through short side flues, each boiler being provided with a special grate, on which coal might be burned if required. The refuse, on arrival at the works, was carefully weighed, and was afterwards shot, without sorting, into trucks, which were raised by electric lifts (of which there were two) to the top platform. On arrival at this point the truck, which was on wheels and fitted with an electric motor, was run off the lift, on the overhead trolley system, to any position where it was desired to empty it : the refuse was then tipped into special charging trucks, one of which was provided for each furnace, and which was operated from the top platform by means of chain gearing. The average amount of refuse received per day was 84 tons, delivered between 9 a.m. and 5 p.m., although as much as 140 tons had been received in one day. It appeared to be impossible in ordinary working to guarantee a regular supply, and it was advisable to provide means of storage to cope with extra large deliveries. This difficulty was met at Shoreditch by means of a large rectangular iron storage-bin fixed under the tipping platform, and holding about 60 tons of refuse. The lifts and trucks were operated entirely by electricity. Forced air draught was supplied to the fires by electrically-driven fans, the pressure in the ashpits being 1in. of water. No coal or other fuel was mixed with the refuse, which burnt freely, the maximum temperature observed being 2,500°F., and the average, 1,500°F. Considerable inconvenience was experienced owing to cold air rushing into flues during clinkering operations, the trouble being to a great extent unavoidable, and called for a perfect system of dampers. The clinker residue amounted to 32 per cent., and was at present difficult to dispose of owing to the cartage from works to the outskirts of the town being high. The clinker was suitable for making mortar-concrete, and when ground and mixed with Portland cement made excellent paving slabs. The works were managed on the eight hour shift system seven days per week. The feed water for the boilers was drawn cold from storage tanks by

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three-throw pumps, which forced it through economisers placed in the main flues, where it was raised to a temperature of about 200°F. depending upon the heat of the flue gases and condition of economiser. The water was then forced upwards into a large feed-water storage cylinder, 30ft. by 8ft., fixed about 20ft. above the boilers, and was connected direct to the main steam line, and which was therefore at the same temperature and pressure as the boilers, which were fed directly from this cylinder by gravity, the water flowing into the boilers freely without any strain or racking action on the check-valves. The steam generated in the boilers, at an average pressure of 140lb. per square inch, was disposed of mainly by the engines attached to the electric generators, although a small portion of live steam was supplied for clothes-washing purposes to the public baths and washhouses adjoining the electricity works; exhaust steam was also supplied to the Baths and Free Library, which were entirely heated from the steam raised by the refuse destructor.

The average cost of burning the refuse during the second year of working, including four furnace men, two top men, and one charge man, supervision clerks, &c., cleaners and yard men, repairs, stores and sundries, was 2s. 6 9d. per ton. The amount of electric energy absorbed in dealing with the refuse, including electric fans, lifts, trucks, and lighting, was 4·98 Board of Trade units per ton per annum. A number of evaporative tests had been taken, with the result that with one boiler and two refuse-furnaces it was possible, by the burning of ordinary refuse, to evaporate 2,888lb. of water per hour, from and at 212°F.

The average calorific value of various tests was 0·99lb. of water per pound of refuse. The heating surface of each boiler was 1,300 square feet; the refuse grate area was 25 square feet, and the coal grate area was 27 square feet. The total amount of energy sold by meter to customers was 1,031,348 Board of Trade units, including 131,140 units supplied to the refuse destructor. The total amount of refuse burnt was 26,201 tons, and of coal consumed 1,344 tons (value £1,308. 14s. 8d.). The item of cost per ton for interest and redemption of land—not usually considered in connection with refuse destructors—was a matter for serious consideration, and in the case of the Shoreditch destructor plant—where land is very expensive—the charge worked out at practically 1s. per ton.

BOOKS RECEIVED.

(Copies of any of the undermentioned works can be had from *The Electrician* office post free, on receipt of published price.)

"The Advance of Knowledge." By W. Sedgwick. (London: George Allen.) 6s.

"Dyes, Stains, Inks, Lacquers, Varnishes, and Polishes: How to Make and Use Them." By J. Bolas. Being No. 4 of the Useful Arts and Handicrafts Series. (London: Dawbarn & Ward.) 6d. net.

ELECTRICITY WORKS ACCOUNTS.

Cardiff Municipal Electric Supply Works.

The results of the working of the Cardiff undertaking during the year which ended at March 31st last are, we must say, somewhat disappointing. The year's output at 405,234 units sold exceeded that of the preceding year by only 48,041 units or 13·4 per cent. This is a poor showing for such a town, and it should be reassuring to find that the lamp connections during the year were such as to raise the total by 25·6 per cent., thus giving a better prospect for the current year.

Up to the end of the year the total authorised capital amounted to £91,660, of which £32,500 had been borrowed and £71,018 spent, being at the rate of £68·3 per kilowatt capacity of generating plant installed.

Owing to a slight increase in the aggregate costs and a drop of 0 54d. in the average total revenue per unit, the ratio of the former to the latter has decreased from 63 per cent. to 72·1 per cent. and the resulting working profit from £2,600 to £1,967.

The allocation of the profits in the last two years has been somewhat extraordinary. In 1897-8 the total balance available for distribution was £1,246. Out of this amount £1,019 was applied in aid of the rates, leaving a small balance of £227 brought forward to 1898-9. Chiefly on account of reductions in the tariff the result of this last year's working was a deficit of £1,068, which has been met to the extent of £650 by the rates, £190 being carried forward to next year.

Among the generating costs the items of fuel and repairs and maintenance at the station have risen, but they still show satisfactory figures. Unfortunately, the other two items of generating costs are rather high, with the result that both works and total costs are, we should say, quite 0·5d. above what they should be at the output.

Newport Municipal Electric Supply Works.

The Newport municipal electric supply undertaking commenced supply on October 14, 1895, and our table therefore presents the results of the second and third completed years of working.

At March 31st last the total capital authorised stood at £80,815, the borrowed capital amounting to £39,000 exclusive of £4,181 value of lands appropriated for electrical purposes. Including this amount of £4,181, the total capital expenditure up to the above date was £69,880, or at the rather high rate of £155 per kilowatt of generating plant installed.

A glance at the following table serves to show that the steady progress which has attended the undertaking from the first is, on the whole, being well maintained:—

Year ended March 31.	No. of consumers.	No. of lamps connected.	Output units sold.	Plant capacity. KW.	Max. supply demanded. KW.	Total costs per unit.	Total rev. per unit.	Gross profit. Actual	Gross profit. % of mean. cap.
1897	130	11,994	195,932	375	192	3·54*d.*	4·25*d.*	£576	1·43%
1898	204	17,722	250,677	375	296	2·79*d.*	4·43*d.*	1,716	3·78%
1899	287	24,707	322,638	450	392	2·82*d.*	4·56*d.*	2,344	3·99%

Last year, with 83 additional consumers, the lamp connection rose from the equivalent of 17,722 8 c.p. lamps to 24,707—an excellent advance of no less than 39·4 per cent. In respect of output the year 1897-8 was better than the preceding one by 28·1 per cent. Last year showed an increase of 28·6 per cent., the output being 322,638 units sold.

The costs in the aggregate have risen, but at 2·82d. per unit they cannot be complained of. The increase is due to a very decided rise in the management charges, all the items under this head showing increased expenditure.

Among the generating costs the items of wages and oil, water and stores are rather high, but the fuel charge, although it has naturally risen, is still very satisfactory. In the item of repairs and maintenance Newport maintains the excellent character already earned, the expenditure on this score remaining no more than 0·034d. per unit.

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

Aberdeen (Municipal)	Jan. 6, 1899	Kingston-on-Thames (Mun.)	April 21, 1899
Ayr (Municipal)	Sept. 22, ,,	Lancaster (Municipal)	Oct. 21, 1898
Bedford (Municipal)	May 19, ,,	Leeds (Municipal)	Dec. 1, 1899
Belfast (Municipal)	Sept. 15, ,,	Leicester (Municipal)	Jan. 20, ,,
Birmingham (Company)	Sept. 15, ,,	Leyton (Municipal)	Sept. 8, ,,
Blackpool (Municipal)	Sept. 29, ,,	Liverpool (Municipal)	June 9, ,,
Bournemouth (Company)	April 29, ,,	Manchester (Municipal)	Aug. 11, ,,
Bolton (Municipal)	Nov. 24, ,,	Newcastle and District (Co.)	Oct. 6, ,,
Bradford (Municipal)	April 14, ,,	Newcastle-upon-Tyne (Co.)	April 14, ,,
Brighton (Municipal)	May 12, ,,	Northampton (Company)	Oct. 20, ,,
Bristol (Municipal)	July 14, ,,	Norwich (Company)	Nov. 17, ,,
Burnley (Municipal)	Aug. 25, ,,	Notting Hill (Company)	Mar. 17, ,,
Burton-upon-Trent (Mun.)	April 21, ,,	Nottingham (Municipal)	July 21, ,,
Bury (Municipal)	Sept. 22, ,,	Oldham (Municipal)	Dec. 1, ,,
Cambridge (Company)	Mar. 10, ,,	Oxford (Company)	May 19, ,,
Cardiff (Municipal)	Jan. 6, ,,	Pontypool (Company)	May 5, ,,
Charing Cross (Company)	Mar. 17, ,,	Portsmouth (Municipal)	July 14, ,,
Chelsea (Company)	Mar. 31, ,,	Prescot (Company)	Dec. 8, ,,
Cheltenham (Municipal)	Nov. 10, ,,	Preston (Company)	Sept. 29, ,,
Chester (Municipal)	June 23, ,,	Reading (Company)	Oct. 13, ,,
City of London (Company)	May 12, ,,	Richmond (Company)	Oct. 13, ,,
Clerkenwell (Company)	Aug. 18, ,,	Scarborough (Company)	Nov. 3, ,,
Derby (Municipal)	Dec. 9, 1898	St. Helens (Municipal)	Dec. 8, ,,
Dewsbury (Municipal)	Nov. 24, 1899	St. James' & Pall Mall (Co.)	Feb. 24, ,,
Dover (Company)	June 2, ,,	St. Pancras (Vestry)	May 26, ,,
Dundee (Municipal)	Nov. 4, 1898	Sheffield (Company)	Dec. 16, 1898
Eastbourne (Company)	July 22, ,,	Shoreditch (Vestry)	Oct. 27, 1899
Edinburgh (Municipal)	Nov. 17, 1899	Southampton (Municipal)	Nov. 10, ,,
Exeter (Municipal)	Aug. 5, 1898	Southport (Municipal)	July 7, ,,
Glasgow (Municipal)	Sept. 1, 1899	South Shields (Municipal)	July 7, ,,
Guildford (Company)	May 5, ,,	Stafford (Municipal)	Oct. 21, 1898
Halifax (Municipal)	July 21, ,,	Sunderland (Municipal)	July 28, 1899
Hammersmith (Vestry)	May 26, ,,	Taunton (Municipal)	June 16, ,,
Hampstead (Vestry)	Aug. 25, ,,	Tunbridge Wells (Mun.)	Sept. 1, ,,
Hanley (Municipal)	April 28, ,,	Wakefield (Municipal)	Dec. 1, ,,
Harrogate (Municipal)	Oct. 20, ,,	Walsall (Municipal)	June 23, ,,
Harrow (Company)	June 16, ,,	Wandsworth (Company)	Aug. 15, ,,
Hast'gs & St. Leonards (Co.)	April 29, 1898	Westminster (Company)	Feb. 24, ,,
H'use-to-H'useCo. (K'ns'gt'n)	Mar. 31, 1899	Whitehaven (Municipal)	July 28, ,,
Hove (Company)	Mar. 10, ,,	Windsor (Company)	Dec. 30, 1898
Huddersfield (Municipal)	Oct. 6, ,,	Wolverhampton (Municipal)	June 30, 1899
Islington (Vestry)	Oct. 27, ,,	Woolwich (Company)	Jan. 13, ,,
Kens'gton & Knightsbr' (Co.)	Mar. 3, ,,	Worcester (Municipal)	April 7, ,,
Kingston-upon-Hull (Mun.)	June 9, ,,	Yarmouth (Municipal)	Nov. 3, ,,

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	CARDIFF.		NEWPORT (MON.).	
Undertaking Worked by	Cardiff Corporation.		Newport Corporation.	
Date of Commencement of Supply	December, 1894.		October 14, 1895.	
System of Supply	Alternate-current transformer sub-stations.		Alt.-cur. transformer sub-stations, 2 and 3-wire.	
Chief Engineer	N. Appelbee.		C. D. Copland.	
YEAR ENDED	MAR. 31, **1898.**	MAR. 31, **1899.**	MAR. 31, **1898.**	MAR. 31, **1899.**
QUANTITIES—				
Units generated	480,538	522,040	390,789	451,560
„ SOLD (TOTAL)	357,193	405,234	250,877	322,638
„ sold to consumers	259,828	305,534	150,017	218,034
„ sold for public lighting, &c.	97,365	101,700	100,860	104,604
„ used on works	5,004	21,274	16,420	14,836
UNITS SOLD PER 8 C.P. LAMP CAPACITY	26·0	12·5	21·4	22·9
Maximum supply demanded	375 kilowatts	420 kilowatts	296 kilowatts	392 kilowatts
Number of public lamps	52	61 arc, 12 glow*	42 arc	42 arc
Number of consumers	184	251	204	287
Connections to mains in 8-c.p. lamps	17,112	21,498	17,762	24,707
CAPACITY OF PLANT IN 8-C.P. LAMPS	13,750	32,500	11,720	14,060
CAPACITY OF PLANT IN KILOWATTS	440	1,040	375	450
CAPITAL—	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.
AUTHORISED (TOTAL)	£59,835 / £136	£91,660 / £88·0	£74,665 / £199	£80,815 / £180
Share	— / —	— / —	— / —	— / —
Loan (including Debenture charges)	59,835 / 136	91,660 / 88·0	74,665 / 199	80,815 / 180
RECEIVED (TOTAL)	32,500 / 73·9	32,500 / 31·3	41,561[a] / 111	43,181[g] / 96·0
Share	— / —	— / —	— / —	— / —
Loan (including Debenture charges)	32,500 / 73·9	32,500 / 31·3	39,000 / 104	39,000 / 86·6
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	27,335 / 62·1	59,160 / 56·9	35,665 / 95·1	41,815 / 92·9
Share (unissued)	— / —	— / —	— / —	— / —
Share (uncalled)	— / —	— / —	— / —	— / —
Loan (including Debentures)	27,335 / 62·1	59,160 / 56·9	35,665 / 95·1	41,815 / 92·9
REPAID (TOTAL)	— / —	— / —	nil / —	nil / —
RESERVE OR SINKING FUND	2,621 / 5·96	3,529 / 3·39	1,593 / 0·42	—[f] / —
DEPRECIATION FUND	— / —	— / —	nil / —	nil / —
EXPENDED (TOTAL)	62,430 / 142	71,018 / 68·3	47,606 / 127	69,880 / 155
Lands and buildings	14,358 / 32·6	15,241 / 14·7	10,149 / 27·1	17,102 / 38·0
Plant	22,770 / 51·8	26,228 / 25·2	20,956[h] / 55·9	30,441[h] / 67·7
Mains	19,990 / 45·4	22,620 / 21·7	12,983 / 34·6	18,261 / 40·6
Miscellaneous	5,309 / 12·1	6,929 / 6·66	3,519 / 9·38	4,076 / 9·06
BALANCE OF CAPITAL ACCOUNT	−29,930[a] / −68·0	−38,518[a] / −37·0	−6,045[b] / −16·1	−26,699[b] / −59·4
REVENUE—	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.
TOTAL	£7,026 / 4·720d.	£7,056 / 4·179d.	£4,632 / 4·430d.	£6,135 / 4·563d.
Revenue from supply	5,984 / 4·020d.	5,927 / 3·501d.	3,373 / 3·233d.	4,813 / 3·580d.
„ meters, &c.	117 / 0·079d.	140 / 0·083d.	134 / 0·128d.	187 / 0·139d.
„ public lighting	925 / 0·622d.	987 / 0·585d.	1,069 / 1·023d.	1,083 / 0·806d.
„ sale of lamps, &c.	— / —	— / —	48 / 0·046d.	52 / 0·039d.
„ miscellaneous sources	— / —	2 / 0·001d.	3 / 0·003d.	— / —
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	£4,427 / 2·974d.	£5,088 / 3·014d.	£2,915 / 2·789d.	£3,790 / 2·820d.
WORKS COSTS	3,578 / 2·405d.	3,918 / 2·321d.	2,217 / 2·122d.	2,837 / 2·112d.
Generation of electricity	*3,069 / 2·062d.*	*3,392 / 2·009d.*	*1,948 / 1·864d.*	*2,462 / 1·832d.*
Fuel (including cartage, &c.)	872 / 0·586d.	1,100 / 0·652d.	582 / 0·557d.	897 / 0·668d.
Oil, waste, water, stores	499 / 0·335d.	482 / 0·285d.	253 / 0·242d.	293 / 0·218d.
Wages at station	1,460 / 0·981d.	1,403 / 0·831d.	1,080 / 1·034d.	1,227 / 0·913d.
Repairs and maintenance at station	238 / 0·160d.	322 / 0·191d.	34 / 0·033d.	45 / 0·034d.
Distribution of electricity	*243 / 0·163d.*	*262 / 0·155d.*	*86 / 0·082d.*	*126 / 0·094d.*
Wages, &c.	89 / 0·060d.	47 / 0·028d.	54 / 0·052d.	43 / 0·032d.
Repairs, renewals of mains, &c.	154 / 0·104d.	215 / 0·127d.	32 / 0·031d.	83 / 0·062d.
Public lighting	*266 / 0·179d.*	*264 / 0·156d.*	*182 / 0·174d.*	*249 / 0·185d.*
Attendance	147 / 0·099d.	178 / 0·105d.	182 / 0·174d.	249 / 0·185d.
Renewals	119 / 0·080d.	86 / 0·051d.		
MANAGEMENT AND PROPERTY CHARGES	849 / 0·571d.	1,170 / 0·693d.	697 / 0·667d.	953 / 0·709d.
Royalties	— / —	— / —	— / —	— / —
Rent, rates, taxes	*80 / 0·054d.*	*217 / 0·129d.*	*185 / 0·177d.*	*132 / 0·135d.*
Management	*769 / 0·517d.*	*953 / 0·564d.*	*512 / 0·490d.*	*771 / 0·574d*
Salaries	570 / 0·383d.	701 / 0·415d.	389 / 0·372d.	610 / 0·454d.
Stationery, &c.	59 / 0·040d.	97 / 0·057d.	26 / 0·025d.	36 / 0·027d.
Establishment charges	54 / 0·036d.	47 / 0·028d.	22 / 0·021d.	45 / 0·033d.
Law charges, &c.	86[b] / 0·058d.	107[c] / 0·063d.	75[c] / 0·072d.	81[c] / 0·060d.
FINANCIAL RESULTS—	Total / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded
WORKING PROFIT FOR YEAR	£2,600 / 4·64%	£1,967 / 2·95%	£1,716 / 3·78%	£2,344 / 3·99%
Sum carried to Depreciation Fund	— / —	— / —	— / —	— / —
Sum carried to Reserve or Sinking Fund	848 / 1·51%	845 / 1·27%	788 / 1·73%	1,076 / 1·83%
Net interest on loans (incl. Debenture charges)	1,667 / 2·98%	2,166 / 3·25%	1,362 / 3·00%	1,560 / 2·66%
BALANCE FROM LAST ACCOUNT	1,186 / 2·12%	227[f] / 0·34%	−262[d] / 0·58%	305[i] / 0·52%
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	1,246[c] / 2·23%	— / —	— / —	12 / 0·02%
Deficit	— / —	*841[g] / 1·26%*	*695 / 1·53%*	— / —
ORDINARY DIVIDEND PAID	— / —	— / —	— / —	— / —
PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE	63·0%	72·1%	63%	61·8%
Expenditure per kilowatt capacity	£10. 1s. 2d.	£4. 17s. 10d.	£7. 15s. 7d.	£8. 8s. 5d.
REVENUE PER KILOWATT CAPACITY	£15. 19s. 2d.	£6. 15s. 7d.	£12. 7s. 0d.	£13. 12s. 7d.
Expenditure per 8-c. lamp capacity	6s. 5½d.	3s. 1½d.	4s. 11¾d.	5s. 4¾d.
REVENUE PER 8-C.P. LAMP CAPACITY	10s. 2½d.	4s. 4d.	7s. 10¾d.	8s. 8½d.
REVENUE PER 8-C.P. LAMP CONNECTED	8s. 2½d.	6s. 6¾d.	5s. 2¾d.	4s. 11½d.
Price charged for lighting, per unit	6d. to 3½d.[d]	6d. to 3d.[d]	6d. to 4d.[e]	6d. to 4d.[e]
Price charged for power, per unit	3d.	2½d. to 2d.	2d.[e]	2d.[e]
Price charged for public lighting	£18 per lamp per ann.	£18 per arc per ann.[h]	£25 per arc per ann.	£25 per arc per ann.

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blished every Friday, Price Sixpence; Post Free, Sixpence-Halfpenny
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Telephone: 949 Holborn. *Telegrams:* "ELECTRICIAN NEWSPAPER LONDON."

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HIGH VOLTAGES AND LONG-DISTANCE TRANSMISSION.

When Prof. GEORGE FORBES read his Paper on "Long-Distance Transmission of Electric Power," at the Society of Arts a year ago, he spoke of the possibility of transmitting power economically over distances of 250, 300 and 500 miles, but only one short paragraph in the Paper was devoted to the all-important question of choosing the pressure at which current was to be conveyed along the transmission line. "The only point affecting the cost," he said, "which has been left to the choice of the engineer, is the electric pressure to be used. . . . In old days the highest pressure for which we could get a guarantee from contractors was used. But expense of insulation increased so much with increase of pressure, that now, as at Rheinfelden, we work at that pressure which is most economical. Manufacturers will now guarantee any pressure if you will pay for it." On the other hand, an article on practically the same subject by Dr. LOUIS BELL, in the December number of *Cassier's Magazine*, discusses the "Practical Limitations of Electric Power Transmission" entirely from the point of view of the fundamental question being the limit of practicable voltage. Dr. BELL reminds his readers that the cost of copper for the transmission line varies inversely as the square of the working voltage, and then proceeds to consider the various phenomena that occur when the voltage is increased. Ten thousand volts he considers the standard working pressure for transmission purposes, it being quite possible to insulate efficiently lines carrying currents at this voltage under the severest conditions of weather and climate. As the pressure is increased beyond this figure to 20,000 volts, except for the necessity of taking still greater care in the testing of insulators and of providing a greater factor of safety for them, the conditions remain more or less the same. Transformers for stepping-up and stepping-down the pressure are not much more expensive than for lower voltages, and the increase in the "striking distance," although considerable, is not serious. At 20,000 volts the lines begin to be faintly luminous at night-time (for Dr. BELL's remarks refer primarily to overhead transmission lines), but this static leakage does not represent any appreciable loss of energy. At 40,000 volts this loss is "very perceptible . . .

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though not material," but from 50,000 to 60,000 volts the static discharge becomes so great as to be prohibitive. To insulate the wires themselves cannot afford a permanent relief, while to increase the distance between them may mitigate the evil, but will not cure it. One might place the conductors in tubes containing oil, which has a greater resistance to disruptive discharge than air, but this would increase the capacity of the system, and cause troubles due to "resonance," which is referred to by Dr. BELL in somewhat vague terms.

Dr. BELL sums up, therefore, to the effect that voltages of 10,000 to 40,000 are being worked successfully, the former being "well-tried and conservative," the latter somewhat experimental as yet. Having satisfied himself as to the question of voltage, he next turns his attention to distance, which resolves itself into a commercial consideration dependent on local circumstances. Generalising, however, from the examination of a number of concrete cases, and taking transmissions of 500 or 1,000 kilowatts, he judges that over distances of 15 to 25 miles a scheme will pay if the output can be marketed. From 25 to 50 miles the circumstances must be rather favourable for a scheme to pay. From 50 to 100 miles the chance of success is smaller, and exists only if the enterprise be large, while beyond 100 miles commercially successful power transmission does exist but is rare.

Let us examine now how far these conclusions will apply in this country. We are faced at the outset with the question whether overhead transmission lines will be permitted by those in authority. While it is extremely doubtful whether a much higher voltage than that customarily employed on tramway circuits will be countenanced in the thickly populated districts where some of the new extensive power distribution schemes will be realised, yet there are other projects—*e.g.*, in the Highlands and in Ireland—for which bare overhead conductors appear particularly well adapted. Our climatic conditions would probably prevent the employment of anything like the maximum pressures declared feasible by Dr. BELL, and, moreover, the shorter distances over which the power would have to be transmitted would render such high voltages unnecessary. Nevertheless, it should not be forgotten that the districts in the Far West where these high pressures are in vogue are visited by heavy snowstorms, which must be at times as trying to the insulation of the line as our perpetual dampness would be. Looking nearer home, we find the 16,000 line from Spiez to Thun in Switzerland, which transmits power to the Burgdorf-Thun railway and to Berne, running for a considerable distance alongside the Lake of Thun, and several spans of it supported above the water at some yards from the shore of the lake. It seems probable therefore that, if bare high-pressure overhead transmission lines are to be permitted in this country, the limiting pressure would be fixed by the powers that be at some point between 10,000 and 20,000 volts.

Descending from the realm of overhead lines and conjecture to that of underground cables and Board of Trade regulations, we find that the limit of "high pressure" is placed at 3,000 volts, beyond which the region of "extra high pressure" is entered. This extra high pressure is mentioned only in two of the Board of Trade regulations, Nos. A2 and A3. These direct that no extra high pressure is to be brought within a consumer's premises or, in fact, anywhere except in distributing stations or other premises in the sole occupation of the undertakers, and that only with the written consent of the Board of Trade and subject to such regulations and conditions as the Board may prescribe. There is no evidence that the Board of Trade has been at all tyrannical in the extra "regulations and conditions" it may have prescribed from time to time for extra high pressures, and yet these voltages have been adopted in very few instances in this country, notwithstanding the fact that it was an English station (that at Deptford) which was the first to generate electricity on a commercial scale at 10,000 volts. Another significant fact is that this pressure of 10,000 volts has not yet been exceeded on transmission systems with underground cables, although we believe that this is shortly to be done in a large power scheme in progress in the United States. For ordinary alternate-current transformer distribution a higher pressure than 3,000 volts precludes the placing of transformers and sub-stations in consumers' premises (it is surprising how few high-pressure supply systems have approached even this maximum "high pressure" of 3,000 volts), but in the case of lines used purely for transmission and not for distribution purposes why make even 10,000 volts a limit? Step up and step-down transformers with high-pressure windings insulated for 15,000 or even 20,000 volts would cost but little more than those for 10,000 volts. In the present condition of cable manufacture many firms would willingly undertake the production of cables for this higher pressure; and here again the radial thicknesses of insulation employed for 10,000 volts would not have to be greatly increased to withstand 15,000, nor would the jointing be any more expensive. An extra item of cost would be in the end connections; but taking it altogether, where the distance of transmission exceeded a few miles there is little doubt that higher pressures will pay to use. If therefore the Board of Trade does not fix a limit of extra high pressure at 10,000 volts, it is reasonable to anticipate that this limit will be exceeded in some of the new power transmission schemes in this country.

FRENCH CABLE PROJECTS.

Periodically our neighbours across the Channel become greatly concerned on the subject of submarine cables all over the world being mainly in English hands. And the fact that it has been found necessary by our military authorities to prohibit the use of code even in the messages of foreign Governments to or from South Africa, lest information should be given to the enemy, has once more raised the question, which is being vigorously discussed in the French Press and considered by the Colonial committee in Paris with a view to seeing what can be done to connect the French colonies with the mother country by means of French cables. It is not unlikely that some of the projected lines will be laid, but it may be said at once that their strategic and commercial value will of necessity be small, because there is not a sufficient number of French commercial ports of any importance *en route* to be used as calling places for the cables. The following are the proposed systems:—

1. A cable from Oran, Algeria, to Senegal, a distance, with 10 per cent. of slack, of 1,925 nauts. This is estimated to cost £400,000, or an average of nearly £208 per naut.

2. Cables between Europe and Madagascar, &c, starting from Bona to El Arich (Southern Syria), thence by the Turkish land line to a point on the Red Sea, thence to Djibouti, Diego Saurez, and Reunion. The cable distance is 6,050 nauts, and the cost is put down at £1,800,000, which works out at the very high average of over £297 per naut. A land line of 100 miles in this project, worked by Turkey, will not add to its commercial or strategic value in the directions of accuracy and speed, and none of the points of call of the cable are likely to yield much traffic. Doubtless, even if these lines are laid, French merchants will continue to use existing routes.

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8. It is proposed to purchase the cable between Cochin China and Tonkin, and to lay a cable to connect Tonkin with the lines of the Great Northern Telegraph Co., which connect with the Russian land system, the expense being borne by the Indo-China budget. This project has been formed with insufficient knowledge of the case, and will probably not be found to be feasible.

4. Then it is proposed to extend the Senegal cable to Conakry, Grand Bassam, and Gaboon, a cable distance of 2,444 nauts, to cost £400,000, or an average of £163 per naut, the cables being comparatively short.

5. A cable from Djibouti to Saigon, probably touching at Pondicherry. This distance would be 5,300 nauts, and is reckoned to cost £1,200,000, or an average of £226 per knot.

6. It is intended to study the development of American and German interests in the Pacific, to profit by their projects in order to connect the French possessions with the general telegraphic system.

Finally, the committee estimates at less than £4,000,000 the total expense of establishing these new systems, and it is proposed to bring a bill before the French Parliament to provide for the carrying out of these lines.

An interesting table is set out of the development under cable connection of the commerce of the British colonies, which shows that, starting in 1871 with 37,000 kilometres of cables and 2,835 millions of francs commerce between England and her colonies, the lengths of cables and volume of trade annually increased until in 1894 they were 276,468 kilometres and 6,121 millions of francs respectively.

The proposed French systems, consisting of single lines of considerable length, would not afford security of communication in time of peace, and could easily be interrupted in time of war; while the fact that the sections would not connect important business centres makes it practically certain that the cables would be worked at loss, which would only be increased by duplication. It will be seen, too, that the estimated costs of the cables are given in highly-inflated figures.

A long and animated discussion took place on the 8th inst., in the French Chamber of Deputies, on the subject of the protection of the colonies and the necessity for their connection by French cables with the mother country on strategic and commercial grounds. Several speakers asserted that the Parliament would vote any number of millions of francs necessary to establish such submarine lines under French control, and M. Decrais, the Minister of the Colonies, promised to bring in a bill on the subject shortly. When this is done it will be interesting to see whether the undoubted difficulties in the way will be recognised by those who support the project.

THE COST OF STEAM RAISING.

The following is an abstract of the discussion which took place on December 7th in connection with Messrs. Holliday and Crompton's Papers on the above subject, at the Institution of Electrical Engineers. Speakers who have returned their proofs corrected are denoted by an asterisk :—

Thursday, November 23.

* Mr. S. Z. DE FERRANTI said that this was the time of the year at which many central station engineers realised what a very difficult problem that of steam generation was. He thought he was right in saying that where difficulty existed in electric supply, the greatest difficulty of all was that of properly generating the steam for running the engines. The question of fuels had been largely dealt with in the Papers, and there was throughout the country, and more especially in London, the greatest trouble at present (through the large amount of coal taken by the Government) in obtaining coal of the desired class when it was wished to force the boilers to their maximum capacity. With regard to cheap fuels as against expensive ones, he had found at the works of his own firm that in generating the current for running the motors, &c., they had gained considerably by using very cheap fuels. They had had no trouble in getting rid of the clinker, therefore this question could be put on one side, although in this matter they were in a better position than in most ordinary towns. The difficulty which did arise was that when they had been running with this cheaper fuel for a number of months with satisfactory results the supply became exhausted and the price rose, so that it was impossible to judge to what extent the use of certain fuels tended to cheapen the cost of raising the steam. With regard to economic working and continuity of working, he thought it very important to have a sufficiently large combustion chamber. The great difficulty was that the hot flame impinged directly upon the cold surfaces, and so combustion was not so complete as it should be. What Mr. Crompton had shown them of his special form of incandescent arch for assisting combustion would, he thought, give a very much better economy. His own experience, unfortunately, was that the furnaces of many electric light boilers at certain times were very much like a blast furnace, and so great was the heat that there was a rapid slaging down of the side linings of the furnaces. A great expense therefore was incurred in maintaining the brickwork, and also in renewing it. A very vital thing in the economy of steam generation for large plants and in electric generating plants in particular was to have a sufficient spare at the worst time of the year, so that cleaning operations could go on all the year round. The efficiency of a boiler decreased very quickly as it was continuously worked, and therefore one of the greatest difficulties in getting good economy was to have sufficient reserve to be able to work the boilers economically and to be able to clean them most systematically and thoroughly at all times of the year.

*Mr. C. E. STROMEYER, dealing first with Mr. Holliday's Paper, said that it was an exceedingly valuable one on account of the detailed information it contained, and this also made it difficult to say much about it, but he had drawn one or two conclusions from it, one of which was that it cost about two shillings per ton to handle coal refuse. This addition should, therefore, always be made to the price of impure coal to get at its true cost. This Paper, also, seemed to confirm his view that impure coal was less efficient than the chemical analysis would make it appear, and he found that to arrive at the practical heating value of coal about 140 per cent. of the contained ash, &c., should be deducted instead of the net amount. This, together with freight and the handling of the refuse, made dirty coal very much dearer than would at first sight appear. If it took 1lb. of pure coal to evaporate a certain quantity of water the amount with 10 per cent. of ash, would be 1⅛lb. ; with 20 per cent. of ash, 2½lb. ; and with 30 per cent. of ash, 4⅓lb. ; so that with 30 per cent. of ashes the value of the fuel was reduced to one-quarter—that was to say, they would require about four times as much fuel with 30 per cent. of ashes in it than if there were no ashes at all. It was quite true, as Mr. Crompton had said, that as soon as colliery proprietors found the demand for slack increased up went the price. Another interesting instance of this increase of price with the increased demand was in the use of the shale oils of Scotland. Three times the attempt had been made to use this oil for fuel on board steamers, and in every case the price increased. In fact, so uneconomical was it found to be that in each case the oil-burning furnaces had to be removed and the ordinary grates substituted again. Referring to the first table in Mr. Crompton's Paper, he drew attention to the figures of 12·7 in the case of the St. Pancras boiler and 3·22 in the case of the Glasgow boiler given as the amount of heat radiated and otherwise unaccounted for. If the two boilers were similar, it appeared likely that something was wrong here. Probably it was in the estimate of the amount of heat carried off by the gases. He did not believe that 25 per cent. was carried away as stated, and the error was very likely due to the sampling of the gases. He had collected some information on this point, and explained how the quantity of gas could be estimated. One method was by analysing the gases—viz., find the quantity of carbonic acid in the gases, and from that calculate the ratio of the coal to the gases; and in that way they would know the quantity passing through the furnaces. Another way was to ascertain the quantity of heat abstracted by the economiser. He believed this method was pointed out by Prof. Reynolds. Measure the quantity of heat taken up by the economiser and the heat which the gases lose. These two must be equal. They could be measured by the fall of temperature in one case and by the rise in the other case. They would know the weight of the feed water, and therefore the weight of the gases was at once known. He had compared the tests made with both these systems on the same boiler by two independent experts. The highest result obtained with the economiser system was 26 per cent. in excess of the gas analysis system, the other extreme case gave by the gas analysis 26 per cent. in excess of the economiser method. Therefore, he did not feel inclined to attach the great importance which was usually attached to the determination of the quantity of gases, and the matter required very careful consideration. Mr. Longridge had made some experiments as to the different temperatures of the gases at various heights of the flue, which were rather discouraging. There was a great difference between the top and the bottom, and they did not quite get at the mean temperature of the gases which left the flue. Mention had been made of turning fuel into gas by the Mond method. But as this process was invented specially for the production of ammonia, and was very suitable for that purpose, it would not always work where there was not sufficient hydrogen in the coal. There were certain coals which would work well with this system and certain which would not, but as soon as it was found which did work the best, the price would go up. Then Mr. Crompton had recommended externally fired boilers, for the reason that it was possible to have a very much larger grate. He quite agreed that this was an advantage, but externally fired boilers had always been unsatisfactory. The best known type of this boiler was the egg-ended boiler, but the plates were always cracking, the scale settled down over the fires, and it generally gave a deal of trouble, and was considered exceeding unsafe. The other extreme was, of course, the water-tube boiler, which, while being much safer, suffered from the same disadvantage as the externally fired boiler—viz., the scale settled on the surface which was directly over the fire, and they then had trouble. The members of the Manchester Steam Users' Association disliked this type of boiler from experience, as they had been used to the Lancashire type, which worked for many years without giving trouble. With a water-tube boiler troubles were frequent, and as soon as there was a leakage the boiler had to be stopped all of a sudden and the whole mill thrown out of gear, whereas by using a Lancashire boiler they could go on with their work quite quietly until the end of the week and then see to the repairs. Probably in large electric installations this question

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did not matter so much, as there were usually a good many spare boilers, and they could put one to work in the place of the doubtful one. In fact, it was his opinion that electric stations should be supplied with a very large amount of spare boiler plant. He doubted very much if the full advantage of externally fired boilers was reaped if they had a brick combustion chamber. He was inclined to think that a very fair combination of systems was to be found in the type in which the initial combustion took place inside the boilers, and then the gases turned into the boiler and the heat abstracted. This is a modified marine boiler and best known under the name of dry back boiler.

*Mr. DUGALD CLERK warned the members against one or two things in Mr. Crompton's Paper. In the first place, he thought it quite a mistake to suppose that a gas producer was ever going to do any good in connection with a steam boiler. All attempts at arranging gas producers to convert fuel into gas up to the present had failed, and for a very easily understood reason. If they took a fuel like pure carbon, and wished to convert it into gas (of course the large majority of fuels had a very large proportion of carbon), they must convert the fuel into CO and then this into CO_2 in the fire. In consequence, if the producer was altogether outside the furnace, the gas produced never gave more than about 70 per cent. of the total heat possible by the combustion of the fuel. In a gas producer like the Dowson or Wilson they would find that they never got more than 70 per cent. of the heat of the coal which they had made into gas; the other 30 per cent. had gone in the losses in the producer. The only way to avoid this was so to arrange matters that there was no producer loss—*i.e.*, have the whole producer inside the boiler; but this had always been found to be impossible. Therefore, except in very exceptional circumstances, he considered that gas producers were not "in it" unless with some exceptionally cheap fuel which could not be burnt in any other way. He quite agreed with Mr. Stromeyer that water-tube boilers were not satisfactory to the ordinary manufacturer. He had had a great deal of experience with them, and it had sometimes been his unfortunate duty to have to turn them out and replace them with Lancashire boilers. A water-tube boiler, such as the Babcock and Wilcox, had a very great advantage compared with a Lancashire, when it was required to get it into a small space or when it was necessary to have a high pressure of steam; but they should carefully consider the efficiency of the boiler and the efficiency of the engine, and in some cases they would find it pay them better to stick to lower pressures and a better and more economical boiler. In Mr. Crompton's table he noticed the amount of heat radiated and otherwise unaccounted for was given at 12·7 per cent. in one case, but with the Glasgow boiler only 3·22. But this was absurd, as no Babcock and Wilcox boiler would give such a low loss in radiation. There was something wrong with it.

Mr. CROMPTON: But it was Mr. Longridge's test.

*Mr. CLERK said it was quite obvious that if they had a furnace in the middle of the water, as was the case in the Lancashire boiler, they would only have the ordinary radiation losses that they had in any boiler. They might have a little incomplete combustion, but in the Lancashire boiler the highest efficiency was obtained when the combustion was slightly incomplete.

*Mr. H. W. MILLER had been experimenting on special smoke-consuming fire bridges for the purpose of improving the combustion, and more especially for the purpose of reducing the smoke produced by boilers of the Babcock-Wilcox type, and he had achieved a certain amount of success. At the present time, on account of the production of smoke, station engineers were bound to burn coals that were almost smokeless, and consequently did not get the best results. It was well known that in the ordinary pattern of Babcock and Wilcox boiler there was no real combustion chamber. Gases rose from the furnace and immediately went among the tubes, and the temperature dropped before the gases reached the so-called combustion chamber on the top of the tubes. The object of putting this special fire-brick smoke-consuming bridge was to raise the temperature to the necessary point to complete combustion. He had found, by using a pyrometer, that in an ordinary boiler the temperature of gases at the top of the tubes measured from 800° to 1,000°, which was much too low to complete combustion; but by fixing the fire bridge, which consisted of a large mass of fire-brick with hollow spaces through which hot air is introduced, the temperature at the back of the bridge was from 1,200° to 1,600°, and if one looked inside the boiler at this point one would see it was full of flame. Referring to the illustrations of the Babcock and Wilcox chain grate and Mr. Crompton's improved fire-brick arch, he said that in some new boilers he was having built for his company he had provided an extra combustion chamber, so that he hoped to burn the North Country coal. In order to accomplish this the whole of the tubes of the boiler had been lifted up 2ft. and a second arch put in. A large combustion chamber was formed in this space which was entirely lined with fire-brick material, and into this space a certain amount of hot air was let in. By this means he hoped to improve the combustion so much that he would not be obliged to burn the Welsh smokeless coal.

*Mr. B. BLOUNT said there had been several chemical questions raised on which he would like to comment. The first was the determination of the efficiency of the burning of the fuel by the analysis of the gases that came away from the furnace. Figures had been given from time to time as to the percentage of CO_2 in these gases, and these often approached the amount of the oxygen from which they had been formed, and considering there was a certain amount of hydrogen in the fuel, this was absurd. When they passed from this region of myth and came to actual facts, they discovered that some users of special forms of boilers, grates, and the like got really remarkable results—12 per cent., and so on. Personally he had analysed a great many gases of this kind, and did not find anything of the sort. He had found something like 10 or 11 per cent.—not more. Then there was another question. It was frequently supposed—not by the authors of the Papers or by those likely to speak in the discussion, but by a great many steam users—that they might incur a serious loss of energy owing to imperfect combustion on account of the formation of some unoxidised carbon. They might relieve their minds on this point, for it must be a very badly run furnace which produced this, and to discover it in ordinary flue gases was not an easy thing; and even if discovered the quantity was very small. Manufacturers seemed afraid, when they saw a little smoke coming out of their chimneys, that they were going to be ruined. It was much more likely that the neighbourhood would be ruined, but their pockets would remain intact. Coming to the remarks of Mr. Dugald Clerk, he said that if a gas producer was employed in connection with steam raising, they would not, as Mr. Clerk had told them, lose 30 per cent. of the calorific value of the coal in the producer, and indeed nothing like it. And further, there was this point, which perhaps Mr. Clerk had not thought of. No one in his senses would think of using a gas producer for the supply of producer gas to feed a boiler. He would use it for a gas engine, which was a totally different thing; and the economy of fuel got in this way was considerably greater than could be got from the steam engine, putting aside the recovery of ammonia which had also been spoken of.

* Mr. G. L. ADDENBROOKE thought electrical engineers were more interested in the relative cost of raising steam in small plants as compared with the cost of steam raised in large plants where every facility could be provided. Mr. Holliday's Paper was an exceedingly pertinent one for that reason, not because it went into the future, but because it gave figures as to good commercial practice. He should say these could be taken as absolutely correct, and the question was how far could they do better than this with higher pressures and modern appliances; and on the other hand, how far would it be possible to supply electric power from one large generating centre instead of from a number of local centres. Three or four years ago, on going into this question, he was exceedingly anxious to get figures and had made inquiries all round, but it was simply astonishing to find the difficulty there was in getting any really reliable figures. He had prepared a table at the time which gave the cost of running a 50 H.P. and a 100 H.P. engine. The general result was that, taking an ordinary engine, worked under commercial conditions with coal at about 6s. per ton, the cost came out at not far off 1d. per indicated horse-power of the engine. He did not mean per indicated horse-power of the work done, but per indicated horse-power of the engine itself. Therefore, to run an engine capable of indicating 40 H.P. or 50 H.P. would cost something like 3s. per hour. This was very much higher than was usually given, but when he read a Paper some time ago in the Midlands on the subject of power generation, one of the ablest men in the district was there, and afterwards took the trouble to go through the calculations relating to the engine driving his own works. It was using coal at about the price of 6s. per ton, and, including depreciation, interest, superintendence, and every other charge, the cost was nearly 1d. per horse-power hour. There was no means of indicating exactly the horse-power of the engine; he knew it was somewhere about 40 H.P. or 50 H.P. He thought it important to get as many figures of this sort as possible, because it showed them what they had to work against. He entirely agreed with Mr. Crompton on this question of cheap fuel, because he was in the middle of the district where cheap fuel was being used, and knew that as soon as the demand rose up went the price. Mr. Crompton was also right when speaking of the very great deterioration of cheap fuel when exposed to the atmosphere. If it lay outside in heaps it absorbed very large quantities of water, so that they got a very much larger proportion of water than they did under ordinary circumstances. Then again in modern collieries, where the seams were thin and electrical cutting was used, the cutters went below the coal itself, and thus a large quantity of dust was mixed with the coal. Under these circumstances, therefore, he thought it a pity to base any large scheme on the use of coal at less than 6s. or 7s. per ton, as prices went at present. He was interested in Mr. Blount's remarks on the Mond process, and his statement that this method could not be employed in raising steam. But he ventured to think he was not wrong in stating that this was the very point on which Dr. Mond was working at present. He (Dr. Mond) was using it for raising steam, and the figures given in Mr. Humphrey's Paper before the Institution of Civil Engineers were undoubtedly very favourable as to the prospects of this system. Probably they could not rely on recovering the amount of ammonia given by Mr. Humphreys, but he thought the subject was well worth consideration, quite apart from this. The following is the table referred to by Mr. Addenbrooke in his remarks:—

SOUTH STAFFS. DISTRICT.—COSTS OF INSTALLING AND WORKING STEAM PLANT.

1. *Capital Cost.*

	For 50 I.H.P.	For 100 I.H.P.
Boilers (50 H.P. two; 100 H.P., three)	£400 0 0	£600 0 0
Engine, including cost of belt and gearing	250 0 0	400 0 0
Pumps, pipes, valves, &c.	100 0 0	150 0 0
Boiler and engine house, stack, water arrangements, and general expenses of installation	250 0 0	300 0 0
Totals	£1,000 0 0	£1,450 0 0
Cost per I.H.P.	£20 0 0	£14 0 0

2. *Annual Costs.*

Driver and stoker, 40s. per week for 50 i.h.p. and 45s. for 100 I.H.P.	104 0 0	117 0 0
Coal, say 5llb. per I.H.P. for 2,700 hours per annum, at 5s. per ton, plus 10 per cent. for raising and banking fires	83 0 0	166 0 0
Oil, waste, &c.	20 0 0	30 0 0
Boiler insurance and other expenses	6 0 0	12 0 0
Interest, say 7½ per cent. on capital costs as above. Upkeep, depreciation, say 7½ per cent. on capital	150 0 0	217 10 0
(Nothing included for superintendence, rates, &c.)		
Totals	£363 0 0	£542 10 0

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Cost per annum if engine is worked at full load per i.h.p. for 2,700 hours per annum.....	£7	0	0 ...	£5	8	6
Cost per annum if engine is worked at two-thirds its full capacity per i.h.p.....	10	13	8 ...	8	4	3

If b.h.p. is taken as the standard ins'ead of i.h.p. the above annual costs must be increased by 15 per cent.

Notes.—In the above table the cost of coal is put at 5s. per ton, which was the figure at which coal could be bought in the Midlands for such purposes when the table was compiled. The present prices would be at least 7s. per ton.

The following addendum to Mr. Crompton's Paper was circulated at the meeting on Thursday, December 7th :—

Test, made since the reading of the Paper, of a Babcock and Wilcox water-tube boiler fitted with the revolving grate described in the Paper.

Heating surface ..... sq. ft.	1,827
Grate surface (7ft. long × 5ft. wide) chain grate stoker...sq. ft.	35
Ratio of heating surface to grate surface ..... ratio	1 : 52·4
Kind of fuel used ..... kind	Boodyke singles
Duration of test ..... time	6 hours
Average observed gauge pressure (atmospheric pressure 14·7) lb.	166·25
Average temperature of water fed by boiler by feed pump deg.	50
Pounds of fuel fired (dry) ..... lb.	4,032
Pounds of fuel fired per hour ..... lb.	672
Pounds of refuse ..... lb.	318·5
Pounds of combustible ..... lb.	3,713·5
Coal consumed per sq. ft. of grate per hour ..... lb.	19·2
Total water evaporated (actual conditions) ..... lb.	27,150
Water evaporated per hour ., ,, ... lb.	4,625
Water evap. per hour from and at 212°F. factor 1·218 ..... lb.	5,511·45
Temperature of saturated steam..... deg.	373
Temperature of superheated steam..... deg.	453
Superheat ..... deg.	80
Water evaporated per sq. ft. heating surface per hour ..... lb.	2·47
Water evaporated per lb. of coal, actual conditions (feed-water 50°F., steam pressure 166·25lb.)..... lb.	6·73
Condition of coal	Very wet
Water evaporated per lb. of coal, assuming feed water at 212 deg. and under atmospheric pressure. Factor, 1·218 ...lb.	8·197
Water evaporated per lb. of combustible, actual conditions (feed water 50°F., steam pressure 166·25lb.) .....lb.	7·31
Water evaporated per lb. of combustible, assuming feed water 50°F. and steam pressure 166·25lb. Factor 1·218.....lb.	8·90
Temperature of boiler rooms ..... deg.	70
Temperature of flue gases..... deg.	524
Force of draught in inches of water ..... in.	0·184
Calorific value, theoretical evaporation from and at 212deg. per lb.	11·33
Efficiency heat utilised in boiler ..... per cent.	72·34
Efficiency heat utilised in superheater ..... per cent.	2·21
Total efficiency ..... per cent.	74·55

ANALYSIS OF COAL.

Proximate Analysis.

		Per cent.	
Volatile matter	Gas, tar, &c.	33·48	46·78
	Sulphur	0·55	
	Water	12·75	
Coke	Fixed carbon	45·20	53·22
	Sulphur	0·61	
	Ash	7·41	
		100·00	

Specific gravity.....	1·30
Weights at 1 cubic ft. in lbs.	81·25
Heating power, practical (lbs. of water at 212°F. evaporated by 1lb. coal), by Playfair's formula.....	6·90

Ultimate Analysis.

Carbon	63·43
Hydrogen	4·03
Oxygen	9·70
Nitrogen	1·52
Sulphur.....	1·16
Ash.....	7·41
Water	12·75
	100·00
Heating power, theoretical (lbs. of water at 212°F. evaporated by 1lb. coal)	11·33
Heating power of dried coal by Thompson's calorimeter	12·87

(Signed) TATLOCK AND THOMSON.

TEST ON NO. 4 BOILER.—*November* 17, 1899.

Analysis of Flue Gases by Orsat's Apparatus.

The average of numerous tests on the above-mentioned apparatus at an average draught of 0·184in. have given :—

12·35 per cent.	CO_2
7·25 ,, ...	O
0·15 ,, ...	CO
and 80·25 ,, ...	N

If ordinary air is taken to contain 20·6 per cent. oxygen, the excess of air will be 50 per cent. over the theoretical quantity required.

By calculation on above data and the temperature of the flue gases compared with the temperature of boiler house, a loss of 1,375·66 B.T.U. – 12·5 per cent. is shown. The calorific value of the fuel used has been found to be, by application of chemical analysis made by R. R. Tatlock and Thomson, in Glasgow, to Dulong's formula equal 10,989 B.T.U.

Heat Balance.

Heat used for evaporation of water	7884·4	B.T.U.	72·34 per cent.
Heat used for superheat of steam...	242·8	,,	2·21 ,,
Loss in flue gases per calculation, as indicated above	1735·66	,,	12·51 ,,
Loss unaccounted for by radiation, incomplete combustion, ashes, &c.	1486·14	,,	12·94 ,,
	10,989·00	B.T.U.	100·00 per cent.

Total efficiency ..... 74·55 per cent.

Thursday, December 7th.

Mr. R. E. CROMPTON, in referring to the above addendum to his Paper, called attention to the first table in the Paper itself, which showed the actual results obtained with a carefully carried out test made in Glasgow by the Engine Boiler and Employers' Liability Insurance Co., and in addition gave the results which would have been obtained if there had not been a great excess of air passing through the fire. This so diluted the products of combustion that 25 per cent. of the calorific value of the fuel went up the chimney. He had also shown in his Paper, he said, that this 25 per cent. could possibly be reduced to 12 per cent. Since the reading of his Paper a very careful trial had been carried out at Glasgow with the same class of coal—it might be slightly inferior, as it only had a calorific value of say 11,000 units—and the results had corroborated very closely indeed the figures given in the last column of the table in question. These results had been incorporated in the above addendum. He had been too sanguine, however, in suppoeing he would be able to reduce the losses which were given as the third and fourth items in the table of his Paper. Here they were about 5 per cent. together, but in this latest Glasgow test about 1,400 units, or 12 per cent., was lost in this way. Although this was so, he did not at all despair of getting to the figures he had originally quoted, because a great many of the losses unaccounted for could be accounted for by the units used in evaporating the large quantity of water contained in the fuel. In the last trial, further, the boiler was set in such a manner that the radiation losses were very considerable. Just after the date of the reading of his Paper he had received a communication from Mr. Dickinson, the engineer at the Leeds station, which was a station above all others in having been successful in using extremely cheap fuel. Mr. Dickinson said in this letter: "The station started in May, 1893, and from then up to the end of last year the fuel used was slack coal costing 7s. per ton. It was then found that much more economical results were obtained by the use of 'smudge,' which is a local name for the fine dust costing only 2s. 3d. per ton delivered, and this class of fuel has been used exclusively from the beginning of this year. During that period, however, the price of smudge has been gradually rising, owing to the increased demand for it in the iron trade, and also in the coke ovens, brick burning, &c. The price has increased in a much greater ratio than slack. Thus a quotation received a few days ago was for smudge at 5s. 6d., against 2s. 3d. in the year 1894. At the beginning of the present year it was deemed advisable to use slack for the boilers in the new half of the station, although smudge is still used in the other boilers. This change was made chiefly because the draught of the new boilers is greater than the others, and there is a tendency with increased draught for the smudge dust to be carried forward without being consumed. As to the economy of smudge, I estimate a great saving. For the eight months from May to December, 1893, when slack was used, the coal bill was £670 with a 500 h.p. plant, whereas the coal bill for the whole of the year 1898, with a 4,300 h.p. plant and an output of 1,200,000 units, was only £1,100." Putting it in another way, said Mr. Crompton, the figures showed that the saving by the use of smudge as against slack had been sufficient to pay the cost of the boilers which had since been installed. Two qualities of this smudge had been used at Leeds—viz., "A" and "B" smudge, the latter being rather the more expensive. The calorific value of the "A" quality was 9,766 heat units, and it contained 12 per cent. of incombustible matter, while "B" contained 9,428 units, and had 23 per cent. of incombustible matter. Continuing to quote from Mr. Dickinson's letter, Mr. Crompton said that as the price kept advancing, it had been found necessary to use smudge fuels of a more superior class having only an average of 10 per cent. of incombustible matter. All these coals were fired under Lancashire boilers by Bennis sprinkler stokers. Now came what Mr. Crompton thought the most important part of this communication. So far everything sounded very well, but Mr. Dickinson now dealt with what had been hinted at in the Paper—viz., the effect of storage on such finely divided fuel as smudge. Mr. Dickinson found that one disadvantage attending the use of smudge was that its value deteriorated by keeping it in stock. The calorific value of six fresh samples of "A" smudge varied between 11,100 and 12,532, but after they had been in stock for six months tests made in a precisely similar manner gave 7,735. This showed a deterioration as 1,200 : 700. This showed a very marked deterioration after six months, while with a longer storage the deterioration would be still greater. He would reply to Mr. Dickinson's communication in his general reply to the discussion.

(To be concluded.)

Tests of Tramcar Brakes.—Twenty-one street-car brakes, out of a total of about 400 sent in, have been selected by the American Association of Street Railways for exhaustive tests. These tests have been conducted, under the supervision of the Railroad Commissioners, on cars furnished by the Metropolitan Street Railway of New York, and their report has been promised within 30 days. This report will be awaited with much interest.

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SOME NOTES ON THE AMOUNT OF LIGHT REFLECTED FROM VARIOUS ELECTRO-DEPOSITED METALS.

BY SHERARD COWPER-COLES.

Electro-deposited palladium does not reflect light as well as a silver surface which is perfectly clean and bright. Silver, after being in close proximity to an arc lamp for a short time, tarnishes, and the light is greatly reduced in intensity. With palladium the intensity of light is found to remain practically constant, as little or no tarnishing takes place. Nickel has been found quite unsuitable. The following table gives the actual and comparative amount of light reflected from various electro-deposited metals; a Bunsen photometer and standard pentane lamps were used:—

Metal.	Distance of standard light from screen.		$\frac{a}{b}$	Actual reflecting power. $\left(\frac{a}{b}\right)^2$
	Direct light. cms.	Reflected light. cms.		
Silver.....	69·5	71·5	0·97	0·94
Chromium...	69·5	71·5	0·97	0·94
Platinum ...	69·5	97·0	0·72	0·52
Palladium ...	69·5	112·0	0·62	0·38

Comparative.

Silver ..... 100 reflecting power $\left(\frac{a}{b}\right)$ taking Ag as 100.

Chromium	100	„	„	„	„	„
Platinum	74	„	„	„	„	„
Palladium	64	„	„	„	„	„

The above tests were made on plates prepared by chemically depositing silver on glass, and backing with an electro-deposit of copper, removing the deposit from the glass and finally coating the silver with the metal to be tested for its light-reflecting properties.

Researches made by Prof. Potter gave a loss of 31 to 35 per cent. for mirror metal; and Stephenson found for polished silver at an angle of 45deg. that the loss was about 44 per cent. Platinum and palladium possess a reflecting power inferior to that of silver for visual rays, but superior for chemical rays and for astrophotography.

Some experiments have been made to find out what effect the metallic surface directly under a reflecting surface of a thin film of an electro-deposited metal has on the reflecting power. A brass plate was polished, silver-plated, and then thickly gilded and finished; and the amount of light reflected was then determined, after which the surface was coated with a very thin film of palladium and the amount of light reflected determined again, with the following result:—

Gold surface	0·77
Palladium surface	0·63

The amount of palladium deposited on one side of the plate was so very thin that the gold could be distinctly seen through it; the measurement obtained from this was likewise 0·63.

REPORT ON THE ELECTRIC LIGHTING OF SHEFFIELD BY MR. R. HAMMOND AND MR. W. JOHNSON.

Last June the Electric Lighting committee of the Sheffield Corporation requested Mr. W. Johnson, the engineer and manager of the electric light department, "to consult with Mr. Hammond and to report fully as to whether there is at present in existence any system for the supply and distribution of electricity applicable to the city of Sheffield, which would, having regard to the capital expenditure already incurred and to all the other circumstances of the case, be more advantageous than the system now in operation, or whether any modification of the existing system of supply is advisable and practicable, and further on what lines the future development of the undertaking should proceed."

Mr. Hammond's report has now been issued. It commences with the remark that the above reference may be divided into three parts:—

(*a*) As to the existence of a better system than that now in operation;

(*b*) Whether any modification of the existing system be advisable; and

(*c*) On what lines the future development of the undertaking should proceed;

the whole of the above being subject to the governing clause, "having regard to the capital expenditure already incurred and to all the other circumstances of the case."

In considering the suitability of any system for the supply and distribution of electrical energy, attention, he says, must be directed to: (I.) excellence of service, (II.) adaptability, (III.) economy of generation and distribution. After a few general remarks as to his sub-headings I. and II., he comes to III.—economy of generation and distribution. Here again he subdivides his report into heads.

The costs of generation and distribution combined are, he says, greatly affected by: (*a*) A large and increasing output; (*b*) a favourable load factor; (*c*) excellent supervision and general good business management. Economy of generation alone is greatly affected by: (*d*) Efficient and reliable plant; (*e*) simplicity of apparatus, entailing a minimum of labour; (*f*) cheap coal; (*g*) ample and suitable supply of water at a low price for boiler feed and for condensing. To secure low costs of delivery to the consumers' terminals careful consideration has to be given to the system of distribution. In making the choice between mains of various sectional areas a comparison must be made between the annual interest on the capital expenditure and the cost of production of the electrical energy used up in the conductor. No distributing system can avoid an expenditure of energy, but that system is the most economical which involves the lowest annual outlay in: (A) Energy used between generating works and consumers' terminals; (B) cost of upkeep of distributing appliances; (C) interest on capital expenditure thereon.

He then proceeds to compare Sheffield, where an alternating-current transformer system with two-wire secondary distribution is employed, with Bradford, where a 2 × 230 volt three-wire continuous-current system is in use, taking the accounts for the year ended Dec. 31, 1898:—

	Sheffield.	Bradford.
(*a*) Capital expenditure on mains and transforming devices	£57,764 ...	£69,745
(*b*) Interest and sinking fund thereon (say 6 per cent.).	3,466 ...	4,184
(*c*) Total number of units delivered to consumers.....	978,088 ...	1,419,306
(*d*) Cost per unit delivered of interest and sinking fund (*b*)	0·85d. ...	0·71d.
(*e*) Percentage of units used in distribution to units generated	29 p.c. ...	7 p.c.
(*f*) Value of units used in distribution at say 1d. unit total	£1,667 ...	£ 82
(*g*) Ditto per unit delivered to customers	0·40d. ...	0·8d.
(*h*) Upkeep of mains, total	£362 ...	£216
(*i*) Ditto per unit delivered to consumers	0·09d. ...	0·03d.
(*j*) Total cost of distribution—		
Sums expended (*b*) + (*f*) + (*h*)	£5,495 ...	£4.882
Per unit delivered (*d*) + (*g*) + (*i*)	1·34d. ...	0·82d.

Dealing particularly with the Sheffield undertaking, Mr. Hammond says that from his conference with the committee, as well as from conferences with Mr. Johnson, the manager and engineer of the undertaking, and from a perusal of reports, he gathers that the words "the other circumstances of the case" may be interpreted to mean that, having by the capital expenditure already incurred involved a heavy annual charge on the city for interest and sinking fund, the committee are not disposed, unless under strong necessity, to increase that charge, so that any improvements which may be suggested should be ones that carry with them such economies in working as to more than balance the annual charge entailed on the capital expenditure thereon.

After an allusion to the amounts already borrowed for carrying on the undertaking, Mr. Hammond drew attention to the very low average price per unit which was anticipated as the yield of the revenue. There are only 10 places in the United Kingdom where these figures are approached—viz., Edinburgh, 2·99d.; Nottingham, 3·34d.; Manchester, 3·49d.; Oldham, 3·49d.; Sunderland, 3·66d.; Salford, 3·67d.; Worcester, 3·67d.; Whitehaven, 3·86d.; Glasgow, 3·89d.; Burnley, 3·96d.; against Sheffield, 3·76d. (estimated for 1899), and 3·33d. (estimated for 1900). These figures do not leave any margin for a further increase in the interest and sinking fund charges, though, on the other hand, they prove the necessity of the most careful handling of the undertaking in order to put the balance on the right side. In the case of the Sheffield undertaking the "standard pressure" was fixed by the Electric Light Co. at 100 volts or 200 volts at the option of the Corporation. From the generating works in Commercial-street, the confines of the borough, following the lines of streets, are distant to the west 9 miles, to the north 2¼ miles, to the east 2½ miles, and to the south 4½ miles. This is a large area to serve, and, in order to give to each consumer a uniform pressure and at the same time to secure the advantages arising from centralisation of plant in one works, the alternating-current high-pressure system is in use. Under this system, as applied at Sheffield, the current is delivered to the feeder mains at the generating works at a pressure of 2,000 to 2,200 volts, and is thence conveyed to convenient spots for transformation to the standard pressure at which the undertaking is bound to supply the consumer. There are 899 consumers, and in the case of 299 the high-pressure electricity enters the premises of the consumer and energises a transformer there.

Coming to the questions, Are improvements necessary, and, if so, in what direction? Mr Hammond says that in regard to adaptability for coping with lighting over an extended area the system in use may be pronounced most satisfactory. On the other hand, up to a comparatively recent date there has existed an objection to a single-phase alternating system of supply like that in use at Sheffield, due to the fact that motors for this system were not a commercial success. Great difficulty was experienced in starting them, and even when running they were liable to stop without much apparent cause. This objection to a single-phase supply does not now obtain to the same extent, however. As to economy of generation and distribution, he remarks that, judging by the Board of Trade returns filed by the Sheffield undertaking, the combined costs of generation and distribution have been satisfactory. However, an examination of the returns of the electricity works of the United Kingdom shows almost as an absolute rule that increased output results in decreased costs per unit, and provided that the

conditions as to rating and as to the price of coal be stable, Sheffield should form no exception to the rule. In spite of the large capital, upon which interest and sinking fund has annually to be paid, the natural expansion of the business should put the undertaking on the right side by the end of the year 1901. There are two ways in Sheffield in which the load factor could be improved. First, by pushing the adoption of electric motors as vigorously and successfully as it has been pushed, for instance, at Bradford; and secondly, in carrying out public lighting in the city by means of arc lighting in the principal streets and by means of incandescent lighting in all by-streets where low pressure mains are laid. The committee should follow Edinburgh's good example, in view of the fact that the costs per unit of generation and distribution at Sheffield are 25 per cent. above those of Edinburgh.

He thinks it is in the direction of distribution that reduction in cost can be most hopefully looked for. The fact is that high distribution loss is the penalty that has to be paid as the price for all the facilities of long distance transmission given by an alternating-current system. If this be so, how can they be minimised at Sheffield? In suggesting a remedy he admits that he is treading on controversial ground. Many electrical engineers are so convinced of the advantage of having only one type of plant at their works, that they shrink from the adoption of "mixed" systems. Yet these systems have been introduced with great advantage at Edinburgh, Brighton, Reading, Bolton, and Sunderland.

In the two former places the original system was a low-pressure one, and high-pressure was adopted in order to cope with the outlying districts. In the case of Reading the system at the start was similar to that at Sheffield, but on the appointment of Mr. Arthur T. Cooper to the management he suggested the desirability of feeding by low pressure the consumers situated in the central part of the town. The plan has proved most successful, and resulted in a diminution in cost of distribution. It appears to him that a similar plan could be applied with advantage to Sheffield. The bulk of the eight miles of low-pressure distributing mains at present laid down are situated within one mile of the works, and they are supplying more than 50 per cent. of the load. Here is a favourable opportunity of low-tension feeding, and it would be wise for Mr. Johnson to consider to what extent a portion of the £40,000 allocated for capital expenditure in 1900 should be devoted to low-pressure generators and feeders. In any case, he counsels the committee when the increase of the load necessitates further plant at the works not to add to the alternating plant until the central area has all been dealt with by low-pressure continuous, and both the consumers and the undertaking would gain by the possibility of the use of motors suited to all classes of work under all conditions. Moreover, from the experience elsewhere of the change of system, there would certainly be an increase in the use of arc lamps by shopkeepers, especially in interiors, continuous-current arc lamps being more suitable and more economical than alternating for such lighting.

There is, he says, also another direction in which the capital account, and, *pari passu*, the interest and sinking fund, can be diminished—viz., by converting the low-pressure mains from the two-wire to the three-wire system. All future extensions of the low-tension network should be so laid.

Finally, dealing with that portion of the resolution which asks him to indicate on what lines the future development of the undertaking should proceed, he says he does not know the surroundings of Sheffield sufficiently well to know whether within a radius of say 10 miles from the works there are localities containing likely consumers in sufficient number to warrant the laying of mains to them, but if this be the case, he should recommend that parliamentary powers should be obtained to supply them.

In conclusion, he summarises the report as follows:—

(1) That in view of the present large capital expenditure, and the amount of interest and sinking fund payable thereon annually, it would be unwise to make any complete change in the system of supply;

(2) That on the whole that system can be relied upon to give an efficient and economical service;

(3) That the direction in which future economies can be effected is in the cessation of expenditure on further alternating plant, and the feeding of the central district by low-pressure continuous current;

(4) That in all extensions of the low-pressure distributing system, whether alternating or continuous, the three-wire system should be adopted;

(5) That it would be an advantage to the undertaking to obtain powers to supply any fairly contiguous districts lying outside the borough where a good demand for electrical energy could be relied upon.

Mr. Hammond's report was handed to Mr. Johnson, who has commented on it as follows to the Electric Lighting committee. He says that there may be some divergence of opinion between Mr. Hammond and himself with regard to dealing with the undertaking in the comparatively near future; but this, he thinks, may be due to his more intimate knowledge of the local conditions. If the suggested remedy as to the distributing system is controversial, then the results to be obtained are of doubtful certainty, and as an expenditure of further large sums of money to supply an area already equipped is involved, the suggestion demands careful analysis and consideration. Mr. Hammond concludes that it is only in a possible reduction of costs of distribution that any improvement is to be effected at Sheffield, and he recommends the adoption of a "mixed" system as a means of securing that end. Mr. Hammond very properly states that many electrical engineers shrink from the adoption of "mixed" systems, but quotes five places where it is alleged the system has been tried with advantage. Mr. Johnson contends, however, that none of these places are examples of original design. Moreover, the most important of them—viz., Edinburgh—is, he says, giving up the system as undesirable. Further, the conditions of a "mixed" system such as would exist in Sheffield would be entirely without precedent, and therefore would not be comparable with any results obtained elsewhere.

In considering the possibility of effecting some saving in the costs of distribution, Mr. Hammond had stated that out of 98 electricity supply works only 14 works show a total cost of production of current below 1½d. per unit, and that out of these 14 works only seven have produced current a little lower than Sheffield. Mr. Johnson amplifies this statement by adding that there are therefore 91 electricity works whose costs of production are higher than Sheffield, and that of these 91 works 54 are alternating-current works and 37 are direct-current works. Under these circumstances, he says, it must be clear to the committee that the prospects of making a substantial saving out of the costs of generation and distribution are not very promising. Mr. Hammond has not informed the committee what expenditure would be necessary, or what the annual payment would be on account of that expenditure, in order to introduce a direct-current system to supply the area within one mile of the generating station.

For the year ending 1898 the cost of the coal used in distributing the magnetising energy over the entire area of the Sheffield supply was £500, and this sum includes the cost of the energy absorbed in the copper conductors, and which is, in a greater or less degree, inseparable from all systems. He therefore puts forward the sum of £250 as being roughly the amount that would be saved in distribution, upon a sale of current equal to that of 1898, by the substitution of direct-current distribution within an area of one mile of the generating station.

Mr. Johnson next asks what would be the cost of supplanting the existing system in order to effect a comparatively small saving in the cost of distribution, and to provide such other advantages as would be derived from a direct-current system. Taking the published returns of all the direct-current works in the provinces, it is found that the capital expenditure on these works averages about 45s. for each 8 c.p. lamp installed. Within a radius of one mile of the Sheffield generating station there are fixed an equivalent of 75,754 8 c.p. lamps, which would therefore represent an expenditure of £170,447. But let the expenditure necessary for supplanting the existing system be estimated at £85,223, which is half the amount just mentioned, then the yearly charge on account of interest and sinking fund for 25 years would be £4,894. Further, as the alteration would be in the nature of a replacement of one system of supply by another, it might ultimately be found that the cost would have to be provided for out of revenue.

There is still another feature, says Mr. Johnson, involved in Mr. Hammond's recommendation requiring careful attention. When the machinery on order for the present site has been delivered, and the boilers which have to work that machinery are in place, the existing generating station site will be covered. There will then be no room for anything except certain spare machines, and the site cannot be extended. The absolute necessity for the provision of a supplementary site will come along very rapidly, and this necessity has been under the consideration of the engineer for a considerable time, but the financial condition of the undertaking has not allowed of such a provision being unduly precipitated, because a supplementary station working on a different system to the existing system would increase the works costs (*i.e.*, the costs of generation and distribution) all round. Mr. Hammond's report states that an examination of the returns of the electricity works of the United Kingdom shows almost an absolute rule that increased output results in decreased cost per unit. Mr. Johnson agrees with this statement so long as the works are under one roof. How far the statement would hold good in those places where an increase in the demand has rendered a duplication of stations necessary (and when working one system throughout) has yet to be proved. He therefore submits that Mr. Hammond's report does not sufficiently show how the finances of the undertaking will be improved by the substitution of another system of supply in the central area.

Mr. Johnson recommends the committee to run the existing station and its machinery for all it is worth, and for as long as it is possible so to do. The brand new machinery now on the site, and the machinery which has yet to be delivered, should be called upon not only to extricate the undertaking out of its serious debts and responsibilities, but also, if possible, to create a surplus fund, which may be available to provide interest and other charges on the capital that will have to be expended in the erection of a supplementary station some time before it begins to earn a return, and as a backing against the possibility of increased works costs, and for other purposes. If, as the time draws nearer when a supplementary generating station must of necessity be started, the finances of the undertaking should be in such a rosy condition that the two capitalisations already involved in the undertaking can bear the addition of further heavy expenditure, with its interest and other charges, in respect to the central area, then the establishment of a direct-current system in the central area would present no further cause for hesitation. The provision of a site for a supplementary station of ample dimensions will, he is sure, receive the best attention of the committee, but in the meantime the central area can be very well served by the machinery already provided.

He cordially agrees with Mr. Hammond that it is wise to so arrange any new underground work that it will be available for either alternating supply or ultimate direct-current supply, and where the possibility arises this will undoubtedly be done. The adoption of three-wire distribution would follow, as a matter of course, with the introduction of a direct-current supply, but he does not think that any serious expenditure in supplementary supply mains in the central area will be necessary for some time to come.

To these criticisms Mr. Hammond replies to the chairman of the Electric Lighting committee, expressing his regret that Mr. Johnson has so completely misread his report. Mr. Hammond then quotes as follows from his own report: "(1) That in view of the present large capital expenditure, and the amount of interest and sinking fund payable thereon annually, it would be unwise to make any complete change in the system of supply; (2) that on the whole that system can be relied upon to give an efficient and economical service." He desired, he says, in these

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clauses to give a clear opinion that there was no necessity whatever to make, at the present time, any drastic changes in the Sheffield system, and he considers that he took a much more hopeful view of the situation than that taken by Mr. Johnson. If in this very paragraph he had misstated the increase of revenue, the misstatement was made upon the basis of figures supplied by Mr. Johnson. In saying "that the direction in which future economies can be effected is in the cessation of expenditure on further alternating plant, and the feeding of the central district by low-pressure continuous-current," Mr. Hammond desired to point out that in his opinion no further expenditure should be made on alternating plant, and that a portion of the £30,000 or £40,000 allocated for 1900 should be spent in direct-current plant. He complains that Mr. Johnson reads into this clause a recommendation that the committee should make an immediate expenditure *nolens volens* on direct-current plant of £170,447. This suggestion he entirely repudiates; and as the expenditure of the £30,000 or £40,000 has been fully mapped out by Mr. Johnson already, he says that the committee must evidently wait till more flourishing times before carrying out what he deems most desirable—the feeding of the central district by low pressure.

Mr. Hammond does not endorse Mr. Johnson's assertion that Edinburgh is giving up the mixed system as undesirable, for he has it on the authority of Prof. Kennedy, the consulting engineer for the Edinburgh works, that Edinburgh is not giving up the mixed system, but that they are pushing the alternating system farther out and taking in a greater area on the continuous-current system, the very plan Mr. Hammond recommends for Sheffield. He is glad to see that on this point Mr. Johnson agrees to the suggestion to adopt the three-wire system for all extensions of the low-pressure network, whether alternating or continuous. In connection with the recommendation to obtain powers to supply contiguous districts outside the borough, he is sorry that Mr. Johnson does not consider the suggestion worthy of note. The policy, however, is one which is being carefully considered by the largest cities in the kingdom. If carried out at Sheffield it will, he says, in years to come provide ample use for the alternating plant, even when the whole of central Sheffield is being supplied direct from the works; and the saving effected thereby which Mr. Hammond foreshadows from experience in other places will, he thinks, support his figures rather than the £250 per annum named by Mr. Johnson.

CARE OF CAR EQUIPMENT.*

BY J. H. VAN DER VEER.

When the writer was first put in charge of a street railway equipment, the road had a certain number of cars, and it took all of them to operate the road, except from 8 p.m. to 6 a.m., during which time all inspections were made and all possible overhauling done. If a car broke down during the day, everyone possible was put to work on it, including the motorman and conductor. As the motormen in those days all carried kits of tools with them and inspected the motors at the end of each round trip, they were very helpful when it came to overhauling. However, those days have passed away with the double-reduction motor.

In the maintenance of motor equipments to-day, where almost continuous service is demanded and high mileage made, only those equipments fitted with both oil and grease boxes will safely run over 40 days without a thorough overhauling. To do this overhauling a large road will be obliged to do it at a number of different points. To overhaul a motor-car thoroughly it is advisable to have at each overhauling shop extra trucks, with motors mounted and all in first-class order ready to run under a car body whose trucks and motors need overhauling. To properly lift the body from the trucks four duplex chain hoists, or air hoists, conveniently located together with two cross timbers and four stirrup irons, form as good a combination as can be found, and will do the work with the least possible injury to the car body. When the body is lifted the truck to be overhauled is run out and the good truck substituted, car lowered, connected up, and turned over to the operating department. The whole operation takes about one hour, and for that length of time only is the use of the car body lost. For convenience in overhauling a suitable crane, properly located, equipped with a carriage and another duplex or air hoist, will be found of great convenience. Such a crane can be readily made in any blacksmith shop, and for the arm a piece of old rail can be used. When the motor is opened the armature should be lifted out and placed on a suitable rack, where the commutator can be cleaned and the armature tested for insulation. The fields should also be tested for drop; and where there is a drop those fields and armatures should be used in motors by themselves, keeping new and rewound fields and armatures in motors by themselves. This prolongs the life of the equipment and reduces the number of crippled cars taken off the road. The motor shell should be thoroughly cleaned out, either by compressed air or by washing with kerosene. The grease in the grease boxes should be taken out and put in the gear case, and the grease boxes thoroughly washed out with kerosene. Brush-holders should be taken out and thoroughly inspected and cleaned. At the same time you have the best opportunity for truck inspection. The writer has found that all overhauling done with the car standing over the pits, the bottom half of motor dropped, does not allow the thorough overhauling necessary to keep the motor equipment in the shape it should be kept, besides tying up a complete equipment while such overhauling is being done.

In the matter of general inspection, a car started out say to-day in perfect order will safely run five days before it is necessary to inspect it again. In this connection, to inspect from 20 to 25 cars per day, one man can be responsible for the proper inspection of all trolleys, including the taking out and replacing of any defective poles, wheels, or springs, and the straightening of all bent poles. Another man should be responsible for the proper inspection of all circuits, together with hood switches, fuse boxes, and lightning arresters. Another should give his whole attention to controllers, while the brakeman and his assistants should be able to keep all brakes in good shape and replace all worn-out shoes. This arrangement of inspection and overhauling should keep the truck and motor equipment in good shape, if the night men take equally as good care. The writer recommends doing as little work as possible at night. At a car house operating say 100 cars three men should be able to grease motors, inspect brushes, and make any small trolley repairs. Car-cleaning should come directly under the operating department. The night car-cleaning should be limited to sweeping out, cleaning windows, and dusting cars, while all washing should be done in the daytime while the car swings or is on the stand, if the car house is on one end of the line. In connection with car-cleaning, if the cars are of the closed type—seat risers and drop sash—the space under the seat should be cleaned once a week, as the travelling public have a tendency to drop newspapers, apple cores, &c., down behind the seat back, not to mention the bits of lunch the motormen and conductors drop there if their runs compel them to eat on the car. The best way to avoid this, and to also save the annoyance of rattling sash, is to make the sash stationary and cover over the space between the top of the seat back and sash rail. This, of course, does away with blinds and compels the use of curtains. The cost of maintenance is reduced by using curtains, and at the same time, if you happen to be an official riding in a car of this type, you need not be in fear of a passenger pulling a blind with three or four broken slats, and the whole thing covered with dust so thick that you can write your name in it with your finger.

A car house from which 100 cars are operated should have a good carpenter stationed there to make small running repairs and to take care of bell cords and register-ringing devices. Any car that has been in a collision, and damaged so badly that it cannot be repaired in one day, should be sent to the general repair shop. All cars should be taken to the general repair shop once a year and the body put in thorough repair, and the car varnished or burnt off and painted anew, as the case may demand. While the car is in the carpenter's hands the wiring should be gone over carefully and put in shape. If the car goes to the shop with its regular truck and motors, the truck should be run out and gone over thoroughly. In case it is a built-up truck, all rivets and bolts should be carefully inspected, and renewed where necessary. In case of a solid side-frame truck, it should be carefully squared to see that it has not sprung. The brake rigging at this time should be taken apart, and if it is a truck with brake beams working in slides, the beams should have what are termed "Dutchmen" jumped into the ends to bring the wearing parts back to their original thickness, as the beams will probably be found to have worn wedge-shaped. If the brake beams are hung by links, these should be renewed where signs of wear show. At this repair shop should be concentrated all classes of repair work; not only repairs to bodies and trucks, but all electrical repairs. The writer believes it pays for all railway companies to make their own repairs to electrical apparatus, including the making of armature coils and renewing of commutators.

In connection with the latter, the writer has found that hard-drawn copper makes the best commutator. This is bought in lengths, and the bars sawed off with an ordinary metal saw. It will be found that the same bar will often do for several types of commutators. In making commutators yourself it is well to study out the diameter, and increase that over those turned out by the factories as much as you can safely get between the brush-holders. Drop-forged bars can also be had for any width of commutators you wish.

On repairs to controllers, hood switches, &c., most roads will find it cheaper to buy the ordinary repair parts and then assemble them themselves.

In conclusion, the writer has found that it is advisable to make car-body repairs, painting, re-winding armatures, making commutators, armature coils, field spools, &c., by piece-work. If good inspection is provided, and the prices honestly watched, both the company and its employés are gainers by this method. The writer has in mind a case in point. A shop was operated by day-work, and the regular carpenters' wages were $2·25 per day of 10 hours. Cars that were being remodelled were costing $120. This was changed to piece-work, and each car given to four men for $110 per car. It was found that the men could do it easily for this, and make about $6 over their regular wages. They soon became so exceedingly expert at this line of work that the price was cut to $80 per car gradually, and the cars are being turned out at this price now, and the men are averaging $2·50 per day. Close inspection, however, is a necessity.

* A Paper read before the Chicago meeting of the American Street Railway Association October 18, 1899.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *December 1, 1899.*

Electrical Equipment for the Elevated Railway.—After several months of consideration and investigation, the Manhattan Elevated Railway Co. of this city has given the contract for part of the electrical equipment which is to be installed for the operation of the railway system. The contract for the generating apparatus was awarded on November 29th to the Westinghouse Electric and Manufacturing Co. The contracts for engines and boilers have already been made, and that for the motors and car equipment is yet to be awarded. It is the presumption that the General Electric Co. will secure this part of the contract, although nothing has been given out to indicate who the successful bidder is. The equipment to be furnished by the Westinghouse Co. includes eight 5,000 kw. three-phase alternators, 26 rotatory converters of 1,500 kw. each, 78 step-down transformers of 550 kw. each. It is stated that the first of the generators will be delivered in 10 months from now, and it is likely that the electrically-operated trains will be running on a portion of the system before the next year closes. The Westinghouse contract represents an expenditure of about $1,500,000.

Marconi Wireless Telegraph Co.—On of the results of Mr. Marconi's visit to this country was developed during the past week in the incorporation of the Marconi Wireless Telegraph Co. of America, under the laws of the State of New Jersey. The authorised capital of the company is $10,000,000, one half of which is Preferred stock with 8 per cent. non-cumulative dividend. Arrangements have already been made for the purchase of the Marconi patents and the acquiring of rights to operate in all the American possessions and in Cuba. The incorporators of the company are William Marconi, of London; Isaac L. Rice, August Belmont, and C. A. Griscom, of New York; and Robert Goodbody, of Paterson, New Jersey. Mr. Rice, who will be the president of the new company, states that special attention will be given to the manufacture of wireless telegraph instruments for the equipment of ships to enable them to communicate with each other and with the shore. It is also expected that the signal and life-saving stations along the coast will be equipped with the system.

Pacific Cable.—It is understood that one or two American companies are getting ready to lay a Pacific cable, which will probably be subsidised in some form by Congress, that body in turn requiring the cable, if possible, to be built in the United States. The bill to be introduced on behalf of the Pacific Cable Co. provides that if the United States Government will contract to use the cable for 20 years and pay a subsidy of $400,000 a year for this period, the company will begin operations at once from San Francisco to Honolulu, from Guam to Manila, and from Guam to Yokohama. It would be agreed that the rates for private messages from San Francisco to Yokohama should not exceed $1 per word. The cable is to be free to the Government for 20 years, and thereafter at half the prevailing rates.

CORRESPONDENCE.

HYSTERESIS LOSS IN ARMATURES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Mr. Scott, in his article which appeared in your last issue, raises one or two questions connected with the hysteresis and eddy current losses in the armature cores of dynamos and alternators. The subject is one of great interest to the manufacturer of electrical machinery, and it is much to be regretted that the useful data and information available are not only limited in amount but very far from being satisfactory or conclusive. It would be a great advantage if some persevering member of the electrical profession, with the necessary scientific training and experimental ability, would devote his attention to this subject and let us know the results of his investigations, provided always that he did not stop half-way or give us his conclusions in such a form as could not easily be assimilated by the practical engineer of average intelligence.

Mr. Scott appears to assume that the designer of dynamos calculates the probable losses in the armature core by the aid of those formulæ which are generally used for determining the core losses in transformers. As a matter of fact, he is not likely to make use of any formula given in text-books; but if he should use one which has been found correct for the case of reversals of magnetism such as occur in transformers, he surely does so with his eyes open, and without attaching any undue importance to the results obtained. In the *Electrical World* of New York of June 15, 1895 (see also *The Electrician* of July 5, 1895) Mr. Frank Holden gives some interesting curves of losses in laminated iron cores due to rotating fields; and those interested in the subject should also read Mr. Ernest Wilson's article on the "Heating of Dynamos" in *The Electrician* of Oct. 11, 1895.

It seems generally to be admitted that the losses per cycle, due to a rotating magnetic field of a certain strength, are less than those due to a reversing field of the same maximum value. The fact that the hysteresis loss in a revolving disc begins to diminish when the induction reaches 16,000 or 17,000 C.G.S. lines per square centimetre is quite sufficient evidence of the fact that the empirical formula with which the name of Mr. Steinmetz is associated is not applicable to the case of dynamo armatures.

I am not of the same opinion as Mr. Scott when he says that (in the case of alternators with internal revolving poles) "the core need only theoretically be the same depth as half the width of the pole-face; but . . . the depth is usually much greater to give mechanical strength." The truth of the preliminary assertion depends to a great extent upon the quality of the theory, and for this reason it does not readily lend itself to discussion; but in any case I do not think that the makers of alternators with iron armature cores are in the habit of increasing the radial depth of the stampings for reasons connected with the mechanical design. If they make the cores deep, it is because they find that unless they put in a fairly large cross-section of iron the temperature rise is inclined to be so high as to very materially detract from the market value of the machine.

It is very distressing to the manufacturer to find that the armatures of his dynamos and alternators invariably get much hotter than they ought to—theoretically; and it is for this reason that he would be glad of some further help from the man who has plenty of time to make experiments.

The question of alteration in the core losses with changes of load is one which is far from being satisfactorily answered. It would seem that, in a dynamo armature, the core losses might be expected to increase with the load—especially in cases where the induction is comparatively low—on account of the crowding together of the magnetic lines due to the reaction of the armature field; and indeed, according to Mr. Otto Blathy (see *The Electrician* of July 17, 1896), the loss of energy, both in dynamos and alternators, may be very much greater at full load than is generally supposed. But, on the other hand, it is well known that in certain cases the loss of power in the core of an alternator is *less* at full load than on open circuit. Some preliminary experiments which I made in conjunction with Mr. Edward W. Cowan four or five years ago—but which we were unable to follow up—pointed most decidedly to a diminution of the core losses in an alternator as the load on the external circuit was increased.

With regard to Mr. Scott's last paragraph, I think he has got on to the wrong track. It is not clear to me what Dr. Fleming intended to say in the passage from his book on transformers which Mr. Scott quotes, but I quite agree with the opinion you express in your "Notes" regarding the maintenance of a given magnetic condition in iron, whether the latter is in a state of vibration or not; and certainly Prof. Ewing's observations concerning the effect of vibration on hysteresis losses are not applicable to the case of field magnet cores, in which the magnetising force is practically constant.

Manchester, Dec. 12. ALFRED STILL.

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FOREIGN COMPETITION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I feel reluctantly obliged to reply to the further letter of the British Insulated Wire Co. in your issue of last week. If their first public letter on the above subject had any object, it was to cast discredit on Mr. Parshall in connection with this contract and to charge the directors of the tramway company with sacrificing the interests of their shareholders.

I have stated that the tender of the American company was accepted in fair competition because it was the best offer we received. I repeat, the work as executed is more favourable to the company than the original tender, and I am not aware that the Dublin Tramways Co. have any obligation to disclose the details of their business to the British Wire Co. further than was necessary for the purpose of their action against the National Conduit Co.

The British Wire Co. think that my knowledge of American electrical engineering must be very limited, but it is wide enough to know that the cable ways and cable system of the Dublin tramways, which are all of American manufacture, form by far the most complete and perfect underground cable installation now in operation in the United Kingdom.—Yours, &c.,

WM. M. MURPHY,
Chairman of the Dublin United Tramways Co.

Dublin, Dec. 13.

A THERMO-COUPLE WITHOUT JUNCTIONS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In a note to my letter which appeared in your last issue you say that you consider it extremely doubtful whether the observed effect is a thermo-electric one at all. The following points seem to show that it is. If the current were due to the formation of an alloy, it would cease as soon as all the selenium had been used up; but this is not the case: the current continues to flow so long as one-half of the loop is kept hot, and the direction of the current is reversed when the heat is transferred to the other side of the loop. Moreover, if the wire be treated with selenium at two places a little distance apart and the heat properly disposed, the current is nearly doubled, the wire now behaving exactly like two thermo-couples joined in series.—Yours, &c.

London, Dec. 11. E. BENNETT VILES.

LEGAL INTELLIGENCE.

Dublin Corporation v. Dublin United Tramways Co. (Ltd.)

JUDGMENT.

In the Dublin Southern Police Court, on Saturday, Mr. Swifte, Q.C., gave judgment in the prosecution brought by the Dublin Corporation against the United Tramways Co. for neglecting to sand the tram tracks in certain streets, whereby it was alleged they were rendered a danger to the ordinary traffic.

Mr. SWIFTE said that on Oct. 24 two summonses were issued against the company for failing to keep in good condition and repair, and so as not to be a danger and annoyance to the ordinary traffic, the rails of the tramways and the sub-structure upon which the same rested, and also the paving of such tramways. The indisputable fact was as to the danger and slipperiness, particularly in certain states of the weather, of the tram tracks, by which he meant the paved space between the tramrails and eighteen inches beyond the rails on each side. The evidence showed that things had come to such a pass as in his opinion to constitute a grave public scandal and a positive disgrace to the city. The question whether the corporation had failed to perform their duty as the road authority was not before him, and his opinion on the subject would be irrelevant to the present case. He had only to decide whether defendant company had failed in the performance of a statutory obligation, and not whether some other body had done the same. If the Corporation had failed, or should hereafter fail, to keep their portions of the streets in proper condition and repair, they could be proceeded against by indictment or otherwise. However proper it was that the present complaint should be brought by the Corporation, it might, in his opinion, be equally and properly brought by any other member of the community as involving a question of public interest. He felt he must discard the evidence of Mr. William Murphy altogether. It did not occur to counsel or to himself to question Mr. Murphy's competency as a witness on the ground that the proceeding in this case was a criminal one, and that Mr. Murphy was chairman of the defendant company. He must therefore reject the evidence given by Mr. Murphy, which was very interesting and important. The main cause of the evil complained of was the condition of the weather at certain times, particularly when it was very dry. Another cause was in dry weather the swishing away of particles of grit, gravel, or dust by the draught produced in the transit of the electric cars over the roadway at a high rate of speed, and lastly, the worn condition of the roadway. As to the remedy for the present state of things, there seemed a concensus of opinion among the witnesses that sanding was the proper remedy. Re-dressing the setts was a remedy, but it would be an unsatisfactory and expensive one, and would, if largely applied, constitute a nuisance in the tramway thoroughfares. Clause 37 of the company's Act, which he had to construct, set out that "The company shall at all times maintain and keep in good condition and repair, and so as not to be a danger or annoyance to the ordinary traffic, the rails of the tramways and superstructure upon which the same rest and also the paving, wires, posts, tubes, and electrical apparatus of any description whatever." The Act, he thought, might reasonably be regarded in the nature of an agreement between the Corporation and the defendant company, and under this sec. 37 the company were in the position of tenants entering into a covenant to maintain and keep in good condition and repair the subject of their wayleave. It was a general principle in the construction of covenants that if the words were of doubtful import that the leaving should always be against the covenanter. The argument that it was inconvenient having the tram tracks sanded by one body and the scavenging of the streets by another, he quite saw the force of; but the objection could easily be got over by the company agreeing to pay the Corporation an annual subsidy, and allow the latter to undertake the whole work. On this point it had been decided under sec. 13 of the Act of 1878 that a certain amount of scavenging came within the term "maintenance" of a road. Mr. Gordon had contended on behalf of the company that sec. 37 only contemplated structural repair, and that if a pavement was once started for use in a perfect state the company had nothing to do with what might be called its superficial or surface condition as affected by the weather. The company had also failed to comply with the conditions of sec. 28 of the Act of 1870, under which one of the summonses was brought. Besides requiring the tram tracks, including the statutory 18in. outside, to be kept "in good condition and repair," it enacted that that should be done with such materials and in such a manner as the road authority should direct, and to their satisfaction—which of course meant reasonable satisfaction. He must therefore, if required by the Corporation, convict on both summonses. He asked if the Corporation pressed for a substantial penalty.

Mr. WHITE said the costs of the Corporation had been very large. Outside those costs, if they had established the principle, they were not inclined to press for a heavy penalty.

Mr. FITZGERALD MURPHY said of course he would not interfere with the discretion of the magistrate, either as regards the penalty or the costs. He would, however, ask his worship to state a case.

Mr. SWIFTE said he would do so, and the case concluded.

Downie v. Adams.

This case came before Mr. Justice Wright and a special jury on Wednesday. Mr. Charles Manners Downie, electrical engineer, sought to recover against Mr. Frederick George William James Adams, electrical engineer, damages for alleged libels. The defence was that the statements complained of were furnished in good faith on privileged occasions. The plaintiff entered into partnership with the defendant in Feb., 1897, and the partnership continued until the beginning of the present year. Last April defendant, writing to Messrs. Francis and Spilsbury, electric supplies dealers, made the libellous statements now complained of. Plaintiff said there was not the slightest foundation for those allegations, but in consequence of their publication he had been unable to go about amongst his business friends. Since the commencement of this action defendant had become bankrupt.

Defendant did not appear, and the jury awarded plaintiff £250 damages. Judgment accordingly, with costs.

A New Friction Dynamometer.—At a meeting of the Physical Society at Finsbury Technical College, on Friday last, Prof. W. E. Dalby exhibited a friction dynamometer. The torque to be measured produces a twist in a spiral spring, and the object is to determine the amount of this twist. Side by side upon the shaft are two pulleys, one keyed to the shaft and the other fastened to the end of the spring. The lead of one pulley upon the other therefore measures the twist. Two other pulleys are mounted upon a slide and are joined up to the first ones by means of a continuous band similar to a Weston's differential pulley block. When the shaft is at rest the two pulleys on the slide are touching, but any motion of the shaft produces a twist in the spring, and therefore a lead of one of the shaft pulleys on the other. This produces a separation of the slide pulleys, which is proportional to the lead and therefore to the torque. In this way, knowing the constants of the dynamometer and its number of revolutions per second, the power transmitted is at once determined.

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TRADE NOTES AND NOTICES.

[Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.]

NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers, or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London :—

NOW READY.

"The Electrician" Electrical Trades' Directory and Handbook for 1899.—The *Second Edition* of the "Big Blue Book" for 1899 is now ready. The volume contains the large Sheet Tables of Electricity Supply Stations and Electric Railways and Tramways. The price of the Directory and Handbook is now reduced to 5s. post free 5s. 9d. ; abroad, post free, 6s. 6d. (United States 7s. 6d.).

"Submarine Cable-Laying and Repairing."—By H. D. Wilkinson, M.I.E.E., &c., fully illustrated ; price 12s. 6d. This work gives a detailed technical summary of modern practice in manufacturing, laying, testing, and repairing submarine telegraph cables.

"Practical Notes for Electrical Students."—By Messrs. A. E. Kennelly and H. D. Wilkinson. Price 6s. 6d., post free. The authors give in a clear and concise manner a good summary of the general principles of electrical science.

"Magnetic Induction in Iron and other Metals."—By Prof. J. A. Ewing. Price 10s. 6d., post free. *New Edition nearly ready.*

"The Incandescent Lamp and its Manufacture."—By Gilbert S. Ram. Price 7s. 6d., post free. The principles underlying the manufacture of the incandescent lamp are carefully and fully dealt with in this volume.

"The Steam Engine Indicator and Indicator Diagrams."—Edited and enlarged by W. Worby Beaumont. Price 3s. 6d., post free. This work is a concise guide to the objects, construction, and use of the steam engine indicator and to the interpretation of indicator diagrams.

"The Art of Electrolytic Separation of Metals."—A second issue of Dr. Gore's book is now ready, price 10s. 6d., post free. The author treats fully both the theoretical principles of the art of electrolytic separation of metals and the practical rules and details of technical application on a commercial scale. The work is adapted to the use of the manufacturer as well as the student.

"The Manufacture of Electric Light Carbons."—A Practical Guide to the establishment of a Carbon Manufactory. Fully illustrated, price 1s 6d. ; post free, 1s. 9d. In this work the author gives useful hints as to the manufacture of electric light carbons, including the preparation of material, firing, saturating, and coring, together with a description and estimate of cost of the plant required.

"The Centenary of the Electric Current, 1799-1899."—By Dr. J. A. Fleming. Price, paper covers, 1s. net, post free 1s. 3d.; strong cloth, 2s. 6d., post free.

"Localisation of Faults in Electric Light Mains."—By F. C. Raphael. Price 5s., post free. The book deals with the important subject of localising faults in electric light and power cables ; and the various methods of insulation testing are here collected and discussed.

"Motive Power and Gearing for Electrical Machinery."—By E. Tremlett Carter, C.E., M.I.E.E. Price 12s. 6d , post free. In this comprehensive work an account is given of the scientific principles and modern practice in the use of engines for dynamo driving, not only for isolated power plants, but also for public electric lighting and power stations. The various forms of gearing in the power station and for electric motors are also dealt with ; and the book contains, in addition, numerous tables giving exact data of the equipment and working of electric power stations.

"The Manufacture of Carbons for all Electrical Purposes."—by Francis Jehl. 10s. 6d., post free. This is a practical handbook, giving a complete description of the art of making carbons for electric lighting, electrodes, &c., with particulars of the various gas generators and furnaces used in carbonising. The work also contains particulars of the cost, &c., of erecting and working carbon works, and plans of a model factory.

"Drum Armatures and Commutators," by Mr. F. Marten Weymouth, also ready. Price 7s. 6d., post free. Propsectus on application. This is a complete treatise on the theory and construction of drum winding, and of commutators for closed coil-armatures, together with a *résumé* of the principal points involved in their design, and an exposition of armature reactions and sparking.

"The Electrician" Primers.—In Two Volumes. Vol. I., Theory. Vol. II., Practice. Price, stout paper cover, 2s. 2d. each, post free ; cloth. 2s. 9d. Single Primers, 3d. each, post free.

"Armature Windings of Electric Machines."—By H. F. Parshall and H. M. Hobart. This work has been compiled from notes made by Mr. Parshall in his capacity as Chief Designing Engineer of the Edison and General Electric Companies of America, and is intended to serve as a working treatise on dynamo design. Large 4to, 370 pages 140 full-page illustrations and 65 full-page tables, 30s., post free.

"Electric Motive Power," by Albion T. Snell, contains the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. Price 10s. 6d., post free ; abroad, 11s.

"Electrical Testing for Telegraph Engineers."—By J. Elton Young, M.I.E.E. The scope of the book aims at furnishing a fuller treatment of the subject, from the standpoint of the Telegraph Engineer, than it has hitherto received, whilst it endeavours to facilitate a thorough comprehension of the theory of testing as applied to electrical lines in general. Demy 8vo, fully illustrated. 10s. 6d., post free.

"The Potentiometer and its Adjuncts": A Universal System of lectrical Measurement.—By W. C. Fisher. Fully illustrated. Price 6s, post free.

"Laboratory Notes and Forms."—We have ready a set of 40 Elementary and Advanced Exercises for use with Electrical Engineering classes. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators and Students. The object of the series is the saving of the time of the Teacher and his Assistants, and to serve as a record of the work done by the Student. Each Form is supplied either singly at 4d., or 3s. 6d. per dozen net ; in sets of any three, 1s. net ; or the set of Twenty (Elementary or Advanced) Exercises can be obtained, price 5s. 6d. net. The complete set of Twenty Elementary and Twenty Advanced Exercises are price 10s. 6d. net ; or in handy portfolio, price 12s. net ; or bound in strong cloth case, price 12s. 6d. net. Strong portfolios can be had, price 1s. each.

NOW READY.—The cheaper edition of Dr. J. A. Fleming's "Electrical Laboratory Notes and Forms." These cheaper Forms have been prepared for the use of students and teachers at the Polytechnics and other Science classes throughout the country. The demand for the original set of these Notes and Forms has led to a request for a cheaper set for use at the day and evening classes at many of the technical institutes. These new Forms, which differ only from the higher-priced set in being printed on smaller and cheaper paper and with less space for tabulated records, are issued at half the price of the original set.

TENDERS INVITED.

The *Ilford* District Council invite tenders for the supply and erection of the following plant: (*a*) Water-tube boilers with fittings, economiser, feed pumps, &c. ; (*b*) pipework, &c. ; (*c*) two 200-kw. and one 100-kw. steam dynamos and motor boosters (vertical enclosed high-speed engines) ; (*d*) storage batteries ; (*e*) main switchboard and connections ; (*f*) overhead travelling crane ; (*g*) underground mains, &c. ; (*h*) arc lamps and posts ; (*k*) station lighting. An advertisement contains further particulars, and copies of specification can be obtained of the clerk to the Council (Mr. J. W. Benton), Council offices, Ilford, after the 12th inst. Plans and specifications have been prepared by the consulting engineer (Mr. W. C. C. Hawtayne), 9, Queen-street-place, London, E.C., from whom further information can be obtained after 12th inst. Tenders (addressed chairman of Council) must be delivered before noon of 20th Jan.

The *Hull* Electric Lighting committee invite tenders for the supply and erection of the following plant at their Sculcoates electric lighting works : Two high-speed vertical engines, two high-tension continuous-current dynamos, and one spare armature (Eickemeyer winding). Further particulars are given in an advertisement, and specifications may be obtained at the city treasurer's office, Town Hall. Tenders to chairman of Lighting committee, Town Hall, Hull, by noon of 28th inst.

The *Bermondsey* (London) Vestry invite tenders for the construction, supply, and erection of a dust destructor, with furnaces, flues, water-tube boilers, economiser, fans, and forced draught appliances. Specifications, &c., can be obtained at the Town Hall, Spa-road, Bermondsey, and a copy can be inspected (but not obtained) at the offices of the engineers, Messrs. Kincaid, Waller and Manville, 29, Great George-street, Westminster, London, S.W. Tenders must be sent in to Mr. Frederick Ryall, Vestry clerk, Town Hall, Bermondsey, before noon of January 13. An advertisement contains further particulars.

The Urban District Council of *Barnes* are prepared to receive tenders for the supply and erection of : (*a*) Boilers ; (*b*) steam dynamos and switchboards ; (*c*) storage batteries ; (*d*) cables, &c. Specifications, &c., can be obtained after 20th inst. from the surveyor, Council Offices, High-street, Mortlake, and can be inspected (but not obtained) at the offices of the engineer, Mr. W. Fairley, 53, Victoria-street, Westminster, London, S.W. Tenders have to be sent to Mr. J. Eustace Anderson, High-street, Mortlake, London, S.W., not later than 12 noon of Tuesday, Jan. 9. Some further particulars are given in an advertisement.

The Tramways committee of the *Manchester* Corporation require tenders for the supply of 450 electric tramcar bodies. Specifications can be obtained of Mr. J. M. McElroy, secretary, tramway department, Town Hall, Manchester, and tenders (addressed chairman of Tramways committee, Town Hall, Manchester) must be sent in not later than Saturday, 30th inst. See advertisement.

The *Bedford* Electric Light committee invite tenders for the supply of a 420 b.h.p. inverted compound double-acting engine and a 250 kw. alternator. Tenders must be sent to the town clerk (Mr. T. S. Porter), Town Hall, Bedford, not later than Jan. 5. An advertisement contains further particulars.

The District Council of *Burgess Hill*, Sussex, invite proposals for the establishment of electricity supply works. Further particulars can be obtained of the clerk to the Council. See advertisement.

The directors of the *Midland Electric Corporation for Power Distribution (Limited)* invite tenders for the supply and erection of plant and conductors for a power-house which, when fully equipped, will be capable of an output of 10,000 e.h.p. Tenders to secretary, 11, Cornhill, London, E.C., before 4 p.m., Dec. 18

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The *Accrington* Corporation invite tenders for switchboards, wiring, &c., for the electric lighting of the Town Hall. Tenders Jan. 10.

The *Gloucester* Electricity Supply committee invite tenders for (*a*) one Lancashire boiler and accessories and mechanical stokers; (*b*) one 300-kw. steam dynamo and accessories, steam, exhaust, &c., pipes, valves, &c.; (*c*) extensions of switchboard; and (*d*) condensing plant. Tenders to town clerk (Mr. George Sheffield Blakeway), Guildhall, Gloucester, before Dec. 28.

The *Blackburn* Corporation invite tenders for the supply and delivery of overhead line equipment. Tenders to the town clerk (Mr. Robert E. Fox), Town Hall, Blackburn, by Dec. 23.

The *Birmingham* Corporation require a high-speed engine and dynamo for their Elan waterworks. Tenders to town clerk by noon, 20th inst.

The *Glasgow* Corporation invite tenders for the supply of a cast-iron cable tunnel, water storage tanks, travelling cranes for outside coal storage, mechanical stokers, coal and ash conveyors, and steel flues. Tenders to the town clerk (Sir J. D. Marwick) by 1 p.m. on Jan. 6.

The *Wallasey* District Council invite tenders for the construction, delivery, and fixing of a steel Lancashire boiler at the electricity supply station. Tenders to the clerk (Mr. H. W. Cook), Public Offices, Egremont, Cheshire, by 20th inst.

The *West Bromwich* Corporation invite tenders for the supply, delivery, and erection of the following: (*a*) Boilers and accessories (*b*) steam dynamos and condensers, (*c*) switchboard, (*d*) mains, (*e*) storage battery. Tenders must be in by 10 a.m. of 22nd inst.

The Electric Lighting committee of the *Hackney* (London) Vestry invite tenders for accumulators. Tenders to Mr. George Grocott, Vestry clerk, Town Hall, Hackney, by 4 p.m. of Jan. 2.

The *Birkenhead* Corporation require tenders for erecting a new electric tramway generating station. Tenders by Jan. 16.

The Royal Commissioner of *Terracina* (Italy) invites tenders for the electric lighting of the town.

TENDERS RECEIVED AND ACCEPTED.

The following tenders have been received by the Plymouth Corporation for the supply of 12 complete electric tramcars:—

British Westinghouse Co. (*accepted*)	£8,085 0 0
British Thomson-Houston Co.	8,311 13 0
R. W. Blackwell and Co.	8,546 0 0
Brush Co.	9,267 7 0
Siemens Bros. and Co.	11,714 0 0

The British Westinghouse Co. has also received an order for two additional motor cars at schedule rates.

The following tenders have been received by the Wrexham Town Council for the supply of electric lighting plant. The tenders marked with an asterisk (*) are recommended for acceptance.

Boilers and Destructor.

Stirling Boiler Co.	£4,262 0 0
B. R. Rowland and Co.	5,029 1 3
*Babcock and Wilcox	5,800 0 0

Steam Dynamos.

Lancashire Dynamo Co.	(Allen engines)	6,471 10 0
Ditto	(Alley and Maclellan engines)	7,260 10 0
* Ditto	ditto ditto	7,422 10 0
Ditto	(Belliss ditto)	7,839 10 0
Ditto	(Reavell ditto)	6,697 10 0
* Ditto	(Willans ditto)	7,786 10 0
Reavell and Co.	(Laurence Scott dynamos)	6,653 10 0
Ditto	(Thames Ironworks dynamos)	6,878 10 0
Ditto	(G. E. C. ditto)	6,961 10 0
Ditto	(Parker ditto)	7,056 10 0
W. H. Allen, Son and Co.	(Allen engines)	7,031 0 0
Thomas Parker (Ltd.)	ditto ditto)	7,459 0 0
Ditto	(Alley Maclellan ditto)	8,333 0 0
Ditto	(ditto ditto)	8,307 0 0
Ditto	(Belliss ditto)	8,627 0 0
Ditto	(Willans ditto)	8,759 0 0
R. W. Blackwell and Co.	(Parsons ditto)	7,661 15 0
Crompton and Co.	(Peache ditto)	8,047 0 0
Electric Construction Co.	(Allen ditto)	8,201 0 0
Ditto	(Belliss ditto)	9,513 0 0
Ditto	(Willans ditto)	9,659 0 0
Ashton, Frost and Co.	(Belliss ditto)	8,330 0 0
Ernest Scott and Mountain	(Own ditto)	8,610 0 0
Johnson and Phillips	(Peache ditto)	8,660 0 0
British Thomson-Houston Co.	(Belliss ditto)	8,711 8 0
Sandycroft Foundry Co.	(Willans ditto)	9,076 0 0
Mather and Platt	(ditto ditto)	9,147 0 0
Ditto	(Belliss ditto)	9,177 0 0
India-Rubber Co.	(ditto ditto)	9,540 0 0
Ditto	(Willans ditto)	9,795 0 0
Brush Co.	(Raworth ditto)	9,662 0 0
McClure and Whitfield	(Reavell ditto)	9,644 17 0
Alley and Maclellan	(Own ditto)	10,339 0 0

Switchboard.

*Brook, Hirst and Co.	£539 0 0	Cowans (Ltd.)	820 0 0
Edwards Electrical Co.	593 10 0	Fowler, Lancaster & Co.	875 0 0
Crompton and Co.	687 0 0	Edison and Swan Co.	915 0 0
Moon, Loughlin and Co.	750 0 0	Elec. Construction Co.	1,025 0 0
James White	790 10 6	British Thomson-Houston Co.	1,123 8 6
General Electric Co.	803 10 0	S. H. Heywood	1,141 0 0
Dorman and Smith	807 0 0		
Veritys (Ltd.)	£819 0 0		

Mains.

*St. Helens Cable Co.	£4,499 11 7	Western Electric Co.	5,526 7 6
Callender Co.	5,290 4 7	Henley's Works Co.	£5,582 17 5
General Electric Co.	5,386 18 4	W. T. Glover and Co.	5,726 4 10
Brook, Hirst and Co.	5,411 0 0	Fidge, Ryman and Graesser	6,483 12 9
British Ins. Wire Co.	5,446 19 6		

Accumulators.

*Chloride Elec. St. Synd.	£991 0 0	Hart Battery Co.	£1,653 0 0
Marquand Accumulator Co.	1,162 13 6	Tudor Accumulator Co.	1,812 0 0
Elec. Power Storage Co.	1,550 0 0	D.P. Battery Co.	2,035 0 0

Crane.

*Carrick and Ritchie	£140 0 0	Carrick and Sons	£150 0 0
Watford Engineering Works	149 0 0	Jas. Spencer and Co.	150 0 0
		Higginbottom & Mannock	168 0 0

Messrs. D. Bruce Peebles and Co. inform us that they have secured the contract for the whole of the electrical equipment for the motors for driving condensers, air pumps, circulators, &c., for the Glasgow tramway station, the contract having been placed with them by the Mirrlees, Watson and Yaryan Co.

The Wimbledon District Council has accepted the tender of Messrs. Babcock and Wilcox for the supply and erection of a new boiler and for the necessary brickwork, at £1,117. The tender of Messrs. Crompton and Co. has been accepted for the supply of two steam dynamos at £6,756. Willans engines are to be used, and the first set is to be delivered by Oct. 1, 1900, the second by Dec. 21, 1900.

The Northallerton District Council have accepted the tender of the local electric lighting company for the lighting of the district. Tenders were submitted by both gas and electric lighting companies.

The Whitechapel District Board of Works have accepted the tender of Messrs. Mather and Platt for the supply of three 275kw. steam dynamos at £7,395, and of Messrs. Babcock and Wilcox for the supply of two water-tube boilers at £2,650. The tender of Mr. W. Griffiths has been accepted for the construction of the foundations and up to the ground-floor level of the Osborne-street electricity station.

The following tenders are recommended for acceptance by the Bradford Tramways committee:—

Brush Co. (25 electric tramcar bodies)	£5,637 10 0
R. W. Blackwell and Co. (Ltd.) (25 trucks and trolleys)	1,947 0 0
Witting Bros. (electrical equipment for 25 cars)	5,625 0 0

The Bradford Tramways committee also recommend the acceptance of the tender of Messrs. V. Demerbe and Co. for supplying and laying the tramway from Four Lanes End to the tramway terminus at Thornton, at 17s. per yard of single track.

The tender of Messrs. Reame, Wokes and Co. has been accepted by the Hull Guardians for the installation of electric light and telephones at the workhouse.

The Dundee Corporation have accepted the tender of Messrs. Cooper and Greig for the supply of exhaust pipes for their electricity station at 14s. 4d. per 100.

APPOINTMENTS VACANT AND FILLED.

The Brighouse Corporation invite applications for the position of consulting electrical engineer to the borough. Applications must be sent in, addressed to the town clerk (Mr. James Parkinson), Municipal Offices, before Jan. 10. See advertisement.

The English Electric Manufacturing Co., of Preston, Lancs., require a secretary at their offices in Preston. An advertisement gives further particulars, and applications must be sent to Mr. George Flett, 110, Cannon-street, London, E.C.

The Bradford Corporation invite applications for the position of electrical engineer to take charge of their electricity department. Salary £500 per annum. An advertisement contains further particulars, and applications must be sent in to the town clerk (Mr. Frederick Stevens) not later than Thursday, Jan. 4.

The Plumstead (London) Vestry invite applications for the post of electrical engineer, to advise upon and design and take sole charge of the erection of the electric light plant, works, and buildings, and subsequently to undertake the sole management and control of the electric light department. Commencing salary £400 per annum. Applications to Mr. E. Hughes, vestry clerk, Plumstead, by 21st inst.

The Norwich Technical Instruction committee require a principal for their Municipal Technical School and School of Science and Art. Salary £300. Applications by 20th inst.

A demonstrator in physics is required for the University of Sydney, N.S.W. Salary £350 per annum. Applications to the

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Agent-General for New South Wales (Sir Julian Salomons), 9, Victoria-street, London, S.W., by Jan. 1.

The Chair of Engineering at University College, Bristol, is vacant, owing to the appointment of Dr. Ryan as principal of the Woolwich Polytechnic. Applications to secretary by Jan. 16.

An assistant is required for the electrical engineer's department of Messrs. Lever Bros. (Ltd.), Port Sunlight, Cheshire. See advertisement.

BUSINESS NOTICES.

The Eastern Telegraph Co. notify that their London telephone numbers have been changed, and are now as follows: Head office Winchester House), 1127 and 1128 London Wall; London station 11, Old Broad-street), 1129 London Wall.

The demand for Brockie-Pell arc lamps necessitates the Brockie-Pell Arc Lamp (Limited) removing from Tabernacle-street to larger and more suitable premises in Worship-street, Finsbury, E.C. In addition to the Brockie-Pell lamps supplied to Greenock, orders are on hand for the street lighting of St. Pancras, Shoreditch, Poplar, Gloucester, Stirling, and South Shields.

Messrs. L. H. Holliday and W. Pearson (trading as Holliday, Pearson and Co.), electrical engineers, &c., 227, High-road, Streatham, have dissolved partnership. Debts by Mr. Holliday.

Messrs. Estler Bros. have removed to 25, Laurence Pountney-lane, Cannon-street, London, E.C.

Messrs. Wilhelm and Co. have removed from 11 and 12 to 3, Westmoreland-buildings, Aldersgate-street, London, E.C.

BANKRUPTCIES, LIQUIDATIONS, &c.

At a meeting of the Bournemouth and District Electric Supply Co. (Ltd.) it was resolved to wind up the company voluntarily, and to appoint Messrs. A. H. Sanderson and H. B. Renwick liquidators, with liberty to carry into effect an agreement made between the company and the Bournemouth and Poole Electricity Supply Co. (Ltd.). These resolutions were confirmed on Nov. 16.

Claims against Vril Launches (Ltd.) are to be sent by Jan. 23 to the liquidator, Mr. A. L. Dickinson, 19, Coleman-street, London, E.C.

In the bankruptcy of W. Rowbotham, electrical engineer, Holmville, Stanley-road, Teddington, the first meeting of creditors will take place to-day (Friday), at 24, Railway-approach, London Bridge, and the public examination on Jan. 9, at the Court-house, Kingston, Surrey.

Claims against W. A. Charles and J. S. Blackwell (trading as the Central Electrical and Engineering Co.), 74 and 111, Church gate, Leicester, and 22, Kennington-road, London, S.E, must be in by 22nd inst. Mr. W. M. Richards, 52, Belvoir-street, Leicester, is trustee.

Claims against A. G. Inrig, electrical engineer (trading as the Globe Electrical Co.), 46, White Post-lane, Hackney Wick, London, E., must be in by 27th inst. Mr. E. H. Hawkins, 3, Barbican, E.C., is trustee.

The examination was concluded last week, at the London Bankruptcy Court, of Edward C. Glass, electrical engineer, lately trading as Geo. Forrest and Son, Nevill's-court, Fetter-lane, E.C. Debtor applied to pass on accounts showing a deficiency of £1,098.

H. L. Howard (trading as Thompson, Howard and Co.), electrical and mechanical engineer, Wyvestow, Dragon-parade, Harrogate, 16, Stonegate, York, and 17, Carlisle-street, Hull, has been adjudicated bankrupt. The first meeting of creditors will take place on 19th inst, at 28, Stonegate, and the public examination on Jan. 5, at the Court-house, York.

A receiving order has been made against Wm. Dalzell (trading as Wm. Dalzell and Co.), electrical engineer, 73, Forsyth-road, West Jesmond (late 8, Brandling-park), Newcastle-on-Tyne.

A meeting of the Northern Electric Wire and Cable Manufacturing Co. (Ltd.) will be held at Barum House, Harrison-road, Halifax, on Jan. 17, to receive an account of the winding up. Mr. J. E. Whitham, C.A., is liquidator.

W. R. Sharp and Co., electrical engineers, 154, West Regent-street, Glasgow, have executed a trust deed. Claims to Messrs. Blair and Sinclair, 144, West Regent-street, Glasgow.

Winding-up Petition.—A petition has been presented by Messrs. A. Vandam and Co. (for the compulsory winding-up of the Phaeton Electrical Co. (Ltd.). The petition will be heard on 20th inst.

Plant for Sale.—As announced in an advertisement, Mr. Herbert Humphries will sell by auction, on the premises of the Midland Acetylene (Parent) Syndicate (Ltd.), Corngreaves, Cradley Heath, on Monday, Tuesday, and Wednesday, 18th, 19th, and 20th inst. (commencing each day at 10 sharp), the whole of the costly electrical and steam plant recently laid down and employed in the manufacture of calcium carbide. The plant includes two Peache high-speed engines, two 150 kw. alternators, three Lancashire boilers, &c. Catalogues may be obtained from Mr. A. E. Mason, C.A., Priory-street, Dudley; Messrs. Burt and Haviland, solicitors, Bournemouth; Messrs. Homfray, Halberton and Mellor, solicitors, Brierley Hill and Cradley Heath; or from the auctioneer (Mr. Humphries), Brierley Hill and Stourbridge.

In an advertisement elsewhere will be found some particulars of electrolytic plant and accessories, which are for sale by treaty in one lot, or divided to suit purchasers' convenience. The whole plant is disposed as an electro-plating plant, and includes anodes of copper, nickel, and zinc, dynamo, and distribution mains and connections for carrying on the business. Inquiries should be addressed to Messrs. C. and J. G. Potter, Belgrave Mills, Darwen.

Messrs. Wheatley Kirk, Price and Co. notify in an advertisement having for disposal a compound lighting or power set, including Willans compound three-crank engine, 320 h.p., and Crompton four-pole dynamo.

Cable for Sale.—The Leeds Electric Lighting department have some second-hand Silvertown cable for sale, particulars of which are given in an advertisement.

American Plant Contract.—It is announced that the British Thomson-Houston Co.'s new works at Rugby will be equipped with American plant, at a cost of about £500,000.

Patent Amendment.—The British Thomson-Houston Co. has applied for leave to amend the specification of their patent, No. 13,920 (1892), granted to W. H. Knight and W. B. Potter for "improvements in methods of regulating electrically-driven mechanism and apparatus for putting same into operation." Particulars of the proposed amendment are given in the Illustrated Official Journal (Patents) of Dec. 6. Notice of opposition must be given by Jan. 6.

Railway and Canal Traffic Act (1888).—Elsewhere will be found the official proposed amendment of classification of the Railway and Canal Traffic Act (1888), for which the consent of the Board of Trade has been asked. It will be seen that the amended classification applies to (1) electroliers, (2) phonographs, and (3) photoscopes. Notices of objection must be sent to the Board of Trade within 21 days from the 18th inst.

Westinghouse Plant.—We have received from the British Westinghouse Co. five circulars illustrating the various types of dynamos and motors made by their American house, and which they are now prepared to supply in this country. The machines described have been on the market in the United States for a considerable time, but nevertheless the circulars in question, which are illustrated with finely-executed blocks, offer a useful summary of some of the company's specialities. The first circular (No. 1,000) deals with polyphase induction motors of the well-known Westinghouse "C" type, and includes illustrations not only of the complete motors but of their component parts. The standard motors of 200 h.p. and smaller sizes are provided with a cylindrical frame in which the stator is mounted. This frame forms a base for the machine and also supports the two end brackets carrying the self-oiling bearings. Perforated iron plates fitted into these brackets protect the rotor and permit excellent ventilation. They may, however, be replaced by solid plates when it is desired to make the motor absolutely dust-proof. Motors of a larger size are in the same general form, but the cast-iron stator frame is made in two parts, which are separated horizontally. The stator consists of a hollow cylinder built up of laminated steel rings, slotted on the inside to receive the conductors, these rings being rigidly supported by the cast-iron housing. In motors of large sizes the rings are not continuous, but are made up of segments and fitted into the corresponding slots in a hollow cylindrical cast-iron shell held in the cast-iron frame of the motor. As a rule, machine-wound coils are employed, but in the large sizes bar winding is made use of. The rotor is, as usual, built up of laminated steel discs mounted upon an open spider, and carries the rectangular copper bars of the winding-in slots. The same general form of rotor construction is used for motors from 1 h.p. to 500 h.p. Circular 1,001 describes belt-driven "railway generators," which are not likely to find a large market in this country. No. 1,002 describes generators and rotatory converters for electrolytic work, some fine examples of which are illustrated in an article in another column of this issue. No. 1,003 describes 125 volt continuous-current generators for direct coupling to engines, and circular 1,004 similar generators for 250 volts. Both of these types of generator are multipolar, the field castings being divided vertically and set upon a guide plate, thus affording excellent facilities for inspecting or removing the armature or field coil, without removing the outboard bearing or dismounting the engine. The field coils are over-compounded to compensate for the drop of potential in the line, unless otherwise ordered. The armature winding is made from bars of drawn copper, which after being shaped are thoroughly insulated, and baked to remove all moisture. The coils are held in slots by means of retaining wedges of hard fibre, driven into notches near the top of the slots parallel with the shaft. It is pointed out that these wedges may be pressed out at will, should it become necessary to remove any armature coil. Attention is called to the fact that the ring carrying the brush-holder brackets does not project over the commutator surface, which is therefore clear of obstruction and can easily be inspected at any time.

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Packing and Jointing Materials.—A very useful and complete catalogue giving particulars of the whole of the various branches of the United Asbestos Co.'s operations is now, for the first time, brought together into one volume, and will be found of service by users of the very varied classes of goods manufactured by this company. Asbestos goods are exhaustively treated, as well as rubber manufactures of every description for mechanical purposes, lubricants, boiler and pipe coverings and engineers stores, tools, and the everyday requisites which to the steam user are a necessity. A special feature of the catalogue is the treatment of packing and jointing materials, which include asbestos, rubber, gutta-percha, fibre, canvas, hemp, metallic packings, &c. For 14 years in succession the company has held Admiralty contracts for these goods, and it is fairly claimed that the company's trade marks and brands are recognised as a guarantee of quality in all parts of the world. The book is in a handy form and is clearly printed.

Electric Supplies Catalogue.—A compact illustrated price list of electrical accessories and sundries is issued by the Universal Electric Supply Co., of 47, Crossliffe-street, Moss Side, Manchester, and can be obtained on application.

Railway Diary and Directory.—We have received from Messrs. McCorquodale and Co. the 1900 edition of the "Railway Diary and Officials' Directory," published at 1s. We have in previous years found occasion to favourably review this useful publication, and on this occasion we have to record the addition of information which helps to expand the book and increase its value as a desk companion. To traders having business relations with the great railway undertakings of the kingdom the book should prove serviceable. A sheet railway almanac accompanies the diary.

1900 Calendars.—We have received from Messrs. Street and Co., the well-known London advertising contractors, a copy of their calendar for 1900. We have previously had occasion to compliment this firm upon the design of its calendar.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Dec. 6 to Dec. 12, with the ports of destination :—

Africa—Cape Town, £259 ; Chinde, £86 (telegraph material) ; Durban, £3,384 (including £3,202 telegraph material). *Argentina*—Buenos Ayres, £2,442. *Australasia*—Adelaide, £100 (telegraph material) ; Auckland, £33 ; Sydney, £1,085 ; Townsville, £265 (including £220 telegraph material) ; Wellington, £67. *Belgium*—Ostend, £37. *Brazil*—Bahia, £57 (telegraph instruments). *Ceylon*—Colombo, £858 (including £34 telegraph material). *Chili*—Valparaiso, £110. *China*—Shanghai, £79. *France*—Bordeaux, £32. *Germany*—Hamburg, £605 (including £230 telegraph material). *Holland*—Amsterdam, £60. *Hong Kong*—£195. *India*—Bombay, £74 ; Calcutta, £10. *Japan*—Kobe, £106 ; Yokohama, £143. *Russia*—Odessa, £151. *Spain*—Santander, £30. *Straits Settlements*—Singapore, £17. *Sweden*—Stockholm, £338 (including £310 telegraph material). *United States*—Boston, £25. *West Indies*—Trinidad, £46. Total, £10,694, against £13,957 in the corresponding week last year (Dec. 7 to Dec. 13).

MUNICIPAL, FOREIGN, AND GENERAL NOTES.

Auckland.—Two applications by private companies for provisional orders have been lodged for this district, but the Council have decided to support that of the Urban Electric Supply Co.

Battersea (London).—The Lighting committee have under consideration the question of installing electric light in private premises on the principle adopted by the gas companies in the supply of gas and gas fittings without requiring direct payment for the latter, and the vestry clerk has been directed to communicate with local authorities supplying electricity in the United Kingdom asking for information on the subject and to report concerning the powers of the Vestry in the matter.

Belfast.—Although the attempts made by the Corporation to acquire the undertaking of the Belfast Street Tramways Co. have proved abortive, the bill to authorise the purchase of the tramways in the city and to work the same electrically is to be proceeded with.

Beverley.—The Council are ascertaining the terms upon which an electrical expert would be prepared to report on electric lighting.

Bolton.—The Bradshaw, Breightmet and Great Lever electric tramway routes were officially inspected by Col Sir F. Marindin and Mr. A. P. Trotter on Friday last. The inspection proved satisfactory, and the lines were opened for traffic on Saturday.

Bradford.—At the Corporation meeting on Tuesday the Electricity committee submitted correspondence with the Board of Trade as to the requirements of the Board relative to the connection of electric tramway rails with water mains or earth plates for testing for leakage of return current. It appeared from this correspondence that the waterworks department have declined to sanction the necessary connection to the water mains on account of fear of electrolytic action being set up, and it was resolved that the Water committee be again requested to give the requisite facilities for connection of the electric tramway rails to the water mains.

The Gas and Electricity committee recommend that the electrical engineer be authorised to lay down electric cables required in connection with the new tramways, at an estimated cost of £7,500.

Cardiff.—At a meeting of the Council on Monday the Electrical and Lighting committee presented a recommendation on the subject of the litigation between the Corporation and Messrs. S. Z. de Ferranti (Ltd). The recommendation was as under: "That counsel be instructed that the sub-committee are willing to settle this action provided the defendants pay the Corporation £2 500 and all costs as between party and party, and that the defendants give a written undertaking to put the engine in proper working order, to the complete satisfaction of the electrical engineer and Messrs. H. R. J. Burstall and Ll. B. Atkinson, within six months from this date, or failing this to supply the Corporation with a new 300 kw. steam alternator, built to and fulfilling all the conditions named in the original specification." Councillor Meyrick said he understood the defendants had paid £1,500 into court, and in view of the intricate nature of the action, the risks of the law, and the fact that a considerable sum in costs would in any event fall upon the Corporation, he asked if it was wise to instruct counsel to act specifically on the lines set out in the committee's recommendation. Were they going to stand out for this particular sum of £2,500 and costs? He thought the action was one in which no reasonable offer should be refused. He did not think the hands of the sub-committee should be tied to the terms of the resolution. He moved the elimination of the minute, and this was approved.

City and South London Railway Rating.—At yesterday's meeting of the Court of Common Council of the City of London, in reply to a question as to why the City and South London Railway was not rated in the City, Mr. H. C. Morris, chairman of the Finance and Improvements committee, stated that the Court did not itself rate; it only accepted the rating as settled by the Guardians. As the result of inquiries made upon the subject, it had been ascertained that at the meeting of the Guardians on Oct. 18 the item was struck out, the view taken by the Assessment committee being that as the line does not pass under any site previously occupied by a building, they could not include it in the supplemental list, but must wait until the next quinquennial valuation.

City of London.—Gas is to be superseded by the electric light at the offices of the City of London Union.

Clacton.—Mr. W. H. Trentham has been appointed consulting engineer to the Council.

Colchester.—The National Electric Wiring Co. has offered to wire premises in this district and to provide fittings, &c., on the easy payment system, and the Council are seeking further particulars. The company undertake to provide and fix all necessary wires and fittings complete and ready for use in all classes of property at a charge of 1d. per unit on all current used through the wires, with a minimum payment of 1s. per 8 c.p. equivalent, no charge being made in the event of the premises becoming untenanted or the Council failing to obtain payment. If the Council adopt a maximum demand system of charging, the company undertake to reduce their price proportionately. Each customer would be given the option of purchasing the installation at any time, and the company would give the authority the option of purchasing the complete installations by one single payment. A hire-purchase arrangement to consumers is included in the company's offer.

Dawson City (B C).—The telegraph line from Skagway to Dawson City has been completed and is now in full operation. The nearest point of call to Skagway for steamers is Cumberland (B.C.), and this places Dawson City within about 2½ days telegraphic communication with the outside world. It is stated that surveying officers are at work for a telegraph line from Ashcroft on the Canadian-Pacific route *viâ* Quesnelle (B.C.) to Telegraph Creek, a point in the valley of the Stikine River. As soon as this survey is completed a telelegraph line will, it is expected, be constructed. A branch line to Atlin (B.C.) from Lake Bennet will shortly be in operation.

Dewsbury.—The Corporation have arrived at an understanding with the British Electric Traction Co. The Corporation's application for an electric tramway order will be withdrawn, and the company agree to take current from the Corporation works.

Dundee.—The electricity rental from May 15 to Dec. 1 amounts to £2,824. 13s. 5d., an increase of £697. 0s. 4d. ; 30 new consumers, representing an equivalent of 1,773 8-c.p. lamps were connected to the mains during November.

Eastbourne.—An inquiry was held here last week into the application of the Council to borrow £88,635 for the purchase of the undertaking of the Eastbourne Electric Light Co. The town clerk (Mr. H. W. Fovargue) said a resolution was passed by the Council in Aug., 1899, to apply for sanction to borrow £82,135 for purchasing the undertaking. Of this sum £80,135 was for the purchase, £2,000 compensation to officers, and £6,500 for new plant and machinery.

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The subject had been before the Council since 1897, when they instructed Mr. W. C. C. Hawtayne to ascertain the cost of providing electric light for public purposes in the borough. Whereas the Corporation lighting Bill was then £5,923 per annum, Mr. Hawtayne advised them that to put down their own plant for light equal to that then received would cost £3,671 per annum, which would result in a considerable annual saving per annum on the lighting of public buildings and lamps. A provisional order was obtained, and negotiations were entered into with the Eastbourne Co. for the purchase of their undertaking. The company's profits for 1898 amounted to £4,574. 5s. 6d., and they had based their calculations on an 18 years' purchase. The gross profits in 1896 were £3,141; in 1897, £3,619; and in 1898, £4,574; and for three-quarters of the present year the profits had been £1,164 more than for the corresponding period of 1898. As to the high charge for current (7½d. per unit), they thought it should be reduced to 5d. or 6d, and even if this reduction took place, there was every reason to believe that the increase in the profits would not only be maintained, but he still further augmented. There was some opposition on the ground that the purchase price was excessive, but the consulting engineer (Mr. W. C. C. Hawtayne), who valued the undertaking, said that the Council had got a very good bargain. It was certainly possible to reduce the cost by the substitution of more modern machinery.

Edinburgh.—The Electric Lighting committee recommend the Council to increase the salary of the city electrical engineer (Mr. F. A. Newington) by £150 per annum.

Electric Tramways in South Lancashire.—A meeting of the representatives of Eccles, Urmston, Worsley, Little Hulton, Little Lever, Whitefield, Barton, and Davyhulme was held last week to consider the draft provisional order which is being applied for by the United Kingdom Tramway and Electrical Syndicate for the construction of a system of electric tramways from Eccles to Whitefield, and also the bill and plans submitted by the South Lancashire Tramways Co. Various proposed amendments of the order have been submitted to the solicitors of the company.

Enfield.—An electrical expert is to be engaged by the Council to report upon the proposed application of a company for a provisional order, and particularly as to whether the Council should itself take steps to obtain electric lighting powers.

Exeter.—Mr. T. P. Wilmshurst, of Derby, has submitted a preliminary report on the arrangement of the new site for the electricity generating station, and on the recommendation of the Electric Lighting committee has been instructed to inspect the site and report Refuse destructor works are also to be erected in conjunction with the proposed generating station.

Great Yarmouth.—In anticipation of obtaining sanction for an additional loan, the surveyor has been empowered to advertise for tenders for further generating plant, estimated to cost £10,500.

Greenock.—Recently the Police Board invited tenders for leasing the local tramways, but only one tender (that of the Greenock and Port Glasgow Tramways Co.) was submitted. It has now been decided to invite fresh tenders from the following firms:—Greenock and Port Glasgow Tramways Co., W. M. Murphy, Dick, Kerr and Co., British Schuckert Co., the British Thomson-Houston Co, Drake and Gorham Electric Traction Co., and the English Industrials.

Hanley.—At a meeting of ratepayers this week it was decided to ask the Council to consider the question of electric lighting.

Hospital Lighting.—Guy's Hospital is to be lighted electrically, and the contract for the generating plant has been given to Messrs. D. Bruce Peebles and Co. Willans engines are to be used.

Howth (Dublin).—An inquiry was held here last week into the application of the North Dublin Rural District Council for powers to light the district of Howth and Sutton. It is probable that the district will before long be lighted electrically, but the Council propose to adopt oil lighting temporarily.

Light Railways.—The application of the Oldham, Ashton, and Hyde Electric Tramway for the extension of their light railway is to be opposed by the Hyde and Dukinfield Councils. A joint municipal electric lighting and traction scheme for Hyde, Mossley, Salybridge and Dukinfield is being prepared.

On Tuesday the Board of Trade heard an appeal against the confirmation of the order of the Light Railway Commissioners for the construction of the South Staffordshire light railways (about four miles in length) which would form a connection with the Wolverhampton tramways. The objectors were the Wolverhampton Corporation, and Mr. Lloyd, Q.C., on their behalf objected to the preamble of the order on the ground that the provisions of the Light Railway Act had not been complied with. There were numbers of tramways within the borough, and the policy of the Corporation had been in recent years to obtain control over the tramways, and they were now negotiating for the purchase of the Dudley and Wolverhampton lines. Negotiations had also taken place with the promoters of the South Staffordshire light railway. They were now objecting because the promoters had introduced junctions which were not in the order before the Commissioners. Mr. S. Morse (for the promoters) said the lines would be useless without these junctions. Mr. Lloyd contended there was no authority under the Light Railways Act to give powers of making junctions against the will of a Corporation. Mr. Morse said the line was essential for the accommodation of the district, and he contended that, as the Commissioners had heard the Corporation, it was now too late to raise the objection. The line would be continuous from Bilston to Wolverhampton, and it was absolutely necessary that the junction should be made. Sir Courtenay Boyle decided that there was no power under the order to make a physical junction with the Wolverhampton Corporation tramways, and therefore it could not be done without the consent of the Corporation. The appeal of the Corporation was upheld, and therefore future negotiations as to junctions must be confirmed by the Board of Trade.

The South Blyth District Council have sanctioned a proposal to construct light electric railways.

London County Council.—At Tuesday's meeting it was agreed to allow the Whitechapel District Board to repay no part of the principal on a loan of £10,000 for electric lighting purposes for the first three years, but to spread the repayment over the term of the remaining 39 years.

The Finance committee recommended that a loan of £16,500 be granted to the Bermondsey Vestry, repayable on the annuity system within 50 years, to defray the cost of freehold land for an electricity station, dust destructor, &c. Dr. Cooper and Lieut.-Col. Ford opposed, and the recommendation was referred back.

A loan was granted to the Newington Vestry of £15,500, repayable on the instalment system, for extensions to the electric lighting plant at the generating station.

The St. Pancras Vestry obtained a loan of £24,720 to defray the cost of electric lighting in the parish. The amount asked for was £24 971, but £159 was deducted for tools and £84 representing the value of a part of the Vestry's chief electrical engineer's services, both of which items it was decided should be charged to maintenance.

The Parliamentary committee received formal permission to proceed with the nine bills which the Council have presented to Parliament dealing with tramways in the Council's area.

Longton.—The gas manager has been instructed to prepare plans and specifications for an electricity supply scheme. The members of the Gas and Electricity committee are to visit Stockport and other electricity stations, in order to obtain information.

Marylebone (London).—Last night the Vestry discussed a letter from the Metropolitan Electric Supply Co., stating that certain repairs were being executed at their works, and asking that consumers should use only a small supply. Sir E. Galsworthy said the company had issued a circular letter yesterday (Thursday) stating that it was anticipated that the necessary works would be executed by Sunday. He urged that the machinery ought to have been erected before the company increased their customers. He hoped the Vestry would do all they could to enforce the penalties. There were numerous complaints. Mr. John Lewis thought the company were liable for having contracted to supply light for a given time, and failing to do so. Mr. Stringer (chairman of the Parliamentary Committee) said they had decided to at once appoint an inspector. They had sent notice to the company to instal without delay indicators at all the circuits the company had. He hoped consumers who were not supplied with electric current would combine and take out a summons against the company, who were liable to a penalty of 40s. a day. When the indicators were put in, then if the company did not give the proper pressure they would be liable to a penalty of £50 per day. The salary of the inspector would be under £5 a week. On the motion of Sir E. Galsworthy it was agreed to give the use of the Court House for a meeting of complaining consumers. Whilst the discussion was proceeding the electric light went out. It was then agreed that the Vestry Clerk be instructed to take out a summons against the Metropolitan Electric Supply Company to recover a 40s. penalty for the non-supply of electric energy.

A debate followed upon the report from Messrs. Whamond, Williams and Co., chartered accountants, as to the valuation of that portion of the Metropolitan Co.'s undertaking, situated in St. Marylebone. Details of this report appeared in *The Electrician* for Sept. 29 last. It was recommended by the Parliamentary Committee that copies of the report should be forwarded to each member of the Vestry with amendment sheets, and that the engineers and accountants should be asked to formulate a joint report on the financial prospects should the Vestry acquire the West London undertaking. Finally, the recommendation was referred back to the committee for further consideration.

Municipal Telephony.—By the casting vote of the Chairman the Worsley District Council have decided to support the application of the Mutual Telephone Co. for a telephone licence.

Omagh (Ireland).—The Council have appointed a special committee to obtain information as to lighting the town electrically.

Pickering.—At the next Council meeting a member will move that information be obtained as to the advisability of establishing electricity supply works.

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Plymouth.—The demand for current for private lighting has exceeded the most sanguine expectations, and the question of extensions is already under consideration. The capacity of the existing plant is equal to about 12,000 8 c.p. lamps. In addition to current for street lighting and electric tramways, already 11,500 8 c.p. incandescents are either being supplied or have been applied for, and the authorities will soon have to decline to make further connections until the plant at Prince Rock works has been extended. The Board of Trade has sanctioned the loan for the conversion of the Compton tramway section to electric lines.

Poplar (London).—Last week the District Board of Works decided to apply for an additional loan of £4,370 for extensions of the electricity supply buildings and to cover excess expenditure on original scheme, &c.

Provisional Order Transfer.—The Glossop Corporation give notice of intention to transfer their provisional order to the Urban Electric Supply Co. (Ltd.). The right to repurchase at the end of seven years or at any subsequent period of seven years is reserved, and the company are to lay (if required) mains in any street where the Corporation have public lamps, and to supply energy to such lamps at 3d. per unit.

Rhyl.—The Council have applied for sanction to borrow £15,250 for electric lighting purposes, and £4,750 for a refuse destructor. Messrs. W. H. Trentham and G. R. Peers have been engaged to prepare the necessary plans and specifications.

St. Giles (London, W.C.).—On Tuesday the St. Giles Board of Works adopted the report of the Law and Parliamentary committee upon a letter from the secretary to the Post Office dealing with the rights of the National Telephone Co. to lay telephone wires and pipes under the streets. The committee recommended that no action be taken in the matter. Mr. E. Upton said that some time ago the Post Office entered into a covenant with the National Co. to permit them to lay their wires in trenches opened for telegraph purposes. The Post Office had since changed their mind and a rivalry now existed between them and the company. He did not consider that they (the Board) should do anything to prevent the National Co. from laying their wires. Neither the Post Office nor the company had authority to open the streets, and if they did the local authority could take action against both.

St. Helens.—Colonel Yorke and Mr. A. P. Trotter officially inspected the Peasley Cross electric tramway route on Friday last. The line was opened for traffic on Saturday.

Sheffield.—It was announced at the Council meeting on Wednesday that there would be a deficiency of about £3,000 on the working of the electricity department for the current year. The revenue is about £2,000 less than last year; the expenditure shows an increase of £1,000; and the sinking fund absorbs £2,600. Alderman Styring said the Electricity committee had an important undertaking to look after, and were justified in saying it would be to the benefit of the Council to have more expert opinion to advise as to the future. Their experts (Mr. Hammond and Mr. Johnson) did not agree on all points, but there was no disadvantage in that, and the reports sent in by these gentlemen conveyed the impression of perfect sincerity. Although Mr. Johnson had taken a somewhat pessimistic view, there was evidence in his report that there was an ardent intention on his part to make the undertaking work out as well as possible for the Corporation. The committee were of opinion that the dividends paid by the old company were earned.

Shildon.—The Council have decided not to proceed with their application for a provisional order, but a committee has been appointed to collect further information, and report to the Council on electric lighting matters generally.

Smethwick.—The Council have decided to oppose the application of the Midland Electric Corporation for Power Distribution for a provisional order for this district.

South Shields.—The accounts of the electricity department for the half-year ended Sept. 30 show a revenue of £2,859. 2s. 3d., and expenditure £1,745. 15s. 3d., leaving a profit of £1,113. 7s. against £150. 13s. 4d. in the corresponding period of last year. For the period under review, interest absorbed £931. 6s. 5d., and sinking fund £998. 8s. 9d, showing a net deficit of £612. 2s.

An inquiry was held here on Wednesday into the application of the Corporation to borrow £15,600 for electric lighting. There was no opposition. Technical details were given by the borough electrical engineer (Mr. J. A. Jeckell).

Tiverton.—The Council have decided, on the recommendation of the borough engineer (Mr. J. Siddalls), to carry out the provisions of their electric lighting order and to erect electricity works on land adjoining the gas works. Mr. Siddalls recommends the Council to lay low tension mains in the principal thoroughfares. He estimates that within three years the equivalent of 2,000 8 c.p. lamps would be taken up by private consumers, and during the time the installation was working up to these figures inquiries should be made as to utilising water-power instead of steam or gas. The capital outlay is put at £6,000, expenditure £1,300, and revenue (when the 2,000 lamps are connected, and including £200 for public lighting) £1,400 per annum.

Telephone in the Navy.—Telephonic communication has been established between the 'Cambridge" gunnery ship at Devonport and the shore training establishment for the gunnery department at Trevol. A scheme is being arranged to connect up all the naval establishments, ashore and afloat, at Devonport by telephone.

Tunbridge Wells.—An inquiry was held here on Friday into the application of the Corporation to borrow £25,000 for electric lighting extensions. The town clerk (Mr. Cripps) said the present electric lighting loans amounted to £40,000. The equivalent of 24,000 8 c.p. lamps had been connected, and this number would be considerably increased by the demands from the extended area. Technical details were supplied by the borough electrical engineer (Mr. H. L. P. Boot). There was no opposition.

Tynemouth.—A loan of £34,850 is to be taken up from the Public Works Loan Board for electricity supply purposes.

Walsall.—Sanction to an additional loan of £15,000 for extensions of the electric lighting undertaking is to be applied for. The demand for electricity has increased 50 per cent. during the year, and the plant at the station is now working at its full capacity.

Warwick.—The Corporation have passed a report recommending the Leamington and Warwick Councils to purchase the existing tramways with a view to equipping the lines electrically either by the Corporation or under lease to a company.

Whitechapel (London).—The District Board of Works have applied for a further loan of £30,000 at 3½ per cent. for electric lighting purposes, but the London County Council have been requested to agree to a proposal that repayment should not commence until three years after the granting of the loan.

Wimbledon.—Up to date the applications for electric current amount to the equivalent of 13,000 8 c.p. lamps for lighting and 1,400 8 c.p. for motor power and heating.

Workhouse Lighting.—The Liskeard Guardians have instructed a committee to obtain information and estimates for lighting the workhouse by electricity and by acetylene gas.

PATENT RECORD.

The following list of Applications for Patents and Specifications published has been compiled for this journal by Messrs. J. C. Chapman and Co., *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs, and Trade Marks may be obtained.*

APPLICATIONS FOR PATENTS.

Note.—*The undermentioned Applications are not open to public inspection until after the acceptance of the complete Specification. The names within parentheses are those of communicators of inventions. When complete specification accompanies application, an asterisk is affixed.*

October 18, 1899.

20,818. A. A. Beadle. London. Improvements in primary electric batteries.

20,862. G. L. Addenbrooke. London. Improvements in or relating to the method and apparatus used in electrotstatically measuring electric currents in a working circuit and calibrating the measuring instruments so employed.*

20,877. The Improved Electric Glow Lamp Co. (Limited) and A. Barnes. London. Improvements in the manufacture of reflecting opalescent surfaces for electric lamps or glass reflectors.

20,882. M. Weidlich and K. Nies (trading as the Sächsische Broncewaarenfabrik Aktien-Gesellschaft). London. Improved sliding contact for telescopic or similar adjustable electroliers.*

October 19, 1899.

20,900. E. M. Salmony. London. Electrically illuminated billiard marking board.

20,903. F. W. Webb and A. M. Thompson. Crewe. Improvements in apparatus for working railway points and signals by electric power.

20,906. E. M. Munro, W. Wood, H. Brecknell, and H. I. Rogers. Bristol. Improvements in trolley standards used on cars or wagons electrically propelled from an overhead wire.

20,912. W. H. Merriman. Birmingham. Improvements in electric tramways on a road-contact system.

20,925. C. Luckow, jun. London. A process for directly obtaining the caustic lyes and ammonia and earth alkaline hydroxides by electrolysis.*

October 20, 1899.

20,983. W. Wood. Bristol. Improvements in trolleys used on overhead wires for electric traction.*

20,986. W. W. Hauscom and A. Hough. Manchester. Improvements in machines for and the method of making electrodes for storage batteries.*

October 21, 1899.

21,054. G. E. Cutland and G. Bryant. Bournemouth. A new hot-wire arc lamp.

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21,076. B. Willcox. London. Improvements in electric cells or batteries. (The Columbus Electricitatsgesellschaft, Gesellschaft mit beschräukter Haftung, Germany.)
21,079. R. C. J. Sutherland London. Improvements in time indicators for use in connection with a telephonic service.
21,033. H. P. Davis and G. Wright. London. Improvements in controllers for electric motors. (Date applied for under Patents, &c., Act, 1883, Sec. 103, March 24, 1899, being date of application in United States.)

October 24, 1899.

21,210. G. Barker. London. Improvements in the method of and means for adjusting or setting of the points of tram lines and trolley wires of electric and other tramways.
21,219. J. Sachs. London. Improvements in electric cut-outs, and in electric switch devices applicable to and serving as holders therefor.*
21,222. C. Oliver. Plumstead. An improved projector arc lamp.
21,232. L. A. Jacobson. London. An improvement in ear-trumpets, applicable also to telephone receivers and the like.*
21,248. W. R. Lambert. London. An improved method of and means for mounting incandescent electric lamps.
21,267. C. Remy. London. Apparatus for enabling the positions of foreign bodies visible by the X-rays to be located, and for guiding the operator in searching for and extracting the same. (Date applied for under Patents, &c., Act, 1883, Sec. 103, April 4, 1899, being date of application in France.)

October 25, 1899.

21,283. M. B. Ryan. London. An automatic electric switch.
21,293. T. H. Parker. Wolverhampton. Improvements in switch apparatus for use in the surface contact system of electric traction and in operating switches used in such system.
21,302. C. Sondermann and R. Berlow. Liverpool. Improvements in or connected with electricity measuring instruments.*
21,311. A. J. Boult. London. Improvements in an apparatus for exhibiting electric signals, advertisements, and the like. (F. Y. Dalziel, France.)*
21,313. A. Fanti. Newcastle-on-Tyne. Electric motor.
21,329. P. E. Placet. London. Means of maintaining and renewing the charge of electric accumulators working motors for carriages, boats, and other vehicles. (Date applied for under Patent, &c. Act, 1883, Sec. 103, May 27, 1899, being date of application in France.)*
21,354. H. Aron and Aron Electricity Meter (Limited). London. Improvements in apparatus for electrically winding up or giving tension to driving springs.*
21,355. H. Aron and Aron Electricity Meter (Limited). London. Improvements in apparatus for measuring multiphase electric currents.*

October 26, 1899.

21,375. R. H. Wilkinson. Liverpool. Improvements in or connected with trolleys or collectors for electrically-operated carriages.
21,378. E. S. Halsey. Chicago. Combined maximum and integrating electric meter. (Date applied for under Patents, &c., Act, 1883, Sec. 103, March 27, 1899, being date of application in U.S.A.)*
21,392. A. J. Boult. London. Improvements in or relating to contact devices for electric railways and tramways. (H. Laval, France.)
21,400. A. T. Wedelin. London. Tanning by aid of electricity.
21,413. J. Sachs. London. Improvements in safety fuses for electric circuits.*

October 27, 1899.

21,445. T. H. Parker. Wolverhampton. Improved means for use in operating from a running car switches employed with a surface-contact system of electric traction.
21,447. T. H. Parker. Wolverhampton. Improvements in the method of forming armature coils for dynamos and electric motors, and in apparatus for use therein.
21,470. A. Mühlberg. London. An automatic charging device for electric motor carriages.
21,498. J. A. Fleming. London. An improvement in receiving apparatus for wireless telegraphy.
21,509. L. de Montgomery. London. Improvements relating to the utilisation of the momentum of railway trains for the production of electricity.

October 28, 1899.

21,543. S. R. Bottone. Wallington. A dynamo coil.
21,562. H. Leitner. London. A separator for plates of secondary batteries.

October 30, 1899.

21,614. A. Wiseman. Birmingham. Improvements in suspension insulators for the trolley wires of electric tramways and the like.
21,630. G. Chappell, Jun., and H. Chappell. Liverpool. An electrical appliance for working points to tram and railway lines.
21,634. M. R. Heide. Berlin. Improvements in incandescent electric lamps.
21,637. H. Bremer. Germany. Electrodes for arc lamps.*
21,643. J. Peschek and N. Edwards. London. Improvements in electric cut-outs.
21,650. The British Thomson-Houston Co. (Limited). London. Improvements in systems of control for electrically propelled vehicles and trains. (W. B. Potter and Frank E. Case, United States.)*
21,651. The British Thomson-Houston Co. (Limited). London. Improvements in electric railways and controlling devices therefor. (W. B. Potter, United States.)*
21,652. The British Thomson-Houston Co. (Limited). London. Improvements in methods of and means for synchronising electric motors. (F. E. Case, United States.)*
21,653. The British Thomson-Houston Co. (Limited). London. Improvements in regulating electric motors. (F. E. Case, United States.)*
21,654. The British Thomson-Houston Co. (Limited). London. Improvements in electric brakes and method of operating the same. (F. E. Case, United States.)*
21,655. The British Thomson-Houston Co. (Limited). London. Improvements in systems of controlling electric motors. (A. S. Garfield, France.)*
21,656. The British Thomson-Houston Co. (Limited). London. Improvements in systems of control for electrically-propelled trains. (E. A. Sperry, United States.)*
21,657. The British Thomson-Houston Co. (Limited). London. Improvements in electric train control systems. (C. E. Barry, United States.)*
21,658. The British Thomson-Houston Co. (Limited). London. Improvements in signal systems for electric railways. (S. B. Stewart, United States.)*
21,659. The British Thomson-Houston Co. (Limited). London. Improvements in circuit breakers for alternating electric currents. (T. J. Johnston, United States.)*
21,660. The British Thomson-Houston Co. (Limited). London. Improvements in electric circuit breakers. (H. W. Buck, United States.)
21,661. The British Thomson-Houston Co. (Limited). London. Improvements in circuit breakers or switches of high potential electric circuits. (E. M. Hewlett, United States.)*
21,662. The British Thomson-Houston Co. (Limited). London. Improvements in electric arc lamps. (G. S. Steven, United States.)
21,663. The British Thomson-Houston Co. (Limited), London. Improvements in electric arc lamps. (R. Fleming, United States.)
21,664. The British Thomson-Houston Co. (Limited). London. Improvements in electric arc lamps. (C. E. Harthan and G. E. Stevens, United States.)*
21,665. The British Thomson-Houston Co. (Limited). London. Improvements in electric arc lamps. (R. Fleming, United States.)*
21,666. The British Thomson-Houston Co. (Limited). London. Improvements in automatic cut-out for rotary electrical converters. (C. P. Steinmetz, United States.)*
21,667. The British Thomson-Houston Co. (Limited). London. Improvements in systems of electrical distribution. (C. P. Steinmetz, United States.)*
21,668. The British Thomson-Houston Co. (Limited). London. Improvements in alternating electric current meters. (W. H. Pratt, United States.)*
21,669. The British Thomson-Houston Co. (Limited). London. Improvements in electric meters. (E. Thomson, United States.)*
21,670. The British Thomson-Houston Co. (Limited). London. Improvements in alternating electric current transformers. (A. R. Everest, United States.)*
21,681. A. J. Boult. London. Improvements in or relating to electric batteries. (E. Perrot, France.)

October 31, 1899.

21,720. T. Bell and S. S. Berry. Manchester. Improvements in and relating to switches for electric lights.
21,730. J. R. Lockie. Glasgow. Improved starting and reversing switch for electric motors.
21,742. T. J. McTighe. Birmingham. Improvements in electric railway rail-bonds. (Date applied for under Patents, &c., Act, 1883, Sec. 103, May 24, 1899, being date of application in United States.)*
21,748. T. W. H. Biddle and F. D. Gray. London. Improvements in or relating to electric lamps for carriages and like vehicles.
21,777. D. Szanka and Ganz and Co., Eisengiesserei und Maschinen-Fabriks Actien-Gesellschaft. London. Improvements in electric conducting sheaths or coverings for articles of ceramic or pulverulent materials.*
21,778. H. Rowntree. London. Improvements in electrically-controlled elevators or lifts.*
21,780. H. H. Lake. London. Improvements in electric relays. (W. G. Nixon, United States.)*
21,785. C. Adams-Randall. London. Improvements in telephonic repeaters or relays and circuits connected therewith and therefor.
21,796. W. M. Mordey and G. C. Fricker. London. Improvements in electricity meters.
21,807. L. Casper and A. H. Peirce. London. Improvements in electric massage instruments.*
21,810. H. P. Davis and F. Conrad. London. Improvements in electrical measuring instruments. (Date applied for under Patents, &c., Act, 1885, Sec. 103, April 1, being date of application in United States.)

November 1, 1899.

21,844. H. C. L. Holden. Woolwich. Improvements in portable telephone apparatus.
21,862. R. Bayer. London. Improvements in bracket for incandescent electric lamps and the like. (Colsman and Co., Germany.)
21,877. A. Vosmaer. London. London. Improvements in or connected with electric arc lighting.
21,881. H. H. Lake. London. Improvements in electric incandescence lamps. (La Société de Commentry-Fourchambault et Decazeville, France.)
21,882. S. S. Grant. London. Improvements in means or apparatus for use at the crossing points of electric traction trolley wires.

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21,886. A. T. M. THOMSON and P. WARNFORD-DAVIS. London. Improvements in connecting plugs for electrical switchboards.*
21,893. R. BELFIELD. London. Improvements relating to electric railways.

November 2, 1899.

21,907. C. A. LEE. London. New or improved filaments for incandescence electric lamps, and processes for manufacturing such filaments.
21,922. S. RICHARDSON. Glasgow. Improvements in and relating to valves for electric action for organs.
21,960. W. A. BURNS. London. Improvements in electric traction.
21,966. F. FANTA. London. Improvements in or relating to the manufacture and repair of incandescent electric lamps.
21,968. H. H. LEIGH. London. Improvements in arc lamps and roller-clutch mechanism for feeding and controlling the electrodes therein. (T. E. Drohan, United States.)*

November 3, 1899.

21,990. H. OPPENHEIMER. London. Improvements in and connected with cord grips for electrical apparatus. Actien-Gesellschaft Mix and Genest, Germany.)
22,008. F. M. STAUNTON. Romford. A new or improved method and means of recording or indicating the amount of electric current or energy in a circuit.
22,016. M. BYNG and F. G. BELL. London. Improvements in electrical switches for telephonic systems and other purposes.*
22,028. R. EYCKEN, C. LEROY, and R. MORITZ. London. Improvements in or connected with electrodes for electrolysers. (Date applied for under Patents, &c., Act, 1883, Sec. 103, May 3, 1899, being date of application in France.)*
22,039. B. T. EMETT. London. Improvements in means for collecting electricity from the overhead conductors of electric tramways.

SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1898.

14,714. MARTINI. Vacuum dielectrics, electrodes, and apparatus for the production of ozone.
21,224. ROSI and VACOTTI. Electric clocks or watches.
21,715. FERGUSON and WHITE. Automatic means of breaking electric circuits.
21,944. LUCAS. Multiple electric switches.
21,974. COWPER-COLES. Electro-deposition of metals.
22,987. STUTTMANN. Electric arc lamps.
23,821. GILLESPIE and GILLESPIE. Coin-freed telephones.
23,841. REID. Brake apparatus for electrically-driven cranes and the like.
25,955. THOMPSON. (Elworthy.) Dynamometer or weighing machine.
36,164. CALLOW and ECK. Resistance switch for electric motors.
26,257. DE COINCY. Method of and apparatus for regulating the difference of potential at the terminals of dynamo-electric and like machines. (Date applied for under International Convention, June 6, 1898.)
25,453. RAINSFORD (Walsh). Collectors for electric tramways on the overhead conductor system.
26,527. LAKE (Maxim). Regulators for electric car motors.
27,453. LEITNER. Electric motors.

1899.

4,963. SAYER. Means for supplying power on electric and pneumatic railways and the like.
14,514. COX. Switchboards.
16,167. JOEDICKE. Switches for conductors in electric traction systems.
17,477. CHASE, CHASE, CODE, and PLANTA. Mouldings for electric wires and other purposes.
18,390. JUSTICE (Emerson Electric Manufacturing Co.). Ventilating fans of that class which is employed in connection with electric motors.
20,972. ANDERS and WILSON. Adaptation of the telephone to electric bell pushes such as are used in ordinary bell and indicator systems for private houses, offices, hotels, and the like.
22,803. STEELE, MAPLE, and VERITY. Incandescence electric lamps.

COMPANIES' MEETINGS AND REPORTS.

India Rubber, Gutta Percha, and Telegraph Works Co. (Limited).

The thirty-sixth ordinary general meeting of this company was held yesterday (Thursday). The Hon. HENRY MARSHAM presided.

The SECRETARY (Mr. T. J. Lloyd) having read the formal notice calling the meeting,

The CHAIRMAN said: You will have noticed that, in accordance with the resolutions passed at the extraordinary meeting held in July, the report and accounts now submitted are for a period extending over nine months, and that in the future our financial year will terminate on Sept. 30 in each year, instead of on Dec. 31 as heretofore. Notwithstanding the trouble to the staff, we believe the balance of benefit has been on the side of the new date. In comparing the present balance-sheet with that presented at the meeting held in February, the only substantial differences to be noticed are due to the company at present holding a larger stock of raw material. From my remarks at the half-yearly meeting in July you would have gathered that, in view of probable work, we had been purchasing larger quantities of gutta-percha than the immediate requirements demanded. It is well that we took the precaution, because since we bought, owing to an extra increase in the consumption of this gum, the available stocks have seriously diminished. In the profit and loss account, on the debit side, you will notice that in addition to the usual depreciations the figures include a depreciation of the c.s. "International." During this year we sold the vessel, and as we made a loss in the sale, we have charged this loss against revenue. The general business of the company has been fairly profitable, and the turnover has exceeded that of the similar period of 1898. In trading we are encountering keener competition every day, and it is much to be hoped that the prices of raw materials will not remain at their present high standards. Since I last addressed you we have been obliged to advance our list prices of certain goods, and it is probable that we shall have to make a further advance in other lines. Our electrical machinery department has been very busy, and, in addition to work done for our own factory at Silvertown, has completed installations for several municipalities, amongst others Leith, Canterbury, and Greenock. As I am addressing you to-day, the official reception of the work done by us at Hereford is taking place. At the half-yearly meeting I informed you that our c.s. "Dacia" was about to start for the West Indies, to lay a new cable for the International Ocean Telegraph Co. of New York, and I have now to state that she successfully completed her task. We have in course of manufacture about 1,000 miles of cable for the Commercial Cable Co. This cable will be laid next year between Canso and New York. I now move the adoption of the report and accounts, and that a dividend of 10s. per share, free of tax, payable on 15th inst., be now declared.

Mr. S. W. SILVER seconded the resolution.

The CHAIRMAN said he would be glad to answer any questions. There being no response, the resolution was carried unanimously.

The Hon. Henry Marsham was unanimously re-elected a director of the company.

The CHAIRMAN, in acknowledgment, said: I thank you very much for the honour you have done me in re-electing me once more a director of the company. I may mention that recently I have had the opportunity of visiting the works at Persan, and according to my judgment they are in a very good condition, and are very actively engaged with good business.

Mr. A. WESTON JARVIS was then unanimously re-elected a director, and Mr. TREBLE moved the re-appointment of Messrs. Turquand, Youngs, Bishop and Clarke, as auditors.

Mr. LAMONT seconded the resolution, and observed that the note appended to the auditor's certificate was exactly the same as that which appeared last last year, and at that time it called forth some comment. It appeared to him that the auditors either told the shareholders too much or too little. Their comments seemed to stir up the suspicion that something was wrong with the accounts, and that on a large scale. Of course, the shareholders were amply covered by the reserve, this fund being £450,000, and why the auditors should put that note to the accounts he could not understand, unless it were to frighten the shareholders. He did not suppose for a moment that there was anything wrong about the accounts, or that the reservation of the auditors involved a tithe or a twentieth of the amount of the reserve. He supposed the directors were satisfied with the matter, but at the same time he did not like to read the comment of the auditors in this respect. As he had said, it stirred up suspicion, and rather tended to cast a doubt as to the correctness and bona fides of the accounts.

The motion was unanimously passed.

A cordial vote of thanks to the chairman, directors, and management of the company terminated the proceedings.

Electric Lighting and Traction Co. of Australia (Limited).

The statutory meeting of this company was held on Monday. Mr. J. B. BRAITHWAITE, jun., presided, and said the 20,000 £5 Preference shares, which were over-applied for, had been allotted. The board had taken steps to find a competent engineer, and they had selected Mr. Clements, who was now in Melbourne in the company's interest. Delay was necessarily involved in carrying out the arrangement for acquiring the undertakings of the A. U. Alcock Electric Light and Motive Power Co. and the New Australian Electric Co. They believed, however, that by the end of this month the company would be in possession of the two lighting stations in Melbourne, and that Mr. Clements would be able to at once concentrate the work of both those undertakings at the Richmond station. The City Corporation of Melbourne had come to an agreement to purchase for £40,000 the portion of the electric cables which lay within its boundaries. In consideration of the transaction the Corporation promised to use their influence to obtain for this company powers to light for 25 years important residential suburbs of the city, and the board had received informat on that such powers had now been granted. By the beginning of the new year the company would be in possession of the two properties, and be enabled to introduce various economies as the result of the proposed amalgamation. The plant of the existing companies was already fully loaded, so that for the moment it was impossible to supply current to any further lights. Orders had already been placed for two additional 500 kw. generators. They hoped to commence the supply of current in the city of Geelong by the winter season, in May or June next. Since the formation of the company the board had taken advantage of an opportunity to acquire the undertaking of the South Australian Electric Lighting Co., which was formed to obtain rather exceptional legislative powers from the colony, including the lighting of Adelaide. The directors regarded this as a somewhat valuable acquisition. He thought the prospects of the company were quite equal to those foreshadowed in the prospectus.

A vote of thanks terminated the proceedings.

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BRITISH SOUTH AFRICA CO.—The report of this company to March 31 states that Rhodesia is about to make application for admission into the Postal Union. On Sept. 30 1898, 62 telegraph offices were open. Of these 17 were in the Bechuanaland Protectorate, 12 on the African Transcontinental Co.'s lines, and 12 on the British South Africa police telephone lines. The Rhodesia telegraph system, including the transcontinental line, consisted of 2,635 miles of line with 3,163 miles of wire. The police telephone system, at Sept. 30, 1898, consisted of 251 miles. Telephone exchanges have been opened at Salisbury and Bulawayo. The transcontinental telegraph line was completed to Karonga on Lake Nyassa in Oct. 1898. On Aug. 25, 1899, the Karonga-Abercorn section had been completed to within 25 miles of Abercorn on Lake Tanganyika, and a temporary telegraph office had been opened at the Saisi river. A branch line, 123 miles long, is being constructed from Domira Bay, Lake Nyassa, to Fort Jameson, in M'peseni's country. In July, 1898, the British South Africa Co. took over temporarily the maintenance and working of the African Transcontinental Co.'s lines under an agreement with that company. The whole of the line from Umtali to Lake Tanganyika is now worked and maintained under the supervision of the Postmaster-General of Southern Rhodesia. The transcontinental line now consists of 1,027 miles from Umtali to Abercorn, and 57 miles of the branch line (Chikwawa), Chiromo—total 1,024 miles. The Imperial German Government has recently agreed to the extension of the line from Abercorn northwards through German territory to British East Africa. Negotiations with the Eastern Telegraph Co. (Limited) and the Eastern and South African Telegraph Co. (Limited) for the provision of additional cable communication between the United Kingdom and South Africa were brought to a successful issue by Mr. S. R. French, C.M.G., the Postmaster-General of the Cape Colony, during his visit to England in Aug., 1899. A resolution in favour of the scheme for a third cable was passed at a conference subsequently held in London, and a draft agreement with the Eastern Telegraph Co. (Limited), and the Eastern and South African Telegraph Co. (Limited), has been submitted to the Colonial Office. The directors have expressed their willingness to support the scheme upon the lines proposed. The rate for cable messages to South Africa was reduced on Sept. 1, 1899, from 5s. to 4s. per word, inclusive of the South African terminal rate. The Rhodesian terminal rate was at the same time reduced from 3d. to 2d. per word. In Bulawayo a system of electric lighting has been established.

CALCUTTA TRAMWAY CO.—The report of the directors states that the protracted negotiations for the introduction of electric traction on the tramways have been brought to a successful conclusion. The principal conditions of the new agreement are: (*a*) That the company shall remain in possession of the lines for 30 years from Jan. 1, 1901, in consideration of the company converting the system from horse to electric traction within three years; (*b*) that the track rent payable to the Corporation for all lines now existing within their jurisdiction shall be Rs. 35,000 per annum from date of completion of the electrical equipment; (*c*) that, in lieu of all existing rights of purchase, the Corporation shall have the right of acquiring the undertaking, at the expiration of the above-mentioned period of 30 years, upon paying 25 years purchase of the average annual profits for the preceding seven years. If the right of purchase is not exercised at the expiration of 30 years, it can only be exercised at the expiration of successive periods of seven years. The climatic conditions, the uncertainty of prices of forage due to recurring periods of dearth and famine, and the inability of the horses themselves to do the work required of them, have hitherto made it almost impossible to meet the requirements of the travelling public, but the introduction of electric traction will obviate these difficulties. In order to provide capital for carrying out the electrical equipment the directors propose to create an issue of £350,000 4½ per cent. first debentures, which they estimate will suffice to redeem the existing issue of £100,000 5 per cent. debentures, to pay for the conversion to electric traction, and leave a margin of capital available for extensions or for the general purposes of the company. Preliminary surveys are in progress, and within a short time the directors will be in a position to let the contract for the electric plant, &c. No time will be lost in pushing on with the work, so that the new method of traction may be in operation at the earliest possible date.

MUTUAL TELEPHONE CO. (LTD).—The report of the directors of this company, dated 29th ult., contains a *resumé* of the proceedings of the directors since the registration. It is stated that capital to the extent of £82,305 was raised directly after resolutions in favour of the company had been received from the local authorities of Manchester. Salford, Eccles, and other districts in the Manchester telephone area. The Postmaster-General was then notified that the complied with the conditions for the grant of a licence required by the Treasury Minute of 1892, and a licence was asked for. Later, on pressure from the directors, the Postmaster-General replied "that he did not propose to issue any more licences to private companies for carrying on telephone business." The directors thereupon appealed to the Manchester Town Council for support, and the council addressed a communication to the Postmaster-General in favour of the company, only to receive a reply similar to that set out above. The council sent a deputation to the Postmaster-General, but without result. The directors appealed to the Treasury, but received no definite reply to their written commication. A final memorial was then prepared and presented to the Treasury, signed by about 100 members of Parliament. Sir W. H. Houldsworth, Bart., M.P., succeeded in inducing the Chancellor of the Exchequer to receive a deputation on behalf of the company, and the directors endeavoured to secure the support of the telephone committee of the Manchester City Council towards this deputation, but without success. Subsequently the directors placed their views before the Manchester Corporation, who appointed three representatives to attend the deputation to support the claims of the company. As a result the company were informed that the Treasury had definitely decided to grant it a licence. This brings the proceedings of the directors up to the passing of the Telephone Act of 1899, and the company were thereupon informed by the Postmaster-General that the resolution in their favour, already passed by the Manchester City Council and other local authorities in the Manchester telephone area, must be again reconfirmed, and the directors have obtained such reconfirmation from the majority of the local authorities, but not from the Manchester Corporation, who adopted an amendment to the company's application by which the final decision of the Council was postponed. This postponement was unfortunate, since the company's capital was subscribed on the condition that the license should be obtained not later than Dec. 31, 1899. A memorial is about to be presented to the Manchester City Council with a view to a special meeting being called to enable the directors to comply with the condition upon which the capital was subscribed. It will be seen that there is no time to be lost.

NEW COMPANIES, STATUTORY RETURNS, &c.

ADELAIDE DEVELOPMENT CO. (LTD.).—This company was registered on Dec. 2, with a capital of £25,000 in £10 shares, to carry on the business of tramway proprietors, electricians, mechanical and electrical engineers, &c., in Adelaide, South Australia, or elsewhere; and to enter into an agreement with the British Westinghouse Electric and Manufacturing Co. and Callender's Cable and Construction Co. (Ltd.). The subscribers are: L. H. Grundy, S. E. Appleton, J. W. Ward, T. C. Richards, E. E. Ford, G. C. Eggleton, and A. Booker.

ATLAS ENGINEERING CO. (LTD).—This company was registered on Nov. 27, with a capital of £2,000 in £1 shares, to acquire the business carried on at Southport under the title of Wild, Rothwell and Co., and to carry on the business of electrical, mechanical, and general engineers, motor car builders, &c. The subscribers are N. T. Pollitt, J. Malam. T. Pendlebury, J. B. Haworth, J. B. Davenport, J. Hall, and Mrs. A. Pendlebury. The first directors are J. Malam, N. T. Pollitt, and T Pendlebury.

ELECTRIC LIGHT INSURANCE AND MAINTENANCE CO. (LTD.)—This company was registered on Dec. 4, with a capital of £10,000 in £1 shares, to take over the business now carried on by the Electric Light Insurance and Maintenance Co. (Ltd.), to carry on the business of an electric light and electrical supply company in all its branches, and any guarantee, indemnity, and insurance business, except life insurance. The subscribers are: A. Lood, H. E. Lowry, J. B. Evans, D. Millist, G. R. Wellington, F. Flower, and H. H. Lyde.

HUDSWELL, CLARKE AND CO. (LTD.).—This company was registered on Nov. 29, with a capital of £100,000 in £5 shares (2,000 Five per Cent. Cumulative Preference), to acquire the business of Hudswell, Clarke and Co., to carry on the business of steel converters, mechanical and electrical engineers, &c.

OLDFIELD AND CO. (LTD.).—This company was registered on Nov. 20, with a capital of £10,000 in £1 shares, to acquire the business carried on by Oldfield and Co. (Limited), and to carry on the business of electricians, brass and iron founders.

ROTARY PISTON ENGINE CO. (LTD.)—This company was registered on Nov. 28, with a capital of £2,000 in £1 share, to acquire patents, Nos. 5,086 and 20,332 (1899), and to carry on the business of electricians, engineers, &c.

BRITISH ELECTRICAL ENGINEERING CO. (LTD.).—The annual return to Sept. 22 gives the capital as £660,000 in 180,000 Ordinary and 150,000 Preference shares of £2 each. 90,000 of each have been taken up and paid for in full.

EAST GRINSTEAD ELECTRIC LIGHTING CO. (LTD.).—This company's annual return to Nov. 3 gives capital as £15,000, in 5,000 Preference and 10,000 Ordinary shares of £1 each. Seven Ordinary shares have been taken up. No calls have been made.

MONTE VIDEO TELEPHONE CO. (LTD.).—This company's annual return to Nov. 9 has been filed. The capital is £160,000 in 87,000 Preference and 73,000 Ordinary shares of £1 each. 86,492 Preference and 72,680 Ordinary have been taken up, and are all considered as fully paid.

CITY NOTES.

MEMORANDA.—Bank rate 6 per cent. (since Nov. 30, 1899). Price of silver 27½d. per oz. (Dec. 14). Consols (2¾ per cent.) 101⅛—101⅞ for money, 102—102¼ for account; 2½ per cent. 98—98½ (Dec. 14). Stock Exchange Settling Days: Consols, Jan. 4; Stocks and Shares Continuation Day, Dec. 27; Ticket Day, Dec. 28; Pay Day, Dec. 29; Mining Share Carry-over Days, Dec. 23 and Jan. 9.

BARROW-IN-FURNESS TRAMWAYS CO.—The undertaking of this company has been purchased by the British Electric Traction Co. The Barrow Co. recently offered the lines and rolling stock to the Corporation for £22,000, but the offer was declined.

CHELSEA ELECTRICITY SUPPLY CO. (LTD.).—The books of this company are closed from 15th to 21st inst. inclusive, on account of payment of interest for the half-year on the Debenture stock.

CITY OF LONDON ELECTRIC LIGHTING CO. (LTD.).—The transfer books and register of holders of the £400,000 Five per Cent. Redeemable Debenture stock will be closed from 18th to 30th inst. inclusive, for preparing the warrants for the interest due Jan. 1.

COMPENSATION AND GUARANTEE FUND (LTD.).—We welcome the formation of this company, which has been established (according to the prospectus) to transact all kinds of insurance business, life assurance excepted. A prominent feature of the company's operations is to be the undertaking of employers' liability and workmen's compensation risks. The company has a strong board of directors, including the heads of many responsible commercial houses. Weakness is shown, we think, in its total authorised capital, which is only £400,000, in 80,000 shares of £5 each. The issue made this week is for £200,000 in 40,000 shares, payable 5s. on application, 5s. on allotment, and 10s. three months after allotment, which provides a present capital of only £40,000. This is a weakness which will be made the most of by the heavily-capitalised insurance companies whose fatuous policy in connection with workmen's compensation and employers' liability has, we believe, been the main cause of the formation of the Compensation and Guarantee Fund, Ltd. Had the capital of the new company been £1,000,000 and the first issue £250,000, the insuring public would have been impressed with the magnitude of the undertaking, but in these days of big figures £40,000 does not seem at all an adequate paid-up capital, even at the start, for the vast amount of business which awaits a company prepared to undertake employers' liability and workmen's compensation, fidelity guarantee, accidents, fire and burglary risks on anything like reasonable terms. We await the publication of these terms with interest, and in the meantime commend the remarks of Mr. J. Chamberlain, M.P., published in our last issue (p. 243) to the directors' careful consideration.

EASTERN TELEGRAPH CO. (LTD.).—This company announce the payment on Jan. 15 next of dividends at the rate of 3½ per cent. per annum, less income tax, on the Preference stock for the quarter ending 31st inst., and an interim dividend of 1½ per cent. on the Ordinary stock, free of income tax, in respect of profits for the quarter ended Sept. 30. The transfer books will be closed from Jan. 8 to 15 inclusive.

ELECTROLYTIC ALKALI CO. (LTD.).—Letters of allotment in the recent issue of capital have been posted.

W. T. GLOVER AND CO. (LTD.).—The Debenture stock transfer books of this company will be closed from 16th to 30th inst. inclusive, for the preparation of interest warrants.

GUTTA PERCHA CORPORATION (LTD.).—An extraordinary meeting has been convened for the purpose of winding up, and, if considered expedient, reconstructing the company.

LONDON ELECTRIC SUPPLY CORPORATION (LTD.).—The transfer books of the Four per Cent. First Mortgage Debenture stock are closed from 11th to 31st inst. inclusive.

NATIONAL TELEPHONE CO. (LTD.).—The transfer books of the Three and-a-half per Cent. Debenture stock will be closed from 18th to 30th inst. inclusive, for the preparation of warrants for the half-year's interest due Jan. 1.

WESTERN TELEGRAPH CO. (LTD.).—The special resolutions changing the name of the Brazilian Submarine Telegraph Co. (Ltd.) and the Western and Brazilian Telegraph Co. (Ltd.) to the "Western Telegraph Co. (Ltd.)" having been duly confirmed by the shareholders of the two first-named companies, sanction to the change has been given by the Board of Trade and a certificate has been issued by the registrar of joint stock companies.

WESTERN UNION TELEGRAPH CO. (LTD.).—The Executive committee recommend the usual quarterly dividend of 1¼ per cent.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	1899	£	£		£	£
*Birmingham Tramways.	Dec. 9	4,134	+ 266	23	95,998	+ 9,811
Blackpool Corporation...	,, 7	138	+ 11	36	20,309	+ 4,366
Blackpool and Fleetwood	,, 9	127	- 10	23	19,864	+ 5,877
Bradford Corporation ...	,, 10	335	+ 88	69	22,969	...
Brisbane Trams	Oct. 25	1,497	+ 385	4	6,146	+ 2,110
*Bristol Trams & Carriage	Dec. 8	2,631	+ 73	23	72,080	+ 8,539
*Buenos Ayres & Belgrano	Nov. 12	2,494	+ 902	45	97,361	+43,862
City & South London Ry.	Dec. 10	1,110	- 7	24	23,650	- 103
Dover Corporation	,, 9	145	+ 3	26	7,762	+ 1,044
Dublin United	,, 8	2,944	+ 230	...	...	...
Dublin Southern Dist....	,, 8	672	+ 22	...	...	...
*Glasgow Corporation ...	,, 9	8,647	+ 602	...	...	...
*Liverpool Corporation...	,, 2	6,982	+1,250	48	331,096	+40,167
Liverpool Overhead Rly.	,, 10	1,453	+ 70	23	38,938	+ 1,883
*Sheffield Tramways	,, 10	1,745	- 161	50	71,317	+20,506
*South Staffs. Trams....	,, 8	671	+ 71	49	32,651	+ 1,701

* Partly electrical.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	NAME.	Previous Week's Price, Dec. 6.	Price Wednesday, Dec. 13.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Dec. 13. Highest	Lowest
			TELEGRAPHS.			£ s. d.			
£110,900	100	4%	*African Direct Telegraph 4% Mort. Deb. (red.)	100 104	100 104	3 16 11	January and July	...	...
25,000	10	...	Amazon Telegraph	3 4	3 4	...	June and December	...	...
£125,000	100	5%	Do. 5 per Cent. Debentures	85 90	85 90	5 11 1	...	...	...
£875,520	Stock	15/0	Anglo-American	65 68	65 68	5 2 3	Feb., May, Aug., Nov.	...	...
£3,062,240	Stock	30/0	Do. Preferred	115½ 116½	115½ 116½	5 3 11	,, ,,	116⅝	115½
£3,062,240	Stock	18/0	Do. Deferred	17 17½	16½ 17½	5 4 4	...	17 9/16	16⅝
206,993	10	5/0	Brazilian Submarine	15 15½	14½ 15½	4 11 10	Mar., June, Oct., Dec.	15¼	14½
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1900)	107 111	107 111	4 11 6	June and December	...	...
$10,000,000	$100	$1¼	Commercial Cable Capital Stock	198 202	198 202	3 19 9	Jan., Apr., July, Oct.	...	...
£1,333,333	Stock	4%	* Do. 4 per Cent. Debenture Stock	103 105	103 105	3 16 6	,, ,,	104	103
16,000	10	8/0	Cuba Submarine Ordinary	9 10	8½ 9½	8 8 5	February and August	9¼	...
6,000	10	10,0	Do. Preference 10 per Cent.	19 20	19 20	5 0 0	,, ,,	...	...
12,981	5	2/0	Direct Spanish Ordinary	4 5	4 5	4 0 0	April and October	...	...
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference	9 10	9 10	5 0 0	,, ,,	...	...
£20,000	50	4½%	Do. 4½ per Cent. Debentures	103⅞ 107⅞	103⅞ 107⅞	4 4 1	January and July	...	...
60,710	20	3 0	Direct United States Cable	11⅞ 12⅛	11⅞ 12⅛	5 14 3	Jan., Apr., July, Oct.	12	...
£120,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red.)	101 104	101 104	4 7 10	June and December	...	...
£4,000,000	Stock	5%	Eastern Ordinary	154 159	150 155	4 11 6	Jan., Apr., July, Oct.	156	153
£1,795,000	Stock	3½%	Do. 3½ per Cent. Preference Stock	98 101	98 101	3 9 8	,, ,,	99⅞	98½
£1,432,268	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.)	116 121	115 120	3 6 11	May and November	116	...
250,000	10	2/6	Eastern Extension	15½ 15¾	15 15½	4 8 11	Jan., Apr., July, Oct.	15 1/16	14¾
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	117 122	116 151	3 6 7	February and August	...	...
£16,200	100	5%	* Do. 5% (Austln. Gov. Sub.) Deb., 1900 (reg.)	99 103	99 103	4 17 4	January and July	...	...
£84,400	100	5%	Do. (Bearer)	100 103	100 103	4 17 1	,, ,,	...	...
£17,400	100	5%	*Eastern and S. African 5% Mort. Deb., 1900 (reg.)	99 103	99 103	4 17 1	,, ,,	...	...
£24,500	100	5%	Do. (Bearer)	100 103	100 103	4 17 1	,, ,,	...	...
£300,000	100	4%	* Do. 4 per Cent. Mortgage Debentures, 1909	101 104	101 104	3 16 11	February and August	...	...
£200,000	25	4%	Do. 4 per Cent. Mauritius Sub. Debs. (red.)	101⅞ 104⅞	101⅞ 104⅞	3 16 10	May and November	...	...
180,227	10	1/9	Globe Telegraph and Trust	11½ 11¾	11½ 11¾	4 9 4	Jan., Apr., July, Oct.	11½	11½
180,042	10	3/0	Do. 6 per Cent. Preference	15¾ 16	15¾ 15¾	3 16 2	,, ,,	15 13/16	15 15/16
150,000	10	5/0	Great Northern of Copenhagen	31 33	31 33	3 15 9	January and July	...	...
£89,500	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb. (red.)	100 103	100 103	4 7 5	...	...	...
17,000	25	12/6	Indo-European	48 52	48 52	4 16 2	May and November	10	...
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904	106 109	106 109	5 10 1	March and September	...	...
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.)	102 105	102 105	3 17 6	June and December	103½	...
11,339	8	4/0	Reuter's	7 8	7 8	5 0 0	April and October	7¼	...
3,381	£100 Cert.	6%	Submarine Cables Trust	127 132	126 131	4 12 1	,, ,,	...	...
15,600	10	...	West African Telegraph	2½ 3½	2½ 3½	4 9 3	December and July	...	...
£200,000	100	5%	* Do. 5 per Cent. Debentures (red.)	99 102	99 102	4 18 0	March and September	101½	100
20,008	2½	...	West Coast of America	¼ 1	¼ 1	...	...	...	...
£150,000	100	4%	* Do. 4 per Cent. Debentures	102 105	102 105	3 16 8	January and July	...	...
88,321	10	6d.	West India and Panama	⅞ 1⅛	⅞ 1⅛	...	May and November	...	...
34,563	10	6/0	Do. 6 per Cent. 1st Preference	9½ 10	9½ 9¾	6 3 1	,, ,,	9 1/16	9½
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	7½ 8½	7½ 8½	7 1 2	,, ,,	...	...
£80,000	100	5%	* Do. 5 per Cent. Debentures	106 109	106 109	4 13 7	January and July	...	...
£399,731	Stock	4%	Western & Brazilian 4 per Cent. Debenture Stock	104 107	104 107	3 15 0	June and December	...	...
£199,100	100	6%	*Western Union 6 per Cent. Sterling Bonds (red.)	98 103	98 103	5 16 6	March and September	...	...

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Dec. 6.		Price Wednesday, Dec. 13.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Dec. 13.	
								£ s. d.		Highest	Lowest
			TELEPHONES.								
44,000	£5	3/0	Chili Telephone (fully paid)	2	3	2	3	6 13 4	August	...	...
224,850	10s.	0/1½	Consolidated Telephone Const. & Manufacturing	¼	¼	¼	¼	4 15 3	July	...	...
72,680	1	0/6	Monte Video Telephone Ordinary	⅜	½	⅜	½	5 0 0	October	...	...
86,492	1	1 0	Do. 5 per Cent. Preference	¾	1	¾	1	5 0 0		...	...
490,000	5	3/0	National	5	5½	5	5½	5 14 3	February and August	5½	...
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Preference	14	15	14	15	4 0 0	,, ,,	14½	...
15,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference	14	15	14	15	4 0 0	,, ,,	...	...
250,000	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref.	5½	5½	5½	5½	4 10 11	,, ,,	...	...
1,329,471	Stock	3½%	* Do. Debenture Stock 3½ per Cent. (red.)	100	102	100	102	3 8 8	June and December	100¼	100
171,504	1	0/4	Oriental	¾	1	¾	1	5 0 0	April and October	...	...
58,000	5	6/0	United River Plate	4¾	5¼	4¾	5¼	5 14 3	July	...	...
16,689	5	...	Do. 5% Cumulative Preference (£3. 10s. paid)	3¼	3½	3¼	3½	...		...	...
£179,947	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	105	108	105	108	4 13 9	June and December	...	...
			ELECTRICITY SUPPLY COMPANIES.								
100,000	1	...	Bl'ckh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.)	¾	1	¾	1	...		...	...
6,000	10	7/9½	Bournemouth and Poole Electricity Supply Ord.	12¼	13½	12¼	13½	2 18 10		...	...
6,000	10	4/6	Do. 4½ per Cent. Cumulative Preference	10	11	10	11	4 1 10		...	...
19,661	5	2/6	Brompton & Kensington Electricity Supply Ord.	7½	8½	7½	8½	3 15 0		...	...
12,000	5	3/6	Do. 7 per Cent. Preference	9	10	9	10	3 10 0	March and September	...	...
20,000	5	...	Calcutta Elec. Supply Ordinary (£4 paid)	6½	7	6½	7	...		6½	...
30,000	5	4/0	Charing Cross & Strand Electricity Supply Corp.	10	11	10	11	4 1 10	February & August	10	...
20,000	5	...	Do. (Nos. 3,001 to 50,000)	9½	10½	9½	10½	...		...	...
20,000	5	2/3	Do. 4½ per Cent. Preference	5¾	6¼	5¾	6¼	3 12 0	,, ,,	...	...
31,000	5	2/6	Chelsea Electricity Supply Ordinary	8	9	7½	8½	3 10 7	March	8½	...
£100,000	Stock	4½%	* Do. 4½ per Cent. Debenture Stock (red.)	111	113	111	113	4 0 9	June and December	113	...
$1,200,000	$1,000	5%	Chicago Edison 1st Mort. 5% 30 year Gold Bonds (red.)	100	110	100	110	4 10 11	April and October	...	...
60,000	10	7/0	City of London Electric Lighting Ordinary	11½	12½	11	12	5 0 0	February and August	11½	11½
40,000	10	6%	Do. 6 per Cent. Cumulative Preference	13	14	13	14	4 5 9	January and July	13⅜	...
£400,000	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	125	130	125	130	3 17 5	June and December	...	...
40,000	10	...	County of London and Brush Prov. Ordinary	10½	11½	10	11	...		10½	...
20,000	10	6/0	Do. 6 per Cent. Cumulative Preference	13	14	13	14	4 5 9	March and September	...	...
£200,000	Stock	7/8	Do. 4½% Deb. Stock Certs. (all pd.) (red.)	111	114	111	114	...		111½	...
15,000	5	10%	Kensington and Knightsbridge Ordinary	12½	13½	12½	13½	4 1 6		...	...
10,000	5	6%	Do. 6 per Cent. 1st Preference	7½	7¾	7½	7¾	3 17 5	January and July	...	...
110,000	3	...	London Electric Supply Ordinary	2¾	3¼	2¾	3	...		...	...
48,050	5	3/0	Do. 6 per Cent. Preference	6	6½	5¾	6¼	4 16 0		5¼	...
£100,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures	104	106	104	106	3 16 4	Mar., June, Sept., Dec.	...	...
62,500	10	5/0	Metropolitan Elec. Supply Ord. (Nos. 1 to 62,500)	14	15	13½	14½	3 9 0	April and October	14½	13¾
22,500	10	3/7½	Do. (Nos. 62,501 to 85,000)	13½	14½	13½	14½	3 7 9		...	...
£220,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage	117	119	117	119	3 15 7	June and December	...	...
£125,000	Stock	...	Do. 3½ per Cent. Mort. Deb. Stock (red)	...	...	97	99	...		...	...
6,452	10	6/0	Notting Hill Electric Ordinary	15½	16½	15½	16½	3 13 0	March	...	...
10,000	5	5/0	Oxford Electric Ordinary	6¾	7¼	6¾	7¼	3 9 0	,,	...	...
300,000	1	8%	Rand Electric	⅜	½	⅜	½	10 13 4		...	...
£130,070	Stock	5%	River Plate El. Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb.	80	90	80	90	5 11 1		...	...
150,000	$100	$2	Royal Electric Company of Montreal Shares	160	180	160	180	4 8 11		...	...
£123,200	100	4½%	* Do. 4½ per Cent. 1st Mortgage Debentures	104	106	104	106	4 5 6	April and October	...	...
31,980	5	5/0	St. James's and Pall Mall Electric Ordinary	15½	16½	15½	16½	4 7 11	February and August	15¾	15¾
20,000	5	3/6	Do. 7 per Cent. Preference	9	9½	9	9½	3 13 8	,, ,,	...	...
65,000	5	...	South London Electric Supply Ordinary (fully paid)	4¼	4½	4¼	4½	...		...	...
79,900	5	5/0	Westminster Electric Supply Ordinary	14	15	14	15	4 0 0	March and September	14⅜	14
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
125,000	1	7½d.	Aron Electricity Meter 6 per Cent. Cum. Pref.	1⅛	1¼	¼	¼	6 17 2		...	...
40,000	5	5/0	British Insulated Wire Ordinary	11¼	12¼	11¼	12¼	4 0 0		...	...
27,500	5	3/0	Do. Preference	6¼	6¾	6¼	6¾	4 8 11		...	...
90,000	2	2/0	Brush Electrical Engineering	1¾	2¼	1¾	2¼	4 14 1	September	...	...
90,000	2	1/2½	Do. 6 per Cent. Pref. Non-Cumulative	2¼	2½	2¼	2½	5 1 1	,,	2 9/32	...
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Deb. Stock	110	115	110	115	3 18 5	February and August	...	...
£50,000	Stock	4½%	* Do. 2nd Debenture Stock (red.)	104	107	104	107	4 4 11	June and December	...	...
20,000	5	5/0	Callender's Cable Construction Ordinary	13	14	13	14	5 7 2	,, ,,	...	...
20,000	5	...	Do. 5 per Cent. Cumulative Preference	5½	6	5½	6	...		...	...
£90,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb. (red.)	113	116	113	116	3 18 7	November and May	...	...
300,000	1	0/9½	Castner-Kellner Alkali Co. (fully paid)	1¼	1⅜	1¼	1⅜	5 6 8		...	...
60,000	1	0/7½	Chadburn's Ship Telegraph Ordinary	1	1¼	¾	1¼	...		...	...
60,000	1	0/7½	Do. 6 per Cent. Cumulative Preference	1	1¼	¾	1¼	5 6 8		...	...
32,098	3	2/1⅝	Crompton and Co. (Nos. 1 to 32,098)	3¼	4	3¾	4	4 10 9	January and July	3¾	...
£100,000	100	5%	* Do. 5 per Cent. First Mortgage Deb. (red.)	100	103	100	103	4 17 10	,, ,,	...	...
60,000	1	0/3	Davis and Timmins 6 per Cent. Cum. Pref.	¾	1	¾	1	...		...	...
99,261	5	1/9½	Edison and Swan United ("A" Shares) (£3 paid)	2	2⅛	2	2⅛	7 4 0	February and August	...	...
17,139	5	2/9½	Do. (£5 paid)	3¼	4¼	3¼	4⅛	6 13 4	,, ,,	4¼	...
£314,023	Stock	4%	Do. 4 per Cent. Mortgage Deb. Stock (red.)	95	97	95	97	4 2 6	June and December	...	...
26,100	5	5/11½	Edmundson's Electric Corporation Ord. (fully pd.)	5	5¼	5	5¼	5 9 1	Half-yearly	...	...
112,100	2	1/2½	Electric Construction Co. (Limited)	2	2¼	2	2¼	5 2 3	January and July	2⅛	...
25,000	2	2/9½	Do. 7 per Cent. Cumulative Preference	2¾	3¼	2¾	3¼	4 6 2	July	...	...
182,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	104	107	104	107	3 15 8	January and July	...	...
91,195	1	...	Elmore's Patent Copper Depositing	⅝	¾	⅝	¾	...		...	...
30,000	5	8/0	Henley's Telegraph Works Ordinary	12¼	13¼	12	13	...	February and August	12½	12
15,000	£5	...	Do. 4½ per Cent. Preference	5¼	5¾	5	5½	3 19 3	,, ,,	5 5/16	5¼
£50,000	Stock	4½%	Do. 4½ per Cent. Morigage Deb. Stock (red.)	111	114	111	114	3 19 6	,, ,,	...	...
50,000	10	5/0	India Rubber, Gutta Percha, &c., Works	21	22	21	22	4 8 11	,, ,,	21	...
£300,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	100	104	100	104	3 16 11	March and September	...	...
37,350	12	12/0	Telegraph Construction and Maintenance	36	40	36	40	4 10 1	March and July	38	36
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909	103	106	103	106	3 15 6		...	...
20,000	5	3/0	Do. Manufacturing Ordinary xd	9	10	9	10	3 10 0		...	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5¼	6	5¼	6	4 3 4		...	...
30,000	5	5/0	Willans and Robinson Ordinary	10½	11	10½	11	4 1 10	April and October	...	...
30,000	5	3/0	Do. 6 per Cent. Cumulative Preference	7	7½	7	7½	4 0 0	,, ,,	...	...
£100,000	Stock	4¼%	Do. 4½ per Cent. 1st Mortgage Debentures xd	104	105	104	106	4 0 2	May and November	...	...
			ELECTRIC RAILWAYS, TRAMWAYS, &c.								
12,000	10	6/0	Blackpool and Fleetwood Tramways	17	19	17	19	3 13 8		...	...
£167,900	100	5%	Brisbane Tramway 5 per Cent. Debentures	104	106	104	106	4 14 4		...	...
50,000	10	7%	Bristol Tramways and Carriage Ordinary	23	24	23	24	2 17 2	February and August	...	...
25,000	10	...	Do. Cumulative Preference (£4 paid)	4⅜	4½	4⅜	4½	...		...	...
£100,000	Stock	4%	Do. 4 per Cent. Debentures	118	119	118	119	3 7 3		...	...
30,000	10	9/0	British Electric Traction Ordinary	16½	17	16½	17¼	3 10 7		16¾	16¼
30,000	10	6/0	Do. 6% Cum. Pref. (Nos. 30,001 to 60,000)	12¾	13¼	13	13½	4 8 11		13⅜	13
£200,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures	126	129	126	129	3 17 10		...	...
40,000	5	1/9	Buenos Ayres & Belgrano 6% "A" Cum. Pref.	5⅛	5⅜	5⅛	5⅜	5 11 7		...	...
27,500	5	...	Do. "B"	4⅞	5¼	4⅞	5¼	...		...	...
265,585	Stock	5%	Do. 5 per Cent. Debentures	108	111	108	111	4 10 1		109	...
35,250	10	3/0	Central London Ordinary	10½	10⅝	10½	10⅝	2 15 10	June and December	10⅝	10⅜
178,303	10	2/4 1/10	Do.	...	...	...	...	...	,, ,,	...	...
£865,000	Stock	2½%	City and South London Railway Con. Ordinary	61	64	61	64	3 7 2	January and July	62¼	61
37,600	10	...	Do. (Nos. 22,501 to 60,000) (£4. 10s. paid)	3⅝	4⅛	3⅝	4⅛	...		...	...
£150,000	Stock	5%	Do. 5 per Cent. Perpetual Preference (1891)	143	148	143	148	3 8 0	January and July	...	...
£200,000	Stock	5%	Do. (1896)	135	140	135	140	3 11 11		...	...
£87,701	Stock	4%	Do. 4 per Cent. Perpetual Debenture	127	133	127	133	3 3 0	May and November	130	...
20,000	10	7½%	†Imperial Tramways Ordinary x new	23	24	23	24	...	March and September	24	23
10,000	10	6%	† Do. 6 per Cent. Preference x new	15½	15¾	15½	15¾	3 13 10	,, ,,	15¾	15½
£200,000	Stock	4½%	† Do. 4½ per Cent. Debenture x new	115½	116½	115	116	3 18 0	January and July	116½	115½
30,000	10	1/3	Kidd'rm'nst'r & Dist. E.L. & Tr'ct'n 5% Pref. (£6 pd.)	6	6¼	6	6¼	4 10 11	May and November	...	...
37,500	10	2½%	Liverpool Overhead Railway Ordinary	8⅛	9 1/16	8⅛	9 1/16	3 11 8	February and August	...	...
10,000	10	5%	Do. 5 per Cent. Preference	13¼	13¾	13¼	13¾	3 12 9	,, ,,	...	...
125,000	Stock	4%	Do. 4 per Cent. Debenture	104	106	104	106	3 16 3	January and July	...	...
24,000	5	...	New General Traction Ordinary	3¾	4¼	3¾	4¼	...		...	...
30,000	5	6/0	Do. 6 per Cent. Cumulative Preference	5	5½	5	5½	5 9 1	May	...	...
4,000	10	...	Oldham, Ashton and Hyde Elec. Tramway Ord.	19	19⅝	19	19½	...	February and August	...	...
4,000	10	5/0	Do. per Cent. Preference	10¼	10¾	10¼	10¾	4 11 11	,, ,,	...	...
13,334	10	...	Potteries Electric Traction Ordinary	12¼	13½	12	13	...		12¼	...
20,000	10	5/10	Do. 5 per Cent. Cumulative Preference	10	11	10	11	4 10 11	,, ,,	...	...

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THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,127. [Vol. No. 9. XLIV.] FRIDAY, DECEMBER 22, 1899. PRICE SIXPENCE (by post, 6½d.). Abroad, 8d., or 15 cents. or 80fr., or 70pf.

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NOTES.

WE print this week the third and concluding instalment of Prof. J. J. THOMSON's Paper "On the Masses of the Ions in Gases at Low Pressures." This is the same Paper as was read before the British Association at their Dover meeting, and we made lengthy reference to it at the time, under the title "On the Existence of Masses Smaller than Atoms." The Paper is undoubtedly one of the most important contributions to molecular physics during the last twenty years. Incidentally we may mention that we have rarely read a Paper dealing with molecular physics so markedly devoid of mathematical symbols. The whole is a consecutive, closely-reasoned, perfectly logical argument, not a single step being missing or superfluous. One cannot but be further struck with the author's modest and unassuming references to his own work, while giving every credit and rendering every praise to the work of those many others who have laboured in the Cavendish laboratory on allied subjects. Like NEWTON, he seems to be impressed only with the minuteness of his own contribution compared to the immensity of the scientific field yet to be investigated. In modern times we may liken him to FARADAY and MAXWELL, the latter on one occasion deriding the assertion that mathematicians possessed ideas which mere human language could not express, saying (Complete Works, ii., 828):—

> Let them make the effort to express these ideas in appropriate words without the aid of symbols, and if they succeed they will not only lay us laymen under a lasting obligation, but, we venture to say, they will find themselves very much enlightened during the process, and will even be doubtful whether the ideas, as expressed in symbols, had ever quite found their way out of the equations into their minds.

PROF. THOMSON began some years ago to investigate the subject dealt with in his Paper, when he turned his attention to explaining a discrepancy observed in the values of the ratio of the mass of an ion to the electrical charge resident on it, according as it was deduced from electrolytic data or from the deflections produced in the path of a cathode ray in a magnetic or electrostatic field. Guided by a truly wonderful instinct, he suspects the explanation must be sought for in his own experiments, and sets himself the problem of finding the value of the mass m, one of the terms in the ratio e/m. Taking it as proved that the cathode rays do consist of negatively-electrified masses shot off from the negative electrode, he attacks the question: What are these particles? Atoms, molecules, or matter in a still finer state of subdivision? The path of an electrified particle moving in a uniform electrostatic field, upon which is superposed a uniform magnetic field, is found to be that of a cycloid. An insulated plate placed at distances from the electrode greater than the diameter of the generating circle will not be electrified, and hence the value of e/m is simply calculable from the strengths of the two fields and the values of the distance between the electrode and the plate when the latter is just not electrified. The value of this ratio he finds experimentally, is of the order $7{\cdot}3 \times 10^6$. To determine the value of e in this ratio, use was made of the discovery by C. T. R. WILSON (*Phil. Trans.*, 1898) that the ions produced by ultra-violet light form nuclei round which water can be made to condense. The number of ions is therefore reduced to finding the number of drops in the cloud. By measuring the rate of fall of this cloud, the size of each drop is easily calculable. If then the weight of the cloud (*i.e.*, the water formed) be taken, the total number of drops, and consequently of the ions, follows easily. A measurement of the total quantity of electricity which crosses any given plane will therefore give us the value of the product of the number of ions by the charges on them, and hence of the ionic charge itself. The mean value of e found by this method is $6{\cdot}8 \times 10^{-10}$.

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This gives the value of m to be about $1{\cdot}4 \times 10^{-3}$ of that of the hydrogen atom, or 3×10^{-26} grammes; and since this value is found to be the same for ions produced from different metals, the assumption is made that all atoms are built up of smaller masses, to which he gives the name "corpuscles." Atoms of different elements contain different numbers of these corpuscles, and electrification is regarded as being due to the splitting up of some of the atoms of the gas, "part of the mass of the atoms getting free and becoming detached from the original atom."

It happens occasionally that a local authority is so anxious to obtain control of the supply of electricity or the working of the tramways in their district, that it is willing to pay far too high a price in order to buy out the company which is exercising one or other of these privileges. In this and our last issue we have recorded cases of purchase or attempted purchase against the wishes of a large body of ratepayers and their representatives. A remarkable method of estimating the purchase price was revealed in one Local Government inquiry with respect to the application by a town in the Midlands to borrow money for buying a company's electric light undertaking. The Corporation's consulting engineer had valued it at £8,320, but had subsequently said that this price might be treated as "somewhat flexible," and had recommended that the Corporation should come to terms with the company for a sum of £11,250, rather than lose the chance of acquiring the undertaking. As in most cases of a similar nature, it was also advised that the works should be reconstructed on a more permanent basis, with more efficient machinery. At Sheffield it will be remembered the Corporation, after buying up a company's undertaking at a handsome figure, immediately reduced the tariff for current, and thereby incurred a heavy loss on the first year's working. In Belfast it was at first decided by a narrow majority that the Corporation should spend a substantial sum to acquire the tramways from a local company, whose licence on several lines will soon begin to expire under the Tramways Act of 1870. At a subsequent meeting, however, called by requisition, this resolution was rescinded by a two-thirds majority. Cases of purchase at an over-valuation, although possibly benefiting shareholders, do not tend to the advantage of the industry at large.

Half a column of last Tuesday's *Times* is filled up with a detailed account of how a fire originated in the circuit of a 32 c.p. pendant lamp in a house in Rutland-gate. From the description it would appear that the cause of the fire was probably a bad joint between the ordinary rubber-covered wire and the flexible cord, and that the fuse protecting this single-lamp circuit was too heavy. The writer of the letter describing this occurrence unkindly mentions the name of the wire employed, but omits that of the contractor, whose workman is presumably the guilty party. It is to be regretted that such an important paper as *The Times* should lend itself to raising a scare as to the fire risks of electric lighting, especially at a time when this method of illumination is in bad odour in the metropolis owing to the shortcomings of one of the supply companies. Mr. Montague Crackanthorpe, our contemporary's correspondent, should be informed that the fire risk from an electrical installation is absolutely nil if only a tithe of the rules and recommendations of the fire insurance offices and electric supply undertakers are carried out, and that electrically-caused fires are of extreme rarity in this country, whereas fires caused by gas, oil lamps, and candles form a large proportion of the total.

An interesting point has been brought to our notice in connection with the subject of "extra high pressure" transmission, discussed in our leading article last week. At present in both cases where "extra high" pressures are employed in connection with electricity supply in this country the transmission pressure is reduced in two steps, and not merely in one transformer between the transmission line and the consumers' distribution mains. If this is necessary to ensure safety for the consumer, it points to an advantage of motor-generators over rotatory converters in cases where continuous-current distribution is to be combined with high-pressure two or three-phase transmission. After an intermediate transformation from "extra high" to "high" pressure, a motor-generator whose motor is a high-pressure machine can immediately transform down to the consumers' voltage. A rotatory converter, however, must be fed at low pressure bearing a certain proportion to the voltage of the continuous-current side, depending on whether the system is a two-phase or three-phase one; and the alternating terminals of the converter are of course in metallic connection, through the armature and mains, with the consumer's house wiring. Thus there would be nothing between the consumer and the extra high-pressure except one transformer earth-shield unless a second transformer were inserted; and to do this would make the cost of the rotatory converter system higher than that employing motor-generators. Possibly the single earth-shield would afford ample protection in the case of a breakdown of the transformer, but tests of this safety device are wanted under various conditions before this point can be definitely settled. It may be presumed also that the Board of Trade would have something to say in the matter.

The Institution of Electrical Engineers is to be congratulated on the first two Papers read before it this session, for not only were the contributions in themselves interesting and instructive, but they led to a discussion above the usual standard of that usually elicited by Papers on details of the business of generating power for electrical distribution. For this reason we have devoted considerable space to our report of the discussion (concluded in the present issue), and have included the valuable tables and data given by various speakers. Although the prime object of the Institution Papers and discussions is not the education of students, these younger members of the profession were afforded an excellent opportunity of learning a great deal on a subject much neglected by them as a rule. Many a "third year" electrical engineering student, and many a one also who has served his time, would, for instance, be unaware that the price and calorific values of various classes of fuel are not the only factors in determining their relative economy in a supply

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station. Yet the second evening of the discussion was very badly attended, and the proportion of young faces was less than usual.

Aluminium as a Bearing Metal.—Aluminium has recently been employed as a bearing metal for shafting in the Madras College of Engineering, and has proved satisfactory.

Cardiff Corporation *versus* Ferranti.—The hearing of this action, which was to have commenced in London on Monday last, in the Commercial Court, has been postponed until the Hilary sittings in January.

200th Anniversary of the Berlin Academy of Science.—Dr. T. E. Thorpe, foreign secretary of the Royal Society, and Prof. W. Ramsay, F.R.S., have been chosen to represent the Royal Society in Berlin on this occasion.

Cable Interruptions and Repairs:—

	Date of Interruption.	Date of Repair.
Latakia—Cyprus	June 21, 1899 ...	—
Cayenne—Pinhieros	Oct. 11, 1899 ...	—
Zanzibar—Mombassa	Oct. 27, 1899 ...	—
San Thomé—Loanda	Dec. 11, 1899 ...	Dec. 15, 1899
Mozambique—Lourenco-Marquez	Dec. 17, 1899 ...	—

The Eastern Telegraph Co. notified on the 18th inst. that a terrific cyclone at Mozambique had caused interruption of the Delagoa Bay cable. Houses were blown down, ships in harbour wrecked, the telegraph station unroofed, but the instruments were saved.

Erratum.—In the addendum to Mr. Crompton's Paper, on page 266 of our last issue, the figure for "Loss in flue gases per calculation" in the heat balance table at the head of the second column should be 1375·66 instead of 1735·66 British thermal units. The item immediately below that should read "Loss to be accounted for by radiation, incomplete combustion, ashes, &c."

Theft of Electrical Energy.—It will be remembered that on more than one occasion the German courts have decided that the theft of electrical energy was not punishable by law, according to the existing code, as electric current or electrical energy could not be considered to be a material object. A bill to remedy this state of affairs has now been laid before the German Federal Council.

County of London and Brush Provincial Electric Lighting Co.—This company has pointed out that our note in last week's issue regarding Mr. Sparks' appointment may be somewhat misleading. A change has been made in the distribution of duties of the staff of the company, and Mr. Sparks has been appointed to succeed Mr. Lawson as engineer-in-chief only, while the managerial work reverts to the secretarial department.

Manchester Literary and Philosophical Society.—The council of the Manchester Literary and Philosophical Society has awarded the Wilde Medal for 1900 to Lord Rayleigh, for his contributions to mathematical physics and to chemistry; and a Dalton Medal to Sir H. Roscoe, in recognition of his services to chemistry and scientific education. The presentation of the medals will take place at a special meeting in February next, when Lord Rayleigh will deliver the Wilde Lecture for 1890.

Combinations of American Telephone Companies.—Our New York contemporaries are greatly interested in recent important combinations of telephone companies in the United States. The American Bell Telephone Co, the company which has owned all the more important telephone patents, and has until now occupied a position somewhat similar to the National Telephone Co. in this country, is to be taken over by the American Telephone and Telegraph Co., or the "long-distance" company, as it is termed. In the meantime new combinations of the so-called "independent" telephone companies are being formed. The situation is not so interesting as in this country, however, as the elements of Government and municipal competition are both lacking.

Royal Institution.—The first of Prof. C. Vernon Boys' Christmas lectures to young people, on "Fluids in Motion and at Rest," will be delivered on Thursday next, December 28th, at 3 p.m., the remaining lectures being fixed for December 30, 1899, January 2, 4, 6, and 9, 1900, at the same hour. Lord Rayleigh will deliver six lectures on "Polarised Light" on the following Saturdays—viz., March 3rd, 10th, 17h, 24th, 31st, and April 7th. Among the Friday evening discussions arranged at present are "Flight," by the Right Hon. Lord Rayleigh, on January 19th; "Motive Power—High-speed Navigation—Steam Turbines," by the Hon. C. A. Parsons, on January 26th; "Wireless Telegraphy," by Mr. G. Marconi, on February 2nd; "Recent Studies in Gravitation," by Prof. J. H. Poynting, on February 23rd; and "Solid Hydrogen," by Prof. Dewar, on April 6th. It must be remembered, however, that these arrangements depend in a great measure on the free kindness of eminent men whose time is subject to the certain claims of public or professional duty. The arrangements are therefore liable to change.

Local Centres of the Institution of Electrical Engineers.—At the meeting of the Institution on the 14th inst. the President mentioned that the Institution for some time had been promoting the organisation of local centres both within the United Kingdom and without. The consequence was that they had three petitions, each signed by more than 50 members, or persons eligible to be members, for the creation of local centres in the following districts—viz, Newcastle-on-Tyne and district, Dublin (for Ireland), and Glasgow. The Council had that evening acceded to the prayer of these several petitions, and had created these three local centres. Further, a petition from a similar number of persons in Cape Town had been before the Council, and they had also decided to create a local centre in that town, so that the articles of association, which were formulated with a view to carrying out this organisation 18 months ago, had now come into operation, and the local centres were actually created before the expiration of the year 1899. He also announced that the Council had, on the recommendation of its Finance committee, taken the step of transferring investments from its general fund amounting to £1,437 to the building fund, which therefore now practically amounted to nearly £7,000.

A Searchlight for the New York Fire Brigade.—The New York Fire Department, says *Electricity* of New York, is soon to have a novel addition to its apparatus in the form of a complete electric searchlight on wheels, which will go to fires with the engine, hook and ladder trucks and fire towers, and, it is expected, will do a share, fully as important as that of any of the other machines, of the work of saving life and property. Its purpose will be to light up dark parts of the street and aid firemen in laying hose, setting ladders, and also to light up the faces of buildings where people may be in danger, and to throw light into the buildings themselves, to aid the firemen in searching for missing persons or other work. The machine will resemble a fire engine in general appearance and will use a similar boiler; but in place of the pumping machinery the engine will drive a dynamo, which will supply the lighting currents for the searchlights. There will be two searchlights, each with an 18in. projecting lens, and these will be carried on a platform behind the driver's seat. They can be used either from the platform or removed and carried to any convenient place near by, their connection with the dynamo being kept by means of flexible cables. The lights will be provided with lenses which will admit of quick regulation, so that their light may be spread out over a wide area or confined and directed to any particular point.

Aluminium-Copper Telephone Lines.—The question has been asked whether an alloy of aluminium with a small quantity of copper could be used as a substitute for silicon-bronze in telephone cables. This question is answered in the negative by M. Massin in a recent number of the *Annales Télégraphiques*, and is based on the following comparisons:—

	Aluminium alloy.	Silicon bronze.
Density	2·8	8·9
Breaking stress in tons per sq. in.	17·74	47·5
Conductivity (copper = 100)	48	41
Resistivity in microhms	3·25	3·81
Coefficient of expansion	0·000023	0·000017
„ elasticity	0·00012	0·00007
Price per pound	1s. 9¾d.	1s. 4d.

With the above data M. Massin has calculated the sag and factor of safety for a span of 75 metres (82·1 yards) for variations of temperature between −20°C. and +40°C. For

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the same factor of safety, 3·25, at −20°C., the bronze lines give a factor of safety 7·5 at +40°C., whilst the aluminium line reaches the same value at +27°C. At +40°C. this factor for aluminium rises to 15·25, and the tension to 1·04 tons per square inch. Further, the common sag at −20°C. being 9·05in., reaches 42·5in. and 24·8in. for the aluminium and bronze lines respectively, thus requiring more careful installation. As also the alloy of aluminium is attacked by most acids, and by potash and sea salt, he thinks it inadvisable, at least for the present, to think of using it for aerial telephone lines.

Wireless Telegraphy in the Andaman Islands.—In a Paper read before the Indian section of the Society of Arts on Tuesday last week, Col. R. C. Temple said that, although the extreme north of the Andaman Islands is distant over 100 miles from the coast of Burma, and the Nicobar group is almost equally distant from Sumatra, the intermediate groups of islands, the Cocos and Preparis, between the Andamans and Burma, would render it possible to extend from the Burmese coast to the whole of the Andamans and Nicobars, perhaps thence to Sumatra, that system of wireless telegraphy now being brought into practical use. The idea of setting up telegraphic communication between the Andamans, the Nicobars, and India had more than once reached the point of plans and estimates, because of the great importance of these islands as meteorological stations, whence timely warning of the cyclones could be given to shipping all over the bay of Bengal. The overwhelming obstacles up to now had been the physical difficulties and the great cost of laying a cable. It was now proposed to utilise wireless telegraphy for the same purpose. The total distance from Madras to Port Blair was 1,000 miles, from Calcutta 750 miles, from Rangoon 350 miles. The whole distance was to be divided up into a number of sections, the greatest being a length of 55 miles between the Alguada Reef and Preparis, and the installations were to be set up on the tops of natural peaks. To extend the communication to Sumatra would involve a 60 miles distance between the Great Nicobars and Sumatra, a distance which ought to be quite feasible. In this way there could be set up an independent telegraph connection between India and the rest of the world.

"Party Lines."—From January 1st next the National Telephone Co. has decided to introduce the "party line" system in connection with its exchanges. By this system, which is employed largely in the United States and has also been used to some extent in France, those who wish to have a telephone at a cheaper rate than the ordinary subscription can do so by sharing a line with other subscribers. Each have their own instruments, but only one subscriber can use the line at a time. We understand that the National Telephone Co. intend to introduce for those who desire it, "two-party," "four-party," and "eight-party" lines, at 10s., 7s. 6d., and 5s. per subscriber per month respectively and a charge of 1d. per call, the latter being collected by a penny-in-the-slot box affixed to each telephone. We are unable at the moment to give full technical details of the system to be employed; but we may briefly mention that each of these lines will be a metallic circuit one, and that the signalling apparatus of each subscriber will be connected between one of the wires and earth, some sort of a code probably being employed when more than two subscribers share one of the lines. In France and America systems of selective ringing with polarised bells and indicators have been tried, and also automatic methods of preventing overhearing. It is doubtful, however, whether the extra expense of these complications do not so much tend to counterbalance the saving in lines as to make "party line" connections almost as costly as independent ones. A simple connection, such as that mentioned above, would, on the other hand, be a considerable saving over the cost of independent lines, and it will no doubt prove remunerative at these rates.

Aluminium Feeders on the North-Western Elevated Railroad.—Although aluminium has been used for some time as a substitute for copper in the transmission of high voltages over long distances and in telephone and telegraph work, its first application to a direct feeder system is, according to the *Street Railway Review*, now being made on the North-Western Elevated Railroad in Chicago. The North-Western will be operated on the third rail system, the third rail conductor being fed from 1½in. aluminium feeder cables, of which there will be more than 20 miles used. The cables are carried in a wooden trough between the up and down tracks, and are supported on vitrified clay insulators. The joints, our contemporary states, are to be soldered with a "secret composition" already referred to in our columns, the invention of one Henry Gronimus, who is making all the joints in the aluminium cables on the North-Western structure. The process of forming a joint is as follows: The ends of the cables are brought up into a movable canvas shanty, which can be erected in a few minutes at any desired point on the structure, and which shields the cable ends from the cold air and wind. It is found that by taking this precaution the joint can be made in about one-third the time. The ends of the cable are covered with fire-clay and fluxed with composition, after which they are brought to a white heat, or about 650°F. or 700°F., by means of gasoline brazers. A copper sleeve 6in. long, tinned on the inside and with an inside bore a trifle larger than the cables, is next slipped over the two ends, and through a pour-hole left for the purpose the melted solder is poured into the sleeve, finding its way between the strands of aluminium and making one solid piece of the copper, the solder, and the aluminium. The joint is said to have a conductivity of about 64 per cent. and the aluminium cable about 62 per cent. of that of fine copper.

Columbus Arc Lighting Plant.—One of the most extraordinary of electric lighting plants, says the *Electrical Review* of New York, is one now operating in the municipal pumping station at Columbus, Ohio. The director of public improvement of that city, finding that the pumping capacity of the station was greater than the city's needs required, hit upon the idea of using the surplus water that the pumps were capable of supplying to drive water-wheels direct-coupled to dynamos, the current thus generated being used for supplying light to the surrounding district by means of arc lamps. The difficulty of the problem was much enhanced by reason of the very limited space available for the machines and piping, and by the high speed required for direct connection to the Western Electric Co.'s 100-light dynamo. This speed, 650 revolutions per minute, necessitated the use of impulse wheels only 18in. in diameter, and in order to obtain 110 H.P. from each unit, 18 nozzles were required. These were arranged with six runners, three nozzles to each runner, since a larger number of nozzles per runner would have reduced the efficiency below the guarantee. The use of contracting nozzles to keep up the efficiency at light loads was prohibited by the great cost and complication of so large a number of contracting nozzles. Ordinary butterfly valves were accordingly used, and the cam mechanism for operating these valves arranged to actuate them one after the other, instead of all together, as had previously been common practice. As a result of this ingenious arrangement all the valves in operation, except one, would be wide open and working, therefore, at their maximum efficiency, and thus the low efficiency of a partly closed butterfly valve would have an almost inappreciable effect in lowering the total jet efficiency of the machine, and at six values of the load, when a valve had just completely closed, would have no such effect at all. The small diameter of the runners, rendered necessary by the high speed, so far reduced their momentum that it was necessary to add a heavy flywheel in order to keep the variations of speed within the guaranteed limits. The high speed also prohibited the use of the ordinary cast-iron flywheel. The wheel was accordingly made with a steel rim shrunk on to a cast-iron web. The governor is the ordinary mechanical relay actuating six cams, the connection between the cam shaft and the governor being by gear and pinion. The water chambers were cast in two pieces, the nozzles being bolted on so as to come in exactly the right position with reference to the runners. This large casting rested on the cast-iron base and was bolted to it. The casing was made of riveted boiler iron, in two parts, the upper half being provided with eye-bolts for lifting.

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CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

Luminescence of Electrodes.—T. Tommasina has observed the luminescence of electrodes under various conditions under the influence of the discharge of an induction coil. Some of the observations are not new, but many of them are of considerable interest. It will be remembered that Wehnelt was led to the discovery of his interrupter in the course of his study of the luminous electrodes described by Braun. Tommasina filled some ordinary Crookes tubes with distilled water. The electrodes were aluminium discs attached to platinum wires. The discs became luminous, and so did the supporting wires when of aluminium instead of platinum. In many places minute gas bubbles traversed by sparks were observed, but the luminosity was not confined to those places. The discs could be photographed by their own light. The glow is essentially anodic, as evidenced by the fact that the current at break makes the anode luminous, and the current at make the cathode. The luminosity, though apparently continuous at both electrodes, is really alternating. Only aluminium, and to a less extent magnesium, show this luminosity, and they only show it when immersed in water, alcohol, or acidulated water, and not in dielectrics like petroleum or vaseline.

[T. Tommasina, *Comptes Rendus*, Dec. 4, 1899.]

Influence of Röntgen Rays upon Selenium —That the Röntgen rays reduce the resistance of selenium is a discovery of some importance; and it is strange that it was not made before, since the corresponding action of light has been known for nearly thirty years, and was utilised by Graham Bell for his "radiophone" as long ago as 1878. M. Perreau has made the simple and obvious experiment of exposing a selenium cell to the action of an X-ray tube at a distance of 5cm. Its resistance fell "rapidly" from 40,000 ohms to 34,000 ohms, and kept oscillating slightly about the latter value, owing probably to variations in the intensity of the rays. When the rays ceased, the cell regained its normal conductivity more slowly than it does after the impact of light. The reduction in the resistance was the same as would be produced by a gas jet placed at a distance of 1·5m. The action of the Röntgen rays diminished with increasing distance, but was still sensible at 17cm. The author made sure that the effect was not due to secondary causes. Electric waves do not affect the resistance of selenium. The newly-discovered property of the rays might be utilised for measuring their intensity, for which purpose it would have several advantages over photographic or ionisation methods.

[Perreau, *Comptes Rendus*, Dec. 4, 1899.]

Chemical Action of Röntgen Rays.—Since the chemical action of Becquerel rays upon oxygen has been discovered by P. and S. Curie, another link has been traced between those rays and Röntgen rays. For, as P. Villard points out, Röntgen rays also exert a chemical action, not only upon photo-sensitive salts, but upon substances contained in some kinds of glass. The author expresses this fact drastically by saying that radiographs can be obtained with simple glass plates instead of sensitive plates. The colouring action of Röntgen rays upon the tubes generating them is well known. The portion of the tube which lies in front of the plane of the anticathode takes a violet or brown tinge according to the composition of the glass. Villard encloses the anticathode in a wide tube, and protects the inner surface of the latter from the action of diffused cathode rays by a lining of aluminium foil. In that case only a violet colouring is produced, even in ordinary lead glass. On removing the aluminium lining the lead glass is coloured brown, owing to the oxidation of the lead by the diffused cathode rays. No colour is produced behind a platinum screen The author proposes to make a silicate in which the reducing action should be more pronounced and apparent.

[P. Villard, *Comptes Rendus*, Nov. 27, 1899.]

ELECTROLYTIC PRODUCTION OF ALUMINIUM.

BY G. H. ROBERTSON, F.C.S.

The methods for the production of aluminium by electrolysis may be divided into two classes, those in which the bath is formed by a solution of its oxide, and those in which it is the sulphide that is dissolved. The former methods are based on the discovery by Deville in 1859 that aluminium can be prepared by electrolysing fused cryolite, the composition of the bath being maintained by the dissolution of anodes of carbon containing alumina. But this process did not come into commercial use owing to the high cost of electrical energy, and aluminium continued to be produced for some time longer by the chemical method based on the decomposition of sodium chloride by metallic sodium. In 1886 Hall in America succeeded in obtaining aluminium by the electrolysis of fused cryolite, which he found was specially adapted to the purpose from its low fusing point. Almost simultaneously Heroult obtained a patent in France for practically the same process, and since then, owing to the cheapening of the cost of electrical energy and improvements in the processes, the electrical methods for the production of aluminium have superseded the chemical. The cost of electrical energy for effecting metallurgical reductions at the high temperature required for the fusion of the oxide of aluminium is high, and therefore efforts were made to find an electrolyte whose chemical reactions would assist in the reduction. This led to the reintroduction of the sulphide process originally patented by Petitjean in 1857. In 1892 Bucherer (*Zeits. Anz. Chem.*, 1892, 483-484) succeeded in decomposing aluminium sulphide electrolytically, and worked out a process by which this might be cheaply produced on a large scale, which consisted in heating carbon and sulphur with aluminium oxide to a white heat in a fire-clay retort. The reaction is represented by the equation—

$$Al_2O_3 + 3C + 3S = Al_2S_3 + 3CO,$$

and is endothermic, the calories absorbed being 180,500. Since the heat of combination is only one-third of that of the oxide, it is evident that it can be more easily reduced electrolytically, and therefore it is not surprising to find that different attempts have been made to improve on the original sulphide process. In February, 1897, Mr. Blackmore read a Paper before the New York section of the Society of Chemical Industry (*The Electrician*, Vol. XXXIX., p. 224) in which he described a process which involved the conversion of aluminium oxide into the sulphide by means of carbon bi-sulphide, and one of the chief points connected with the invention was the cheapening of the cost of production of the latter substance. Instead of iron vessels Mr. Blackmore employed earthenware ones, which he impregnated with lead salts, which became converted into the sulphate and protected them from the corrosive attack of the carbon bi-sulphide. By the substitution of aluminium sulphide for its oxide, Mr. Blackmore claimed that the voltage required to effect decomposition was reduced from the five volts employed in the Hall and Heroult processes to 3·8 volts, and that by his method of manufacture the cost of aluminium sulphide is reduced to six cents per pound. The most recent sulphide process is that patented by Mr. Gooch, who claims for it that, in contradistinction to existing processes in which aluminium sulphide is either formed without the bath and then added to it or else formed from alumina suspended in the bath, he forms it from the aluminium oxide dissolved or combined in the bath, which is prepared as follows:—Three parts sodium fluoride to two parts aluminium chloride are fused in an iron tank provided with sleeves for the insertion of the anodes, and lined on the bottom and half way up the sides with compact carbon. The remainder of the tank and the sleeves are lined with compact alumina, which serves to keep the anodes from electrical contact with the tank and casing. The anodes, which are perforated longitudinally, are formed of carbon, and partially immersed in the bath, and connected by copper rods to a metal bar, which rests on wooden supports. The carbon lining serves as the cathode. The carbon bi-sulphide is

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introduced into the bath through pipes which form tight joints with the anodes, so that the pipes are continuous with the perforations in the anodes. The gaseous products escape from the bath through a bell made of boiler iron plate and lined with compact carbon, which is suspended from the bar over the bath, so that its opening can be lowered below the level of its surface when it is in operation, and the space between the rim of the bell and the interior surface of the tank is covered with powdered carbon sprinkled thickly on the surface of the bath. Through this space, when desired, alumina is introduced into the bath in the quantities required. A moderate excess does no harm. When the carbon bi-sulphide is introduced it acts on the dissolved alumina to convert that oxide to aluminium sulphide, while carbon oxy-sulphide or carbon monoxide is formed at the same time. Then an electrical current of suitable low voltage (which will vary according to the constitution of the bath and the size of the electrodes) is passed through the bath, thereby electrolysing the solution. The aluminium deposited at the cathode is removed by ladle or siphon, while the sulphur liberated at the anode passes off through an outlet in the bell. By supplying alumina to the bath, and maintaining the current of carbon bi-sulphide, the production of aluminium sulphide goes on continuously, and, if properly regulated, keeps pace with the electrolysis. One advantage claimed for this process is the low voltage (about 0·9 volt) which is required to electrolyse aluminium sulphide.

NOTES ON THE FORMATION OF COPPER "TREES" AND "NODULES."

BY SHERARD COWPER-COLES.

Everyone who has electro-deposited copper, either on a laboratory or commercial scale, must have experienced great difficulty in preventing the formation of copper "trees" and "nodules," and must have noticed the different formation obtained under apparently the same conditions. No systematic work appears to have been done to determine under what conditions copper "trees" most rapidly grow, or what conditions vary their formation. Mr. J. W. Swan found that regularity and smoothness of deposit was almost entirely dependent on the absence of solid particles held in suspension in the electrolyte, and that excrescences could be entirely avoided by taking care that the electrolyte was free from solid floating particles. He observed that at the seat of each nodule was a speck of some foreign substance.

Dr. Gore has given the matter some thought, and has observed that the greatest length of "nodule" is in the direction of the greatest intensity of current and amount of copper in solution. The author has tried the effect of various current densities, strength of solution, acidity of solution and temperature, and cathodes of various shapes. The following three photographs (Figs. 1, 2, and 3) show the formation of copper "trees" or "nodules" in a neutral solution and solutions containing various percentages of free acid. The initial current density in each case was from 60 to 70 amperes per square foot. This was found the best for the growth of copper "trees"; the copper deposited was of a good salmon colour and crystalline. In all cases the cathodes were placed on edge to the anodes, there being a space of from ½in. to 2in. between them, the anodes being of sheet copper. The potential difference between the terminals of each cell was from 2·4 to 2·8 volts. The solution employed contained 25oz. of copper sulphate to the gallon of water, to which was added various percentages of free acid.

A fine "nodule" was obtained from a solution of copper sulphate containing about 30oz. to the gallon of water and 12oz. of free sulphuric acid, the current density being 15

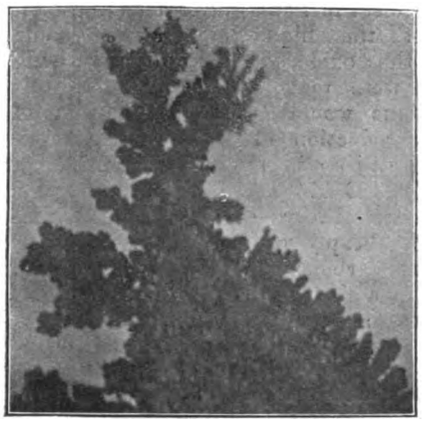

FIG. 1.—Copper Trees from Neutral Solution.

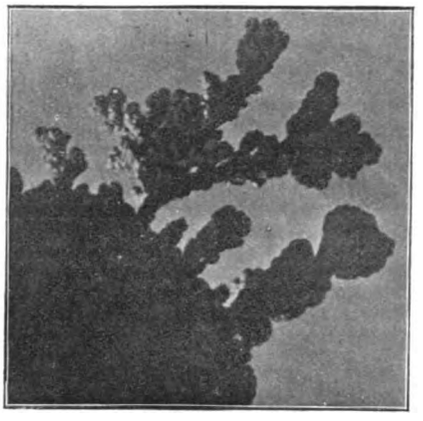

FIG. 2.—Copper Trees. Solution containing free H_2SO_4—6oz. to the gallon.

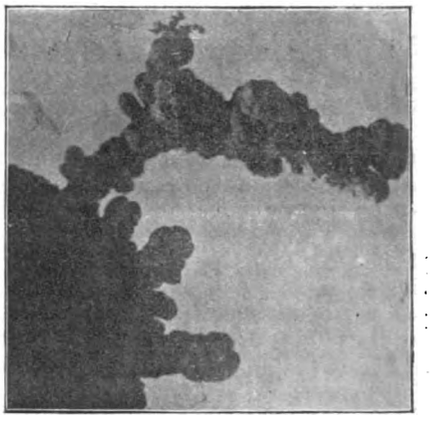

FIG. 3.—Copper Trees. Solution containing free H_2SO_4—10oz. to the gallon.

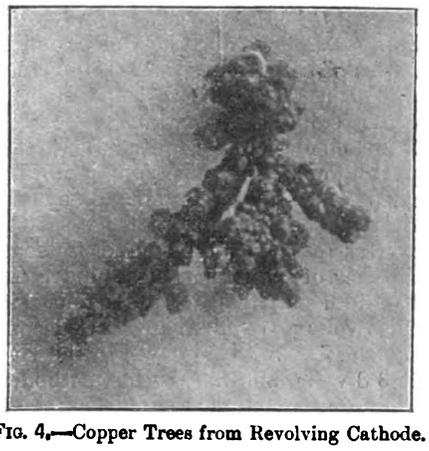

FIG. 4.—Copper Trees from Revolving Cathode.

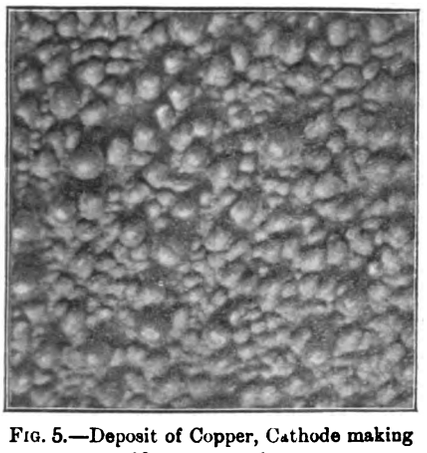

FIG. 5.—Deposit of Copper, Cathode making 10 revs. per min.

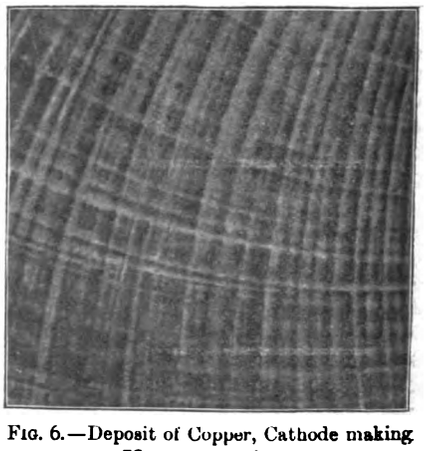

FIG. 6.—Deposit of Copper, Cathode making 32 revs. per min.

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amperes per square foot of cathode surface, the cathode being revolved at about 17 revolutions per minute, the diameter of the disc being 30in., the "nodule" was removed from the edge of the disc. Fig. 4 illustrates a "tree" obtained under similar conditions. Fig. 5 shows the apex of a copper cone deposited from the same solution, the cathode making about 10 revolutions per minute. Fig. 6 shows a copper cone deposited under the same conditions, making about 32 revolutions per minute. In the one case the surface is covered with a mass of small "nodules," and in the other case the rotation lines can be distinctly seen, the cross lines being caused by a change in the direction of rotation, which took place about every 15 minutes: the current averaged about 15 amperes per square foot.

THE E.C.C. ELECTRICALLY-CONTROLLED LIFT GEAR.

The Electric Construction Co. have recently introduced a lift gear of novel design, for which it is claimed that failure of any part of the apparatus is unattended by danger, that nothing depends on the skill of the operator, and that a very high efficiency is attained. We give below a general view of the gear and a drawing and diagram showing its construction in greater detail.

Two of these lifts have been erected as part of the electric installation at the new factory and warehouse of Messrs. Bovril (Ltd), where they have been in successful operation for some time under very severe conditions, being in continual use all day under widely varying loads.

The motor is of the E. C. C. enclosed iron-clad type, and the weight of the empty lift is balanced by counterweights to the usual extent. If the load is such, in ascending or descending, that it drives the motor above its proper speed, the motor itself acts as a brake by generating current and returning it to the supply mains. Should the supply mains at any time be incapable of absorbing power, provision is made to prevent over-running by applying a powerful friction brake through the action of a solenoid, the circuit of which is closed and opened by a centrifugal governor driven from the motor shaft. This brake consists of two arms, which are held clear of the brake-drum by means of an electromagnet against the pull of a strong spiral spring. The coil of the magnet is in shunt across the mains, the circuit being made and broken along with the starting switch. The motor is connected by a claw coupling having 90deg. play to two right-hand and left-hand worm gears, which take up the thrust, thus preventing loss of power by friction. Upon the axle of each worm-wheel is mounted a pulley, round which the steel ropes run for supporting the cage and counterweights, as shown in the diagram. The worm gear is completely enclosed in an oil bath, and will run for a considerable time without attention.

An endless rope running through the cage actuates the starting and reversing switch, shown on the right hand of the photograph. The motor is started up through a resistance, the cutting out of which is not under the control of the driver, but is performed automatically. The accelerating switch, which automatically cuts out the starting resistance in series with the motor armature, is mounted on the bedplate. This switch is put into action by an oscillating lever driven by an eccentric from the motor shaft. The lever carries a pawl which is actuated by a small magnet. When all the resistance is cut out the magnet is short-circuited and the switch-bar ceases to move, although the lever still oscillates. The switch bar is retained by a brake band passed round a drum on the switch-bar operated by another small magnet, and on the circuit being broken the switch-bar is automatically returned to the position in which all resistance is by the weight which can be seen in the illustration.

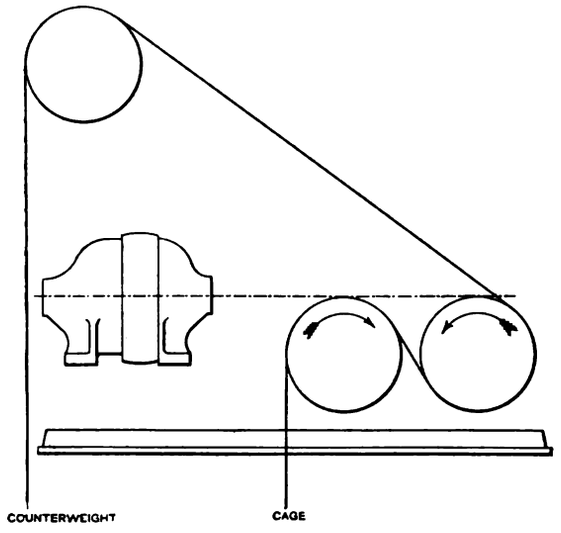
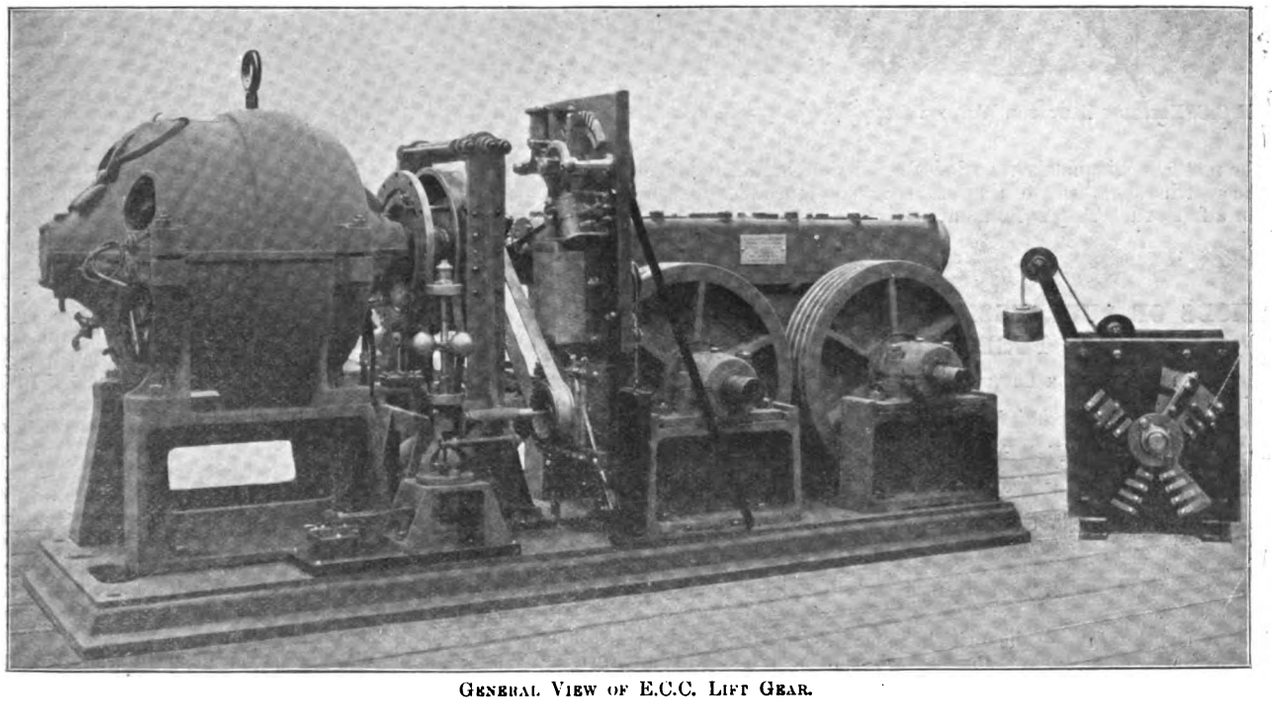


Diagram of Ropes for Electric Lift.

The gear to enable the motor to generate a current with increase of speed when it called on to act a brake, either when the cage is ascending with a light load or descending with a heavy one, consists of a disc mounted upon a screwed portion of the motor shaft, and driven by a pin fixed to the gear half of the coupling. As mentioned above, there is 90deg. of play between the halves of the coupling, and should there be a tendency on the part of the gearing to drive the motor, it will be necessary for the half coupling on the gear side to travel through an angle of 90deg. before it comes into position for driving. In traversing this distance the disc will travel along the screwed shaft sufficiently to short-circuit a resistance in the motor field. The counter-E.M.F. of the motor is correspondingly raised, and a braking current generated which prevents undue rise of speed. On closing the starting switch, by means of the hand rope from the cage, the following action takes place.



General View of E.C.C. Lift Gear.

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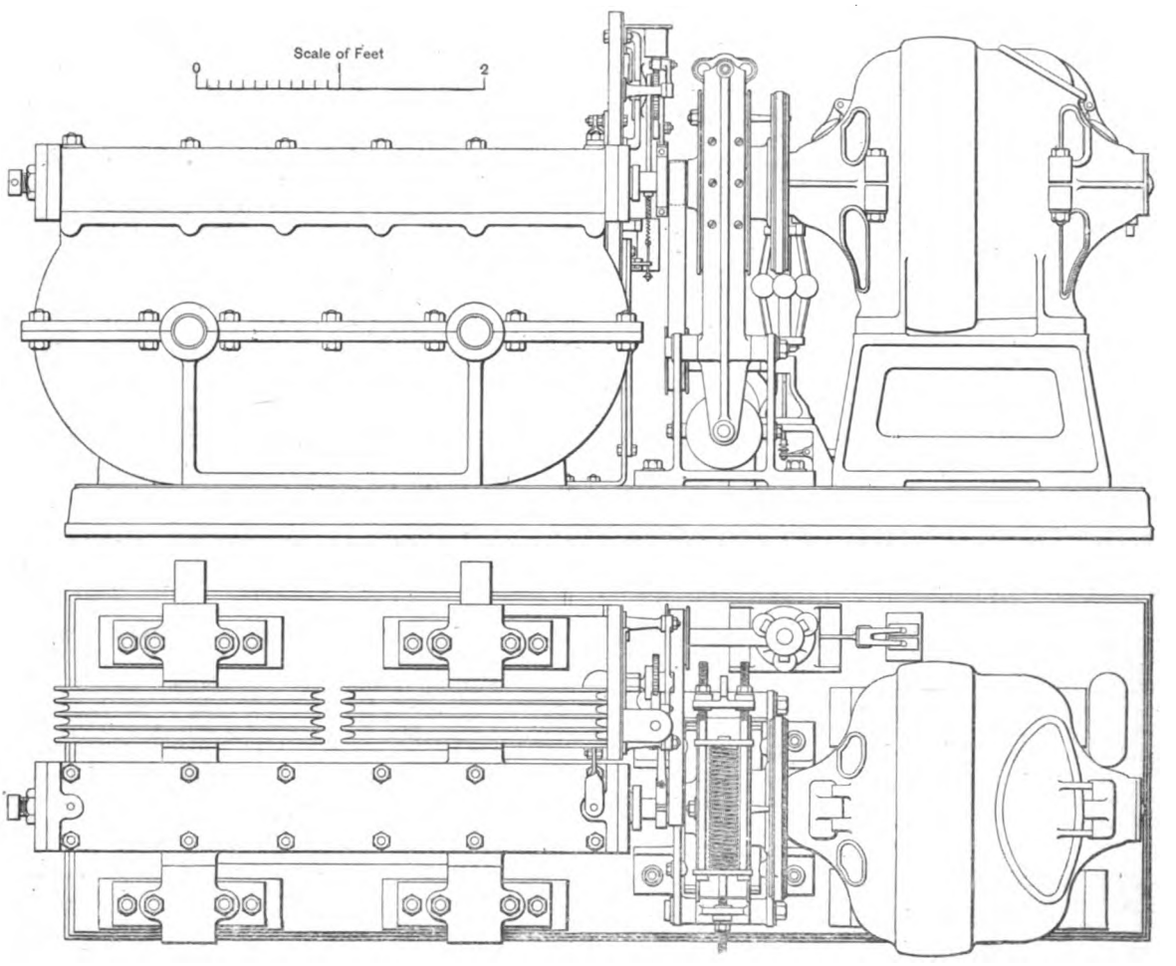
The brake is held off and the motor starts slowly, gradually increasing the speed as it cuts out the resistance in circuit with the armature until full speed is attained. On switching off the motor is short-circuited upon itself through a fixed resistance of such amount that the motor is adequately retarded, the friction brake is applied, and the switch-bar returns to its position of "resistance in" in readiness for a fresh run. Trip switches are provided in the lift hatchway should the cage exceed the limits of its travel. These are arranged so that the switch-bar is carried clear of the contacts by the cage, and cannot be replaced in the contacts until the cage has been run back. When either of the trip switches is broken the circuit is made by means of a switch placed in parallel with the trips. This switch is placed outside the hatchway and is in a locked box, so arranged that the cover cannot be shut down until the switch is broken.



E.C.C. Electric Elevator Winding Gear, Automatic Accelerating Controller, Electromagnetic Brake, and Speed Limit Governor.

METHODS OF SUPPRESSING ARCS IN SWITCHES, FUSES, &c.*

BY ERNEST KILBURN SCOTT, A.M.INST.C.E.

(*Concluded from page 257.*)

The Fowler (Hall and Fuller) Switch Fuse has a porcelain handle similar to the above, but each fuse wire is in this case closely surrounded by two lengths of asbestos sheathing, the whole being further protected by a glass tube. The fuse wire is placed in the asbestos by attaching it to the hemp core, which is then withdrawn and the wire takes its place (see Fig. 15). The asbestos is slightly porous, and this, together with its incombustible nature, helps to quench the arc.

Thomson-Houston Fuse.—The British Thomson-Houston Co. use a somewhat similar arrangement, the fuse wires being stretched tight between two fuse blocks, and each wire simply enclosed in a thin rubber tube. When the fuse wire melts the intense heat causes a heavy sulphide gas to form from the sulphur in the rubber, and this reduces the arc. Although the wires are entirely out of sight, the smell is sufficient to indicate when they have melted. This fuse has been used by the City of London Co. for some time, and is well spoken of.

Ferranti Oil Fuse.—One of the most ingenious devices for suppressing high-tension arcs is the Ferranti oil fuse. This consists of a rectangular porcelain vessel containing resin oil to a deph of several inches. It is divided lengthways into two compartments, and in each there is a spring which, when at rest, has its free end resting on the bottom of the vessel. To set the fuse, the free ends of the two springs are raised up until they are clear of the oil, fuse wires are attached from terminal to terminal, their middle portion resting on the dividing porcelain partition, as shown in Figs. 16 and 17. Naturally, when an excess current passes the wire melts, releasing the two springs, which plunge down through the oil on both sides and thus put out the arc. This arrangement will satisfactorily break 500 amperes at 5,000 volts, and it forms one of the most important details in the successful Ferranti switch panel. It may be mentioned that on the Continent for extra high-tension switches it is quite the usual arrangement to make the final break under oil.

Verity and Steele's Oil Fuse.—A high-tension fuse has been recently introduced by Veritys (Limited), which is more or less on the lines of Mr. Ferranti's device, in that the broken end of the fuse wire is submerged in oil, gravity taking the place of the springs used in the original type. The 50-amperes size is shown in Fig. 18, from which it will be seen that the fuse wire is passed through a U-shaped glass tube. On excess of current the wire fuses in air at the point C (the opposite end B being thickened up by having an extra strand wrapped round it), and the tube with the oil in it immediately drops, the broken end of the fuse wire being drawn under the oil at double the rate of travel of the tube.

Spring Back Fuse.—A somewhat similar idea, used in America, is shown in Fig. 19. The fuse made of sheet metal is in a state of tension between two-hinged terminals, which are pulled apart by springs. Around the central portion of the fuse the porcelain blocks are recessed so as to provide an air chamber, which is vented through the hole in the upper block. As the fuse loses its tensile strength at a low red heat, it is pulled apart almost before the metal has had time to melt, with the result that very little of the metal is

* Paper read before the Northern Society of Electrical Engineers, Dec. 5.

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volatilised. With a fuse of this type, occupying only 6in. by 3in., Mr. W. L. R. Emmett says he has repeatedly broken 300 amperes at 13,000 volts without injury to the device. The very ingenious "time fuse" made by Messrs. H. F. Royce and Co., in which a resistance coil heats up the fuse wire, is also provided with a spring which draws the ends of the wire apart directly it is melted.

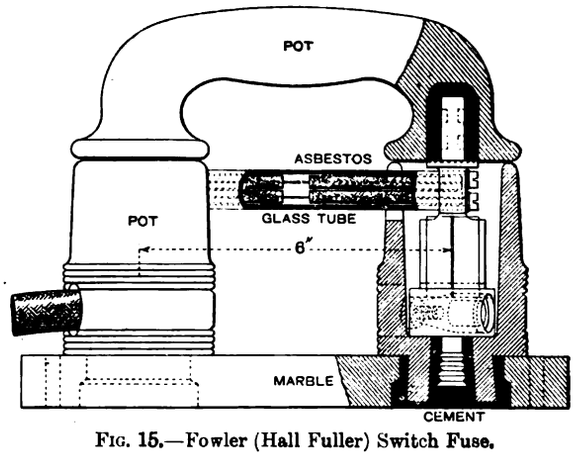

FIG. 15.—Fowler (Hall Fuller) Switch Fuse.

Shunted Fuse Working by Gravity.—The writer has suggested a combination of the shunted fuse with this springing back of the terminals. The arrangement is shown in Fig. 20 applied to a high-tension transmission of power line. The heavy fusible alloy which

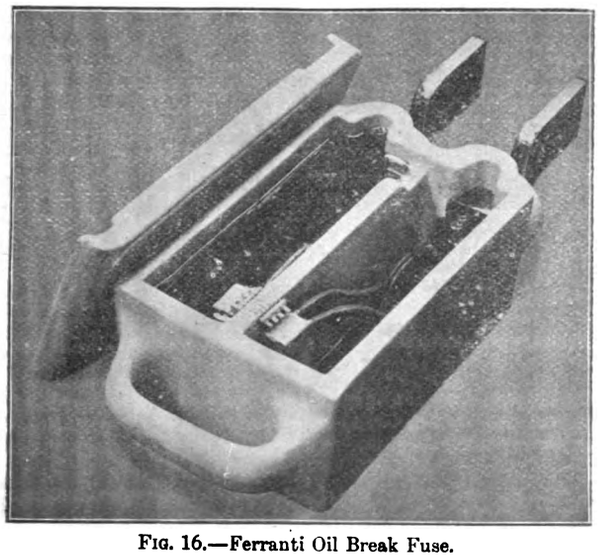

FIG. 16.—Ferranti Oil Break Fuse.

ordinarily carries the greater portion of the current is plugged in between the two lower terminals, whilst the shunt, consisting of a fine copper wire, connects the two upper terminals. These are hinged and weighted, so that, directly the copper wire melts by

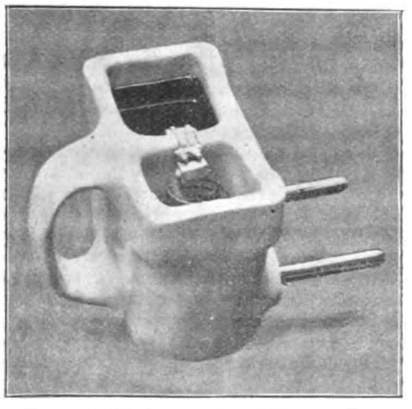

FIG. 17.—Ferranti Oil Fuse. Small Size for Transformers.

having the main current shunted through it, they fall back into the dotted position. Any arcing that may occur will soon go out, because the hot air tends to make it rise, as in the exceedingly simple but effective Siemens and Halske lightning arrester, which works entirely by the arc creeping up two (or three for three-phase current) curved arms and gradually lengthening until it flickers out.

PART III.—NON-ARCING METALS, &C.

The perfect non-arcing metal would be one having no resistance, for then there would be no heating of the final point of contact, and consequently the arc would not start. This is of course impossible, and therefore the term non-arcing metals is always taken to mean

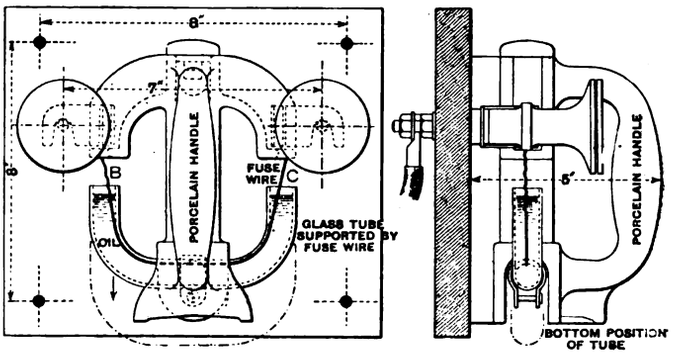

FIG. 18.—Verity and Steele's Oil Break Fuse.

metal which on commencing to arc gives off a vapour which forms an exceedingly high resistance.

The Wurts Non-Arcing Arrester.—As the result of most exhaustive researches Mr. Wurts found that certain particular metals and combinations of metals—the most important being zinc and antimony—gave a non-arcing effect when the distance between the metal was only $\frac{1}{32}$nd of an inch (see Fig. 21). Various explanations are offered to account for this non-arcing property, but the one most generally accepted is that the metals immediately produce a non-conducting oxide vapour over which the current cannot pass. It has been thought that, besides the non-arcing property of the alloy, the considerable mass of metal which is necessary for the rollers has a beneficial effect in cooling off the small arcs produced. A peculiar feature in connection with the device is that if the spark-gaps are long, say $\frac{1}{4}$in. each, most vicious arcing will occur, probably because the oxide vapour has a much better chance of being dissipated. Although originally introduced

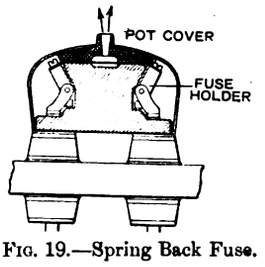

FIG. 19.—Spring Back Fuse.

for the purpose of being applied to lightning arresters, it involves a principle of suppressing arcs which the writer believes will some day have a much wider application. In the discussion on Mr. Byng's Paper before the Institution of Electrical Engineers the writer suggested the application of the idea to switches, and it is

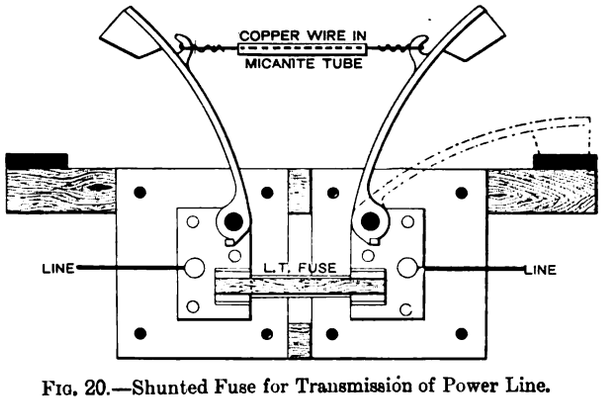

FIG. 20.—Shunted Fuse for Transmission of Power Line.

interesting to note that this has now been tried with satisfactory results.

Müller Non-Arcing Switch.—Mr. H. Müller, of the Electricitats Actiengesellschaft (late Schuckert & Co.), has designed a high-

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tension switch for alternating current in which the Wurts non-arcing device is introduced. It consists of 16 small rollers (see Fig. 22) of non-arcing metal, having spaces of 1mm. to 1½mm. between them. When the switch is made, a cam comes between the two sets of rollers and forces them all into contact, at the same time rotating the rollers slightly, causing new faces to be brought into contact and rubbing off any oxide which may have been produced. These switches will break 6,000 volts with very slight sparking, and they have been in use for some time in the municipal lighting station at Nurnberg, working with 2,000 volts 150 amperes. As the rollers are not very good conductors, for extra large current the rollers are used as a final break to an ordinary switch of the hatchet pattern con-

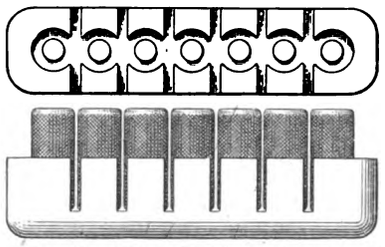

Fig. 21.—Wurts Lightning Arrester.

nected to the same cam which actuates the rollers. In switching on the rollers are first connected up, and then the main switch. When the latter is home it takes all the current (see Fig. 23).

Aluminium, Platinum, &c.—Experience with aluminium has been so favourable that it is now used almost exclusively for high-tension fuse wires in America, and it is possible that this preference may be due to its forming a non-arcing oxide. In a power-transmission line in South California, working at 33,000 volts, the fuse wires are of No. 20 gauge pure aluminium wire. They are 3ft. long, and run through wooden tubes, on the ends of which hatchet contacts are fixed, which can be quickly removed for re-fusing. On another plant working with 10,000 volts an aluminium fuse wire about 1ft.

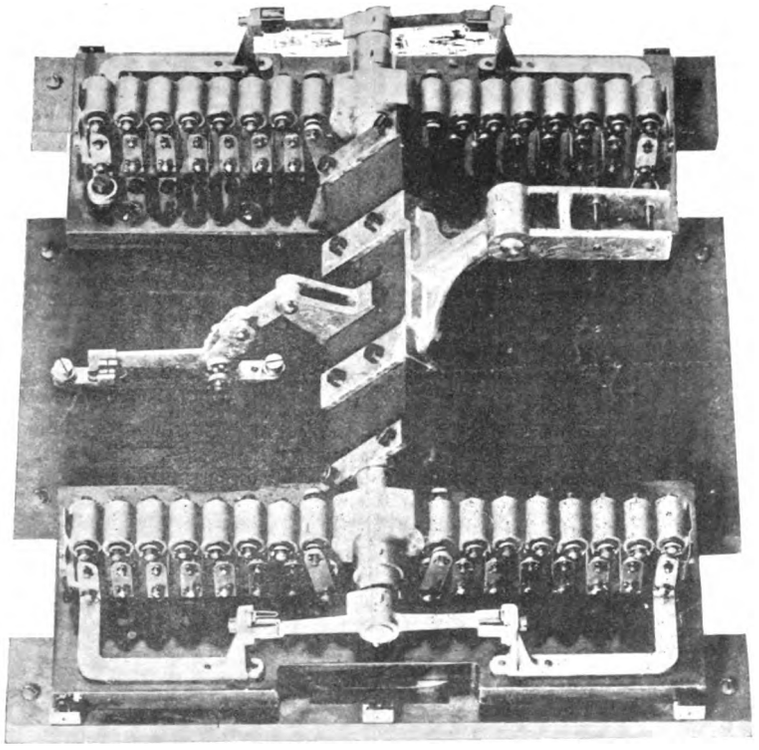

Fig. 22.—Müller Switch, with Non-Arcing Metal Rollers.

long is stretched horizontally, the wire being surrounded by a soft rubber tube. When the fuse goes, this tube drops by its own weight, carrying with it the molten metal and giving a clean break. It is interesting to note that some metals do not readily oxidise with an arc. Platinum oxides, for example, can only be made by the wet process, and they are at once dissociated by the application of heat. Platinum is thus in a sense a non-arcing metal, and its efficacy when used as the final breaking point of switches, &c., is well known.

Part IV.—Conclusion.

Many suggestions have been made which have not been put into practice: thus, one idea is that the fuse wire should have attached to it a small cap, which will explode when the wire melts and thus dissipate the metallic vapours. Another suggestion is that the wire should be covered with some material which would combine with the metal to form a heavy insulating gas. It has also been suggested that the fuse be surrounded by carbon dioxide gas, which ordinarily will not support combustion. This would not be much good with the electric arc, however, because we know from experience that an enclosed arc or semi-enclosed arc,† as it really is, burns well in an atmosphere consisting mainly of carbon dioxide gas. In 1894 Mr. J. Sachs suggested burying the fuse wire in a chemical salt which would combine with the metal of the fuse when heated. Something of the sort might be done, but there would always be the danger that its carrying capacity might be lessened, due to the salt attacking the metal when it was only warm.

A curious development of the difficulty in dealing with the large amounts of current at extra high voltages on transmission of power lines is the suggestion to do away with safety devices altogether. It has long been known that certain types of alternators could be so designed that they would withstand considerable overloading without showing evil effects. It appears that American engineers are now going further in this direction, and actually designing multiphase alternators for transmission of power work, with the sole idea of their being able to withstand short-circuiting, so that when a fault occurs on the line a large current is passed sufficient to burn it out. The change is not so drastic as appears at first sight, because the

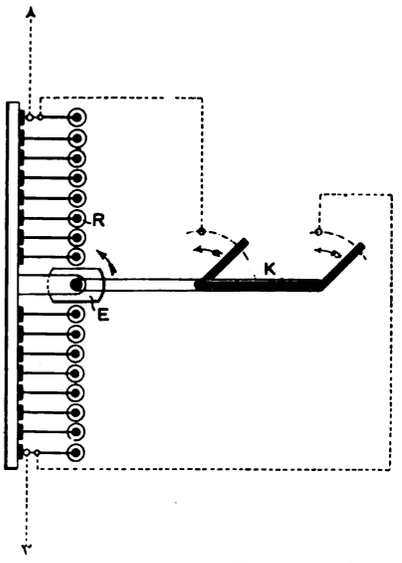

Fig. 23.—Diagram of Müller Switch.

writer understands it has been the practice in this city for some time to burn out any faults which may occur on the underground continuous-current cables.

COST OF STEAM RAISING.

(*Concluded from page 266.*)

The following is the conclusion of the discussion on Mr. R. E. B. Crompton's and Mr. John Holliday's Papers on this subject at the Institution of Electrical Engineers. Speakers who have returned their proofs corrected are denoted by an asterisk :—

*Prof. JOHN PERRY said that electrical engineers were people who dealt in energy, and to them questions of economy of fuel were more important than to any other class of engineer. He agreed pretty well with all that Mr. Crompton had said in his Paper on furnaces in general, and he hoped the furnace devised by the author of the Paper had a great future before it. The old theoretical notions were coming to the front. He need not refer to all the old notions in detail, such as high-pressure, superheating, high-speeds, and steam-jacketing. All these theoretical notions as published first were usually incomplete, and it was not until there were attempts made to carry them out by practical engineers—good, practical engineers who had common sense—that everybody got to see what a lot of force there was in these thermodynamic notions. It had always been said that it was very important to have a good combustion chamber, and if they could not get complete combustion otherwise, then it was necessary to have a combustion chamber completely lined with firebrick. He noticed that one of Mr. Thornycroft's latest patents proposes to use a

† As there appears to be some misconception on the point, it may be mentioned that an *entirely* enclosed arc will not work satisfactorily. Directly every particle of free oxygen has been burnt up the carbons begin to pump violently, and a steady arc is out of the question, however much the mechanism may be adjusted.

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firebrick-lined combustion chamber with his water-tube boilers. He would like to point out that heating surface by itself was really not a very important thing in boilers. A more important thing was what the hydraulic engineer called the "hydraulic mean depth." It was enormously important, if heat was to be given from gases to metal, that the metal should be scrubbed with the gases. The velocity of the gases in the flue was a very important thing—in fact, the most important thing. From experiments that had been very carefully made it was quite clear that when the velocity of the gases in the flue was doubled, twice as much heat was given to the metal; treble the velocity and they got three times as much heat, and so on. But what many people forgot was that on the other side of the metal the water had to take up the heat. There was really very little attention paid to the taking up of the heat by the water from the metal of the flue. In the old days of low pressures, steam had a small density. A pound of evaporation meant a great volume. The result was that there was a great commotion of the water, a great deal of circulation. In these days of high pressure the steam was very dense, and there was nothing like the same commotion of the water for a pound of evaporation, and he thought they were all coming round to the idea that they must have mechanical scrubbing in the water of a boiler. Many of the increases of economy that he had noticed in recent boilers were really due to the production of more commotion of the water and hence more scrubbing of the metal surface. There was another point to which sufficient attention was not paid, and that was the fact that in boilers for condensing engines the water in the boiler was "airless" water. A great chemist had told him some little time back that airless water could not be boiled. No doubt there was a tremendous lot of difficulty in heating airless water, but in boiling it there was greater difficulty still. This was the reason why there was so much trouble sometimes with ordinary cylindrical marine boilers, and he thought the great merit of Thornycroft was in his having seen that not only must they have a rapid circulation and scrubbing action of the water on the metal, but a gurgling scrubbing action such as they had in water-tube boilers. Mr. Holliday had compared the cost of evaporating with two kinds of fuel—viz., the 3s. 6d. and 14s. 6d. fuel, and had given the cost of coal and the cost of evaporating 1,000 gallons of water. Mr. Crompton had considered a very important thing—viz., the load factor. This was probably the most important thing for them, as electrical engineers, to consider, and Mr. Crompton had made calculations for two common load factors. They would observe that Mr. Holliday employed a fairly high load factor, and he (Prof. Perry) had endeavoured to make use of his figures in making calculations concerning many other load factors. Perhaps the President would allow him to incorporate in his remarks when they were printed in the *Journal* the method of calculation he had adopted; it would take too long to describe that evening. He wished he could make a fair comparison between the numbers he had worked out and those that had been published by Mr. Crompton, but unfortunately his own costs, as also were Mr. Holliday's, were *total* costs, whereas Mr. Crompton only took the cost of coal and the working expenses. He himself had included the cost of maintenance, insurance, rates, taxes, and rent; in fact, he had taken all Mr. Holliday's conditions. Therefore there was only one point on which he could make a comparison with Mr. Crompton, and he was sorry to say that in that respect his figures did not quite agree. The difference was this. In the last page of his Paper there was a table which enabled them to find out the number of pounds of coal per unit adopted by Mr. Crompton. Thus, for coal at 17s. 5d. per ton with an 18 and a 33 per cent. load factor Mr. Crompton gave 5·25lb. of coal per unit in one case and 5·24lb. in the second case, while for coal at 5s. 4d. per ton his figures were 5·15 and 5·17 respectively. He (Prof. Perry) had made calculations for a good central station, and had obtained the following figures—viz., 6·3lb. of coal per unit in the first case and 4·6lb. per unit in the second, while using the cheaper fuel his results were 9·8 and 7·2. He thought Mr. Crompton's numbers were a little too equal, and although one must not criticise actual figures obtained at Chelmsford, he submitted that his figures *did* represent the more usual results one would obtain at a good central station. Mr. Crompton had kindly promised to check his figures, and he hoped he would be allowed to correct them. Prof. Perry then exhibited curves showing the results he had obtained by taking the figures given in Mr. Holliday's Paper, the horizontal distances representing the cost of coal per ton and the vertical distances the total cost of evaporation in pounds per electric unit. The following table gives the results:—

Total Cost in Pence of Evaporation per Electric Unit. Also Cost of Coal alone.

Load factor per cent.	Price of coal per ton.											
	3s. 6d.		5s. 4d.		7s. 6d.		10s. 6d.		14s. 6d.		17s. 5d.	
	Tot. cost.	Coal alone.	Tot. cost.	Coal alone.	Tot. cost.	Coal alone.	Tot. cost.	Coal alone.	Tot. cost.	Coal alone.	Tot. cost	Coal alone.
10	2·56	0·30	2·49	0·43	2·43	0·55	2·34	0·67	2·28	0·81	2·24	0·90
18	1·09	0·21	1·10	0·29	1·10	0·37	1·13	0·47	1 13	0·56	1·14	0·61
33	0·53	0·15	0·56	0·21	0·59	0·27	0·63	0·35	0·65	0·42	0·67	0·45
66	0·28	0·12	0·32	0·17	0·35	0·21	0·39	0·27	0·43	0·32	0·45	0·37

It was seen, he said, that the cost per unit, so far as evaporation was concerned, diminished as the price of coal increased, when taking the load factor as low as 10 per cent. But taking the more usual load factor of say 15 per cent. to 22 per cent., they found it did not make much difference whether they used a cheap or more expensive coal, whereas if they had a higher load factor, say 33 per cent., of course it was more expensive to use the more expensive coal, and it was still more expensive to use an expensive coal with a load factor of 66 per cent.

*Mr. J. N. SHOOLBRED thought the circumstances under which the figures in the Paper had been arrived at should be taken into account. Mr. Holliday had a whole stock of boilers running through the week with practically a middle load which was very different from what, at present at least, they had to put up with in electric light stations. The question of the economy of forced draught was very much dependent upon this fact. Forced draught required a state of equality of the load that did not create any variation in the working. The thermal condition of the pipework itself was also a very important factor, and more so than was generally supposed. He thought it would be generally found that forced draught was not a success in circumstances which were of a much more intermittent character than those experienced by Mr. Holliday. With regard to the difference in the cost of fuels, Mr. Holliday had pointed out that cheaper fuels—not the very cheap ones—were really more economical to use than the high-class coals which had been made considerable use of so far. Mr. Dickinson's figures read by Mr. Crompton seemed to bear this out, while he himself had had considerable experience in this, and agreed with Mr. Dickinson. The reason that these low-price coals were more efficient, appeared to him to be that the calorific value of these coals did not descend in the same proportion as the market value. A coal that they could get for half the price of the best anywhere near the coalfields would probably give them three-quarters the calorific value of the best. This coal of course would give a result that would be economical. It was very largely due to the great proportion of incombustible matter that these cheap fuels, when used with forced draught, gave practically the same results that were obtained with middle-class coal.

*Mr. H. L. P. BOOT had carried out experiments, chiefly with a class of Welsh coal, under exactly the ordinary daily working conditions of the electricity works. The coals tried were Nixon's Navigation, which came out at 1·02d. per unit; Ocean Co.'s washnuts and large, 0·96d. per unit; Hood's Merthyr nuts, 0·78d. per unit; Wayne's Merthyr, 1·2d.; Gelli nuts, 0·96d.; coke at 15s. per ton, 0·879d. per unit; Penrikyber, 0·894d.; Great Western Colliery Co.'s coal, 0·810d. per unit. These figures of course applied to Welsh coal.

Prof. PERRY: Are they total costs?

*Mr. BOOT said these figures represented only the cost of the coal. The tests were made under ordinary working conditions, with a poor load factor. He might mention that the average price of a good-class coal in Tunbridge Wells was something like 24s. or 26s. per ton. If they took into account the railway rate, which in many instances was twice as much as the value of the coal, they would see at once that it was necessary to burn the very best class of fuel possible, so as not to pay too much into the railway company's pocket in rate. He had worked out some figures, and found that, taking coal at 5s. per ton at the pit's mouth, and adding sums to include railway rate, unloading, stoking, getting rid of ashes, and extra capital required on boilers, the total amounted to 16s. 9d. per ton for a very bad class of fuel. Comparing this with the best class of fuel, costing 24s. per ton, and allowing for a smaller outlay on boilers owing to the higher evaporation, the fact that they had got to deal with a smaller percentage of ash, the fact also that very often it was found that one stoker could do the work of two, and that the cost of unloading and the railway rate were very much less, he had found the total difference per unit under these conditions in his own particular instance to amount to 0·184d. per unit. Another point was the deterioration of the coal by storage. He had found that sea-borne coal had not the same value when it reached its destination as the same class of coal brought from the same colliery by trucks. He had also found that Welsh coal, after being stored for a month, had lost as much as 25 per cent. of its value, while the same coal under the same conditions after 2½ months had actually lost 33 per cent. of the value it would have had if he had burned it immediately it had been received. At the last meeting it was said that if a tube of a multi-tubular boiler went it was necessary to draw the fires. He was speaking from experience when he said this was not the case. A tube might burst—an ordinary burst which took place in practical working—but it was not necessary to draw fires before it was possible to spare the boiler. Of course they would have to bring the pressure down, but the boiler would still be capable of going on working.

*Mr. W. GEIPEL said that there were not a few electric light stations at this time of the year which were face to face with the difficulty of raising more steam than they really could with their existing boilers. Prof. Perry had anticipated some of his remarks, mainly on the question of the load factor. The load factor mentioned in the tests made by Mr. Holliday was almost a constant load factor. It was a factor which they never had, in their experience in electric lighting at any rate, been fortunate enough to come across. The boilers that were discussed in the Paper by Mr. Holliday had, he calculated, about 850 sq. ft. of heating surface on the average for each boiler, and those with Perret forced draught were evaporating 3·2lb. of water per sq. ft. of heating surface. But this was not enough, and with boilers properly installed they should get three to four times as much. Then in the case of the hand-worked boilers Mr. Holliday had an evaporation of only 4lb. to 4½lb. per sq. ft., it was not surprising, then, that he (Mr. Holliday) should have made the remark that as he got more work for the boilers he got better results. It might be that the water-tube boiler is less efficient with some classes of coal, if they took it for a 24 hour load where the question of raising steam was not important, but where they had to raise steam for two or three hours' use they were very valuable. It had been acknowledged that Lancashire boilers were very costly and wasteful in this steam-raising question. Mr. Mountain, in his Paper before the Northern Society of Electrical Engineers some year ago, had stated that for hours after the steam had been raised the boiler was cold at the bottom, showing that he had not yet got his water up to the proper evaporating point right through the boiler. Prof. Perry had suggested mechanical circulation. He (Mr. Geipel) was quite sure that mechanical circulation would have very beneficial results, and he thought the Institution might like to know of another

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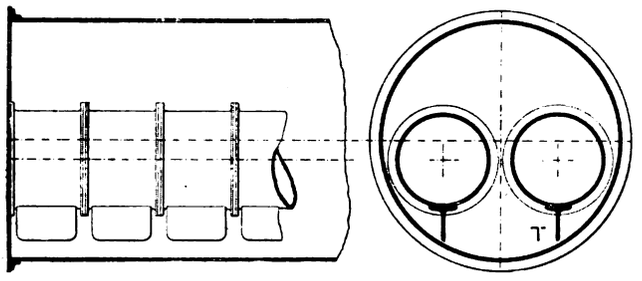
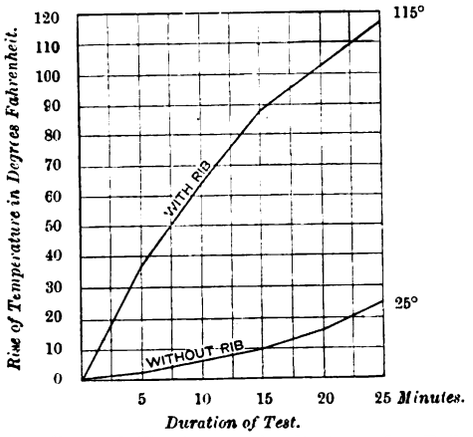
means of obtaining this result—a means which his own firm used in practice. The diagrams below showed the arrangement of this device. By attaching to the bottom of the flues of a Lancashire boiler thick ribs of iron they induced circulation through the thermal conductivity of the iron. It was well known that water would not transmit the heat downwards except at a very low rate; but by the thermal conductivity of these ribs the heat was carried down and caused the heating of the water at the bottom, which becoming lighter rose upwards and induced a circulation very much in the direction shown by the arrows. This might appear to be a somewhat



Geipel and Lange's Circulator for Boilers.

theoretical proposition, but the appended curve showed the actual results of the application of the system. The curves were taken from laboratory tests, but he had found by actual experience that these laboratory tests had been fully fulfilled. One curve was drawn from a test made without this rib simply by heating the water downwards, and showed the rise in temperature for each five minutes, and it was seen that the temperature



Curve showing Rate of Heating at the Bottom of a Boiler with and without Geipel and Lange's Conduction.

at the bottom of the water rose in 25 minutes to about 25°F. Then with exactly the same conditions in every way, with the exception that a thick rib of iron was attached to the bottom of the boiler, he had obtained the second curve, and as they would see, he had got a rise of temperature in the same time of 115°F.—about four or five times the increase which was obtained without the rib.

Prof. PERRY: Where was the thermometer?

*Mr. GEIPEL: About that point [indicating point T on the diagram]. Continuing, he said the iron was simply T iron riveted on to the bottom of the flue. Once they had set up the circulation in the bottom of the boiler, it was extraordinary how it drew the cold water to it. Referring to the question of inferior fuel, he mentioned an experience of his in this connection at Chatham, where he said there were two stations, one a very small one using forced draught and inferior coal, and the other a large station using a better coal. His experience here enabled him to confirm Mr. Boot's assertions fully, as he had obtained at Chatham a cost of 0·75d. per unit with inferior coal, against about double that with the Welsh coal. Mr. Crompton had spoken of the difficulty of coking stokers. He agreed with Mr. Crompton entirely in this, owing to the difficulty of keeping the grate properly covered and free from air holes, but this difficulty he had never yet seen with a properly arranged spreading stoker. With spreading stokers (his experience had chiefly been with the Bennis) the fire was fairly level right throughout, whilst the clinker, which Mr. Crompton had also referred to as a great difficulty, was very much reduced compared with what they had with hand firing, as it was passed over the end of the firebars. Altogether there was very little trouble indeed with this particular form of stoking. He also agreed with Mr. Crompton that it was most important that the proper proportion of heating surface and grate areas should be arranged according to the fuel, draught, and other circumstances; but he did not quite agree with his idea of putting the furnace outside the boiler. Wherever they had heat they were bound to have conduction and radiation, and if they could get the furnace surrounded by water it was very much better. At Frankfort there were tubular boilers with the furnaces enormously increased in size by a particular arrangement of the boiler which kept the whole of the fire inside the boiler and surrounded by water. In conclusion he pointed out an interesting coincidence in Table V. of Mr. Holliday's Paper. They would find the depreciation was calculated at 5 per cent. per annum on the cost of the boiler, and the amount set aside formed 5 per cent. of the total yearly working costs, which meant 5d. per thousand gallons. Probably Mr. Raworth would call that the rule of five.

*Mr. A. J. LAWSON thought that from time to time they were all indebted to Mr. Crompton for the very valuable suggestions put before the Institution. Some years ago Mr. Crompton, in another Paper, had suggested 3d. per unit as the cost of electricity, and many were very much frightened at the low price mentioned. Since that time, however, provisional orders and bills had been passed through Parliament in which the maximum price for the supply of power during the day must not exceed 3d. per unit for the first hour and 0·825d. for every subsequent hour, or an average of 1d. per unit for an eight-hour day. He (the speaker) could confirm the statement in the Paper as to the adhesion of the clinker to the brickwork, which was always considerably damaged in the operation of removing the clinker. He suggested, with regard to double furnace boilers, the use of a single arch and a dividing wall between the two doors, by which means the cost of re-lining the arch was very much cheapened. As to the relative cost, he said that, taking stations in which Welsh coal was burned under the boilers similar in every respect to stations burning North Country coal, he had found the cost of repairs in the former case to work out at about 0·033d. per unit, while in the case of the latter it was 0·150d., or four and a half times as much. This was taking the average figures of two stations of either kind for two years. They must also take into account the cost of the clinker to be removed, and this was found to be from two to three times more in the case of the bituminous coal than with Welsh coal. In London they must pay at least 50 per cent. more for their Welsh coal and also more for handling and storing, as well as more in stokers' wages, whilst the evaporating value was only 25 per cent. greater than North Country coal. At present the North Country coal, water-borne, was obtained on contract at 12s. per ton, while the Welsh coal was 20s. If they took South Hetton or Harton coal, with good automatic stoking and taking into account the economisers, they would get an ordinary evaporation of 8lb. of water per pound of coal, while Welsh coal would evaporate 10lb., taking the economiser into account; and he wished to point out that, however important it might be to use cheap coal, it was very much more important to use an economical engine. For, taking the steam consumption at 20lb. per horse power and downwards, and the efficiency of the engine and dynamo at about 80 per cent. or 600 watts delivered at the brushes for every indicated horse power of the engine, then, assuming no other losses, they required $1\frac{3}{4}$ h.p. to produce a kilowatt. In connection with this he had compiled the table below, giving the cost of coal per unit generated when burning North Country coal and a similar cost when burning Welsh coal, the over-all efficiency, as he had mentioned, being taken at about 80 per cent. From this table they would see that with an engine taking 18lb. of steam per horse power hour, it would cost 0·201d. per unit generated, assuming coal at 10s. per ton. Taking coal at 12s., the engine should take only 15lb. of steam per horse power, and if coal cost 14s. per ton delivered then the engine steam consumption should be only 13lb. per horse power to produce a unit at the same cost for fuel. These figures were obtained when using North Country coal. With Welsh coal, costing 14s. per ton, to obtain the same results the engine should take only 16lb. as against 18lb. for North Country coal costing 10s. per ton. Some speakers had dwelt on the

Cost of Fuel per Board of Trade Unit generated with an over-all efficiency of 80 per cent. when burning North Country rough small coal, evaporating 8lb. of water per pound of coal and the ton of coal when delivered into the coal store costing:—

Lbs. of steam per h.p. hour.	10s.	12s.	14s.	16s.	18s.
20	0·223	0·268	0·312	0·357	0·402
19	0·212	0·255	0·296	0·339	0·382
18	0·201	0·241	0·281	0·321	0·362
17	0·190	0·228	0·265	0·303	0·342
16	0·178	0·214	0·250	0·286	0·322
15	0·167	0·201	0·234	0·268	0·301
14	0·156	0·188	0·218	0·250	0·281
13	0·145	0·174	0·203	0·232	0·261
12	0·134	0·161	0·187	0·214	0·241
11	0·123	0·147	0·172	0·196	0·221
10	0·112	0·134	0·156	0·179	0·201
Half of	above figures per unit		generated	= a cost per	ton of—
	5s.	6s.	7s.	8s.	9s.

Cost of Fuel per Board of Trade Unit generated with an over-all efficiency of 80 per cent. when burning Welsh coal, evaporating 10lb. of water per pound of coal and the ton of coal delivered into the coal store costing:—

Lbs. of steam per h.p. hour.	14s.	16s.	18s.	20s.	22s.	24s.
20	0·250	0·286	0·321	0·357	0·393	0·429
19	0·237	0·272	0·305	0·339	0·373	0·408
18	0·225	0·257	0·289	0·321	0·354	0·386
17	0·212	0·243	0·273	0·303	0·334	0·365
16	0·200	0·229	0·257	0·286	0·314	0·343
15	0·187	0·215	0·241	0·268	0·295	0·322
14	0·175	0·200	0·225	0·250	0·275	0·300
13	0·162	0·186	0·209	0·232	0·255	0·279
12	0·150	0·172	0·192	0·214	0·236	0·257
11	0·137	0·157	0·177	0·196	0·216	0·236
10	0·125	0·143	0·161	0·178	0·196	0·215
Half of	above figures per unit generated =			a cost per		ton of—
	7s.	8s.	9s.	10s.	11s.	12s.

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very much greater grate area required when burning North Country coal, and the much less work they were able to get out of the boilers in consequence of its use. But he had not found this to be so much the case, for taking a Babcock and Wilcox boiler rated at 6,000lb. of water per hour, using similar coal, he had been able, on long-continued runs, to get an evaporation of from 7,500lb. to 8,000lb. He could also say that in any station where they wanted to run up their load rapidly it was impossible to find a better boiler than a water-tube boiler. They could get up a full head of steam from a cold water-tube boiler in three-quarters of an hour with ease, while if they wanted to do this with safety with a Lancashire boiler they would take many hours.

Prof. R. H. SMITH said that while of course it was an actual fact that the chimney temperature was nearly always higher with forced draught than without it, he had never yet found, himself, any reason for believing that this was a necessity. If forced draught were more intelligently applied, if the arrangements in connection with it were better thought out, he thought they might have less temperature at the base of the chimney than when working without it. With forced draught he had sent gases into the base of the chimney considerably cooler than the steam in the boiler. This was not a result to be desired, but it showed there was a possibility of getting practically all the heat that could be theoretically got out of the hot gases before they went into the chimney. He thought the results in Mr. Holliday's paper were somewhat affected by the large amount of superheating. In these experiments the feed water had been heated up to 220°F. by the exhaust steam of the feed-pump engines. These feed pumps were ordinarily frightful steam consumers, and so long as they were used in this form it was well to use their exhaust steam in heating the feed; but this did not show any merit in the whole installation referred to in the Paper, but simply illustrated the frightful waste of steam used in working the feed pumps. In connection with Mr. Crompton's Paper, he particularly agreed with his recommendation of firebrick lined furnaces where a very high economy was aimed at; and he also agreed with Mr. Crompton's remarks on diminishing the quantity of excess of air introduced into the furnaces. This would operate in two ways: in reducing the percentage of heat wasted by discharge into the chimney, and in making it more easy to get a much greater perfection of combustion in the furnace, extra facility for which was particularly important with low-class fuels and with all kinds of mechanical stoking.

*Mr. F. J. APPLEBY was surprised that Mr. Crompton had made no reference to a system of utilising cheap fuel which combined the highest efficiency with very great economy. He referred to the use of powdered coal, which since the experiments of Mr. T. B. Crampton in 1873 seemed to have been left alone until 1892. Since then it had been taken up by the Germans. The coal had to be reduced to such a state that there was only about 5 per cent. residue left upon a sieve of 7,000 holes to the square inch. This coal required very different handling to coal dust. To ensure the success of the system they must have a mill able to produce a perfectly divided coal with absolute uniformity and without any sifting. This has been a great source of trouble in Germany for some time, but there was already an English mill on the market that fulfilled all conditions, and the system was going ahead in the North of England. The coal powder had to be fed in in an unbroken stream, and it must also be held in suspension in the air current until perfect combustion ensued. There must also be provision for the maintenance of a continuous high temperature in the combustion chamber. This could be maintained by lining the furnace with firebrick. When these conditions were fulfilled ash would be no hindrance to the system, no matter how high the percentage. For instance, one large firm in Germany was using coal with as much as 45 per cent. of ash, and what was more, they were working successfully. Another firm in Austria reported a saving in their coal bill of 22 per cent. The system seemed particularly adaptable to large central stations, and this opinion was the conclusion Mr. Schneider had come to. With average care the system ensured a perfect absence of smoke. Considering the high price of Welsh coal in London, when good North Country coal could be bought for 12s. per ton and it only cost 12d. to 15d. per ton to pulverise it, he thought the system was worth the attention of every engineer associated with large steam plants. There was a large installation now erecting in the North of England, where they would grind 1,400 tons in 24 hours, and expected to sell the pulverised coal at 5s. per ton. A large central station could well do its own grinding if conditions of space allowed.

*Major-General WEBBER asked the last speaker if he would favour the Institution with a short description of the mill alluded to for pulverising. He had had a good deal of experience with pulverising materials harder than coal, but the difficulty was uniformity of size. He thought such a description might follow the speaker's remarks in the Institution *Journal*.

The PRESIDENT read a letter from Mr. Holliday, in which he regretted being unable to attend that evening, and expressed his appreciation of the way in which his Paper had been received.

*Mr. R. E. CROMPTON did not know whether he had to reply for Mr. Holliday as well as for himself, but he could not help doing so in some few instances. He did not intend being drawn off into side issues; his Paper was on the use of cheap fuels. Certainly cheap fuels requiring a large grate could be burned more easily under boilers having external means of firing, and the Lancashire boiler, with its narrow grate, was not suited for this for that reason. But he thought it was quite outside the Paper to discuss the suitability of water-tube boilers as compared with other kinds of boilers. He was addressing an audience of skilled electrical engineers who had got a good deal beyond that kind of thing. There were a large number in that room who had threshed that subject out years ago and had long since formed their opinions on the subject, and it would be flogging a dead horse if he tried to reopen that controversy. He only mentioned water-tube boilers in his Paper because they were so largely in use. They were practically a standard type for power stations. Mr. Ferranti, he thought, agreed with the Paper. Referring to Mr. Ferranti's remark, he pointed out that when it was attempted to get perfect combustion in the chamber the walls of that chamber must suffer. It was with this very object that he proposed the use of a removable furnace, so that it could be easily repaired. Mr. Ferranti had called his attention to a point with which he did not deal sufficiently in his Paper—viz., as to the character of the material used for lining combustion chambers. Many of them had no doubt wondered why firebrick bridges and devices of that kind had proved successful in some cases and in other cases not successful at all. He had never seen publicly stated the enormous effect the character of the firebrick used had on the usefulness of the combustion chamber. In the material in combustion chambers one was dealing with something more of the nature of the mantles of incandescent gas lamps. A material was wanted which could take in and give off heat with extreme rapidity, and he believed researches into this class of highly refractory materials would be of enormous use in developing combustion chambers and enabling them to give far higher efficiencies than had yet been reached. He himself had found differences of as much as 100 per cent. in the effective nature of the surface according to the material used. He had found that softer surfaces, something like pipeclay, not only were not so easily melted, but had also increased the efficiency of the furnace as a means of preventing smoke and of getting a high percentage of CO_2. He had got as much as 10 per cent. without any alteration in the form of the furnace, but only in the material used. Mr. Stromeyer's remarks were to be received with the greatest respect. The early part of this gentleman's remarks referring to Mr. Holliday's Paper had greatly impressed him, and it was difficult to reply to them. He took them from him as correct. However, he would refer to that part of Mr. Stromeyer's speech in which he stated that if the coal were pure the cost of evaporating would be 1d.; if the coal had 20 per cent. of ash the cost would be 1½d., 30 per cent. of ash 2½d., and 40 per cent. of ash 4½d. These were very startling figures, and he could not understand how they had been obtained. He admitted that cheap coal which contained much ash did not mean a saving at the present time, but he (the speaker) had given them in the body of his paper the means by which he hoped this could be done. Now, the figures he had given in the addendum were to a certain extent a proof that an advance had been made. They had a fuel with a very considerable percentage of non-combustible and a very high percentage of water, which gave results comparable with the very best fuels, and he thought this showed that the ideas of those who had been working in this direction, and which he had attempted to put forward in his Paper, were promising; and although they might not get such very high results in constant practice as given in the addendum, yet he did not see why when they had a machine-worked furnace the results on long tests should be as good as on short tests. Mr. Boot's figures were extremely interesting. He took it, however, that the same boilers were used throughout the different tests. At the same time, to get the best results with different kinds of fuel the boilers required considerable adjustment. The length of the fire bars and the grate area required to be experimented with before they could get the best results with each class of coal, and he did not think any short tests were of very great value. Mr. Boot had corroborated what he himself had said about the great loss by storage of fuel, and of course there was no doubt about it. The more finely the fuel was powdered the more rapid was the deterioration. It was well understood what was the cause of this. During storage the material was slowly oxidised, and the amount of earthy matter in the coal thus increased. Mr. Geipel had given some very interesting information, but he thought he was a little unfair to Mr. Holliday. Mr. Holliday did really consider capital cost, and put it down very clearly in his table. He quite agreed that it was a splendid thing to force the boilers, as this did reduce the capital charge. Mr. Miller had told them that at one station they sometimes used to fire a 750 H.P. Babcock and Wilcox boiler up to 1,100 H.P. by injecting oil fuel, but now the oil fuel had employed gone up in price just as the cheap coal did. Mr. Lawson's remarks were practical, as they always were. On the subject of brickwork he had given them some valuable hints, which might not be known to all of them, as to the way the brickwork should be put into boilers so as to reduce the cost of repairs. He differed from Prof. Smith's opinion that the question of energy and economy was not purely one for electrical engineers. Until electrical engineers talked about energy nobody in England thought of it. Waterworks engineers and railway engineers might have done, but they kept it to themselves, but until electrical engineers published their results very little was said about it. The fact of it was that all manufacturing firms in the country were putting down power stations instead of going on in the old way. All the old things were being reformed by electrical engineers now, simply because they had studied the question of producing energy cheaper. Coming to Mr. Appleby's remarks, he said no doubt there was a great future before the invention mentioned by that speaker. The late Mr. Crampton had worked it out at Woolwich Arsenal, but he believed there were very great difficulties connected with it. He would like to ask Mr. Appleby where the incombustible part went to. If he had a fuel containing 20 per cent. of incombustible made into powder, the whole of the combustible matter was burnt, and the remainder had to go somewhere. It was either blown all over the parish in the form of dust, or it stayed in the flues. He was afraid that periodical flue cleaning would be one of the difficulties of the method, and this meant shutting down the works and causing a great deal of trouble. He believed this was experienced at Woolwich. But Mr. Appleby must not take these remarks as throwing cold water on the idea. He thought it worth developing. Every idea for using cheap fuel to the best advantage was worth developing.

The PRESIDENT announced the receipt of a communication from Mr. Bryan Donkin, which would be printed in the *Journal*. He then proposed a hearty vote of thanks to Mr. Crompton and Mr. Holliday, and this having been unanimously accorded them, the discussion concluded.

THE FRENCH PHYSICAL SOCIETY.

At a meeting of the French Physical Society, held on December 1st, M. Bouty, in his Paper on

"The Electrolytic Conductivity of Rarefied Gases,"

pointed out that in general, when the electrical properties of rarefied gases are studied, tubes with electrodes are used which can be put into the circuit of a continuous or alternating E.M.F. In the neighbourhood of the electrodes there is then found to be considerable heterogeneity, but J. J. Thomson has shown that perfectly homogeneous discharges can be obtained by using electrodeless tubes. From experiments thus made Thomson had concluded that rarefied gases, at a pressure less than 2mm. or 3mm., have an electrolytic conductivity which, referred to its volume or to its mass, is of the same order of magnitude as acidulated water or good metal conductors respectively. E. Wiedemann, on the other hand, by studying the products of decomposition of various compound gases through which a discharge has been passed, concluded that these products were due, perhaps exclusively, to purely thermal actions, and that rarefied gases could not be considered as electrolytes.

M. Bouty arrives at the same conclusion from experiments on rarefied gases in a uniform electrostatic field. If between the plates of a condenser a conductor is placed, the capacity of a condenser is increased, sometimes considerably. A glass vessel coated inside and out with paraffin, and filled with air at atmospheric pressure, will produce only a very moderate increase of the capacity, say about 2 per cent., though the same vessel filled with mercury produces an increase of about 50 per cent.: if water, alcohol, or petroleum be substituted, in spite of their small electrical conductivity these behave like mercury. Hence, bodies having one-hundredth the conductivity of these bodies can be detected by this method. Now, Crookes tubes carefully coated with paraffin inside and out behave exactly as if filled with air at atmospheric pressure; they produce only a very small increase in capacity, due to the glass, even under a potential gradient of 1,000 volts per centimetre. Geissler tubes behave similarly so long as the gradient does not exceed 300 volts. Hence a rarefied gas has not a conductivity equal to one-hundredth that of acidulated water, or of the most perfect liquid dielectrics.

M. Bouty finds, however, that for every pressure there exists a maximum electrostatic field such that for higher fields the gas behaves like a conductor, in that increases in the capacity are observed identical with that obtained with mercury. In a dark room it is seen that there is a luminosity at the instant of *charging* as well as of *discharging* of a condenser, so that the apparent conductivity is in some way connected with the luminous appearances.

M. Bouty's hypothesis, in explanation of his experiments, is that the ether (*i.e.*, an absolute vacuum) possesses *dielectric elasticity*, and that its *dielectric cohesion* can be overcome by sending discharges through it. On the contrary, a rarefied gas possesses a limiting dielectric elasticity which is a function of the pressure, and the corresponding electrostatic field may be determined. Briefly, then, the properties of rarefied gases may be considered under three aspects: (i.) Its dielectric properties in weak electrostatic fields; (ii.) effects produced, internal and external, by the discharge; (iii.) the limiting values of the *dielectric cohesion* for different gases under different pressures.

A Paper was also read on

"The Wehnelt Interrupter,"

by M. Rothé. If the resistance in series with a Wehnelt interrupter be gradually diminished, the E.M.F. being constant, the current reaches a maximum, and then suddenly falls to about 2·5 amperes, at which it remains for considerable changes in the resistance, positive or negative. This stable condition he supposes to be due to a coat of the gas round the platinum wire. It can be destroyed by cooling and produced by heating.

ELECTRICITY WORKS ACCOUNTS.

The Woking Municipal Electric Supply Co. (Ltd.).

Although not the smaller or the younger of the two company concerns which we notice this week, the Woking undertaking comes off very second best in a comparison of results. Supply was commenced in November, 1890, so that the details given in our table are those of the seventh and eighth completed years of working. From the data supplied us, there appears to have been a retrogression in the output of 1898 as compared with 1897. The lamp connections indicate an increase of about 12·4 per cent., or to the equivalent of 9,008 8 c.p. lamps. Up to the end of last year the capital expenditure had amounted to £30,543 in total, or £107 per kilowatt of plant installed.

In the matter of costs the results of 1898 are far behind those of 1897. At 6·78d. per unit the total costs at Woking are quite 2d. per unit higher than they should be, even making allowance for the small output of the station. In the more important items and in the aggregate, generating costs have fallen, but the distributing costs and the management and property charges have risen very appreciably. Owing, however, to the fact that the average revenue has increased, the actual working profit has been kept up, but the ultimate result is that the deficit from 1897—viz., £476—brought forward has been increased to £1,277.

The Windsor Electrical Installation Co. (Ltd).

It is gratifying to find from the accounts for 1895 of the Windsor Electrical Installation Co. (Ltd.) that the results obtained show a marked improvement over those of 1897. The aggregate costs, at 4·22d. per unit, are no less than 1d. below those of 1897, and upon an output of only 105,828 units sold this figure is quite satisfactory.

With the exception of distributing charges, all the items of works costs have shared in the general improvement, but we should like to see the total generating costs still lower than they now are.

The average revenue from all sources has remained very constant at about 7·71d. per unit, so that the full benefit of the reduced costs is seen in the net revenue account.

As compared with 1897, the working profit has risen from £542 to £1,536, or from 3·3 per cent. to 6·7 per cent. of the mean capital expended.

After a contribution of £794 to the depreciation fund, the net profit for the year was £723, an amount which has been swelled by £310 brought forward from 1897, thus enabling a dividend of 3 per cent. to be paid.

The installing department of the company has been able to make the substantial profit of £1,008, which has been sufficient to meet a further dividend of 3 per cent., making in all 6 per cent. with the lighting department.

Excellent promise for the current year is contained in the good increase in the lamp connections which has taken place during 1898; the equivalent of 2,929 additional lamps were connected, being an increase of 59 per cent.

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

Aberdeen (Municipal)	Jan.	6, 1899	Lancaster (Municipal)	Oct.	21, 1898
Ayr (Municipal)	Sept.	22, ,,	Leeds (Municipal)	Dec.	1, 1899
Bedford (Municipal)	May	19, ,,	Leicester (Municipal)	Jan.	20, ,,
Belfast (Municipal)	Sept.	15, ,,	Leyton (Municipal)	Sept.	8, ,,
Birmingham (Company)	Sept.	15, ,,	Liverpool (Municipal)	June	9, ,,
Blackpool (Municipal)	Sept.	29, ,,	Manchester (Municipal)	Aug.	11, ,,
Bournemouth (Company)	April	28, ,,	Newcastle and District (Co.)	Oct.	6, ,,
Bolton (Municipal)	Nov.	24, ,,	Newcastle-upon-Tyne (Co.)	April	14, ,,
Bradford (Municipal)	April	14, ,,	Newport (Mon.) (Municipal)	Dec.	15, ,,
Brighton (Municipal)	May	12, ,,	Northampton (Company)	Oct.	20, ,,
Bristol (Municipal)	July	14, ,,	Norwich (Company)	Nov.	17, ,,
Burnley (Municipal)	Aug.	25, ,,	Notting Hill (Company)	Mar.	17, ,,
Burton-upon-Trent (Mun.)	April	21, ,,	Nottingham (Municipal)	July	21, ,,
Bury (Municipal)	Sept.	22, ,,	Oldham (Municipal)	Dec.	1, ,,
Cambridge (Company)	Mar.	10, ,,	Oxford (Company)	May	19, ,,
Cardiff (Municipal)	Dec.	15, ,,	Pontypool (Company)	May	5, ,,
Charing Cross (Company)	Mar.	17, ,,	Portsmouth (Municipal)	July	14, ,,
Chelsea (Company)	Mar.	31, ,,	Prescot (Company)	Dec.	8, ,,
Cheltenham (Municipal)	Nov.	10, ,,	Preston (Company)	Sept.	29, ,,
Chester (Municipal)	June	23, ,,	Reading (Company)	Oct.	13, ,,
City of London (Company)	May	12, ,,	Richmond (Company)	Oct.	13, ,,
Clerkenwell (Company)	Aug.	18, ,,	Scarborough (Company)	Nov.	3, ,,
Derby (Municipal)	Dec.	9, 1898	St. Helens (Municipal)	Dec.	8, ,,
Dewsbury (Municipal)	Nov.	24, 1899	St. James' & Pall Mall (Co.)	Feb.	24, ,,
Dover (Company)	June	2, ,,	St. Pancras (Vestry)	May	26, ,,
Dundee (Municipal)	Nov.	4, 1898	Sheffield (Company)	Dec.	16, 1898
Eastbourne (Company)	July	22, ,,	Shoreditch (Vestry)	Oct.	27, 1899
Edinburgh (Municipal)	Nov.	17, 1899	Southampton (Municipal)	Nov.	10, ,,
Exeter (Municipal)	Aug.	5, 1898	Southport (Municipal)	July	7, ,,
Glasgow (Municipal)	Sept.	1, 1899	South Shields (Municipal)	July	7, ,,
Guildford (Company)	May	5, ,,	Stafford (Municipal)	Oct.	21, 1898
Halifax (Municipal)	July	21, ,,	Sunderland (Municipal)	July	28, 1899
Hammersmith (Vestry)	May	26, ,,	Taunton (Municipal)	June	16, ,,
Hampstead (Vestry)	Aug.	25, ,,	Tunbridge Wells (Mun.)	Sept.	1, ,,
Hanley (Municipal)	April	28, ,,	Wakefield (Municipal)	Dec.	1, ,,
Harrogate (Municipal)	Oct.	20, ,,	Walsall (Municipal)	June	23, ,,
Harrow (Company)	June	16, ,,	Wandsworth (Company)	Aug.	19, ,,
Hast'gs & St. Leonards (Co.)	April	29, 1898	Westminster (Company)	Feb.	24, ,,
H'use-to-H'useCo. (K'ns'gt'n)	Mar.	31, 1899	Whitehaven (Municipal)	July	28, ,,
Hove (Company)	Mar.	10, ,,	Windsor (Company)	Dec.	30, 1893
Huddersfield (Municipal)	Oct.	6, ,,	Wolverhampton (Municipal)	June	30, 1899
Islington (Vestry)	Oct.	27, ,,	Woolwich (Company)	Jan.	13, ,,
Kens'gton & Knightsbr' (Co.)	Mar.	3, ,,	Worcester (Municipal)	April	7, ,,
Kingston-upon-Hull (Mun.)	June	9, ,,	Yarmouth (Municipal)	Nov.	3, ,,
Kingston-on-Thames (Mun.)	April	21, ,,			

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	WOKING.	WINDSOR.
Undertaking Worked by	The Woking Electric Supply Co., Ltd.	The Windsor Electrical Installation Co., Ltd.
Date of Commencement of Supply	November, 1890.	November, 1896.
System of Supply	Alternate-current transformer sub-stations.	Continuous-current three-wire.
Chief Engineer	A. J. Wheatley.	A. E. Farrow.

YEAR ENDED	DEC. 31, 1897.	DEC. 31, 1898.	DEC. 31, 1897.	DEC. 31, 1898.
QUANTITIES—				
Units generated	—	—	—	—
„ **SOLD (TOTAL)**	118,135	114,170	52,095	105,828[h]
„ sold to consumers	87,140	91,845	—	105,828[h]
„ sold for public lighting, &c.	17,345	18,313	—	—
„ used on works	13,500	13,980	—	—
UNITS SOLD PER 8 C.P. LAMP CAPACITY	14·8	12·8	5·95	12·1
Maximum supply demanded	129 kilowatts	135 kilowatts	98·4	165 kilowatts
Number of public lamps	105 (25 c.p.) glow	111 (25 c.p.) glow	—	38 arc, 260 glow[g]
Number of consumers	213	241	—	160
Connections to mains in 8-c.p. lamps	8,012	9,003	4,935	7,914
CAPACITY OF PLANT IN 8-C.P. LAMPS	7,970	8,910	8,750	8,750
CAPACITY OF PLANT IN KILOWATTS	255	285	280	280
CAPITAL—	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.
AUTHORISED (TOTAL)	— / —	— / —	£25,000 / £89·4	£25,000 / £89·4
Share	£20,000 / £78·4	£20,000 / £70·2	25,000 / 89·4	25,000 / 89·4
Loan (including Debenture charges)	— / —	— / —	— / —	— / —
RECEIVED (TOTAL)	22,900 / 89·8	29,585 / 104	19,970 / 71·3	25,000 / 89·4
Share	15,000 / 58·8	15,000 / 52·6	19,970 / 71·3	25,000 / 89·4
Loan (including Debenture charges)	7,900 / 31·0	14,585 / 51·2	— / —	— / —
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	— / —	— / —	5,030 / 18·0	nil / —
Share (unissued)	4,991 / 19·6	4,991 / 17·5	5,000 / 17·9	nil / —
Share (uncalled)	9 / 0·035	9 / 0·032	30 / 0·107	nil / —
Loan (including Debentures)	— / —	— / —	— / —	— / —
REPAID (TOTAL)	— / —	— / —	— / —	— / —
RESERVE OR SINKING FUND	— / —	400 / 1·40	— / —	— / —
DEPRECIATION FUND	688 / 2·70	1,199 / 4·21	— / —	— / —
EXPENDED (TOTAL)	28,942 / 114	30,543 / 107	20,469 / 73·2	25,414 / 90·6
Lands and buildings	—[a] / —	—[a] / —	4,843 / 17·3	5,754 / 20·5
Plant	—[a] / —	—[a] / —	8,583 / 30·6	11,583 / 41·3
Mains	—[a] / —	—[a] / —	5,876 / 21·0	6,913 / 24·7
Miscellaneous	—[a] / —	—[a] / —	1,167 / 4·18	1,165 / 4·16
BALANCE OF CAPITAL ACCOUNT	6,042 / 23·7	−958[c] / −3·36	−499[a] / −1·78	−414[a] / −1·48
REVENUE—	Total. / Per unit sold.	Total. / Per unit sold	Total. / Per unit sold	Total. / Per unit sold.
TOTAL	£3,574 / 7·270d.	£3,651 / 7·682d.	£1,674 / 7·718d.	£3,398 / 7·710d.
Revenue from supply	2,958 / 6·019d.	3,038 / 6·500d.	1,553 / 7·160d.	2,947[i] / 6·690d.
„ meters, &c.	135 / 0·274d.	158 / 0·332d.	34 / 0·157d.	80 / 0·182d.
„ public lighting	364 / 0·740d.	385 / 0·310d.	— / —	— / —
„ sale of lamps, &c.	117 / 0·238d.	— / —	— / —	— / —
„ miscellaneous sources	— / —	20 / 0·042d.	87 / 0·401d.	371 / 0·842d.
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	£3,147 / 6·400d.	£3,221 / 6·780d.	£1,132 / 5·220d.	£1,862 / 4·225d.
WORKS COSTS	2,623 / 5·333d.	2,669 / 5·620d.	778 / 3·590d.	1,333 / 3·025d.
Generation of electricity	*2,417 / 4·915d.*	*2,311 / 4·860d.*	*773 / 3·563d.*	*1,276 / 2·895d.*
Fuel (including cartage, &c.)	1,458 / 2·964d.	1,341 / 2·820d.	463 / 2·133d.	830 / 1·884d.
Oil, waste, water, stores	116 / 0·236d.	129 / 0·272d.	83 / 0·383d.	137 / 0·311d.
Wages at station	593 / 1·205d.	617 / 1·298d.	183 / 0·844d.	179 / 0·406d.
Repairs and maintenance at station	250 / 0·508d.	224 / 0·471d.	44 / 0·203d.	129 / 0·293d.
Distribution of electricity	*174 / 0·354d.*	*339 / 0·711d.*	*5 / 0·023d.*	*57 / 0·129d.*
Wages, &c.	66 / 0·134d.	102 / 0·215d.	4 / 0·018d.	14 / 0·032d.
Repairs, renewals of mains, &c.	103 / 0·220d.	231 / 0·486d.	1 / 0·005d.	43 / 0·098d.
Public lighting	*32 / 0·065d.*	*19 / 0·040d.*	— / —	— / —
Attendance	} 32 / 0·065d.	19 / 0·040d.	— / —	— / —
Renewals			— / —	— / —
MANAGEMENT AND PROPERTY CHARGES	524 / 1·065d.	552 / 1·161d.	354 / 1·632d.	529 / 1·200d.
Royalties	— / —	— / —	— / —	— / —
Rent, rates, taxes	*73 / 0·148d.*	*63 / 0·133d.*	*63 / 0·290d.*	*114 / 0·259d.*
Management	*451 / 0·917d.*	*489 / 1·029d.*	*291 / 1·342d.*	*415 / 0·942d.*
Salaries	178 / 0·362d.	179 / 0·377d.	177 / 0·816d.	270 / 0·613d.
Stationery, &c.	31 / 0·063d.	12 / 0·025d.	27 / 0·124d.	42 / 0·095d.
Establishment charges	102 / 0·207d.	60 / 0·126d.	31 / 0·143d.	59 / 0·134d.
Law charges, &c.	140[b] / 0·285d.	238[d] / 0·501d.	56[b] / 0·258d.	44[j] / 0·100d.
FINANCIAL RESULTS—	Total / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded
WORKING PROFIT FOR YEAR	£427 / 1·52%	£430 / 1·45%	£542 / 3·30%	£1,536 / 6·70%
Sum carried to Depreciation Fund	528 / 1·88%	512 / 1·72%	— / —	794 / 3·46%
Sum carried to Reserve or Sinking Fund	— / —	— / —	— / —	— / —
Net interest on loans (incl. Debenture charges)	499 / 1·78%	721 / 2·42%	— / —	19 / 0·083%
BALANCE FROM LAST ACCOUNT	122 / 0·435%	−476 / 1·60%	82[e] / 0·500%	310 / 1·35%
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	— / —	— / —	1,257[d] / 7·66%	2,036[k] / 8·87%
Deficit	*476 / 1·70%*	*1,277 / 4·29%*	— / —	— / —
ORDINARY DIVIDEND PAID	— / —	— / —	4% / —	6%[l] / —
PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE	88%	88·2%	67·6%	54·8%
Expenditure per kilowatt capacity	£12. 7s. 0d.	£11. 6s. 0d.	£4. 0s. 10d.	£6. 13s. 0d.
REVENUE PER KILOWATT CAPACITY	**£14. 0s. 0d.**	**£12. 16s. 0d.**	**£5. 19s. 7d.**	**£12 2s. 10d.**
Expenditure per 8-c. lamp capacity	7s. 10¾d.	7s. 2¾d.	2s. 7d.	4s. 3d.
REVENUE PER 8-C.P. LAMP CAPACITY	**8s. 11¼d.**	**8s. 2½d.**	**3s. 10d.**	**7s. 9½d.**
REVENUE PER 8-C.P. LAMP CONNECTED	**8s. 11d.**	**8s. 1½d.**	**6s. 8½d.**	**8s. 7d.**
Price charged for lighting, per unit	8d.	8d.	7d.	6½d.[f]
Price charged for power, per unit	—	—	—	4d.
Price charged for public lighting	5·04d. per unit.	5·04d. per unit.	—	—[g]

WOKING.—REMARKS.—*a* Items not given in accounts. *b* Includes auditing £26, and insurance £43. *c* Over-expended. *d* Includes auditing £36, and insurance £40.

WINDSOR.—REMARKS.—*a* Over-expended. *b* Includes £31 to insurance. *c* Includes £59 law costs transferred to capital account charged against revenue last year. *d* Includes £12 received as interest for money at deposit and £621 profit on installation work. *e* At March, 1899. *f* With rebates. *g* For glow lamps in Windsor £3. 7s. 6d., and in Eton £3. 12s. 6d. each. For 2,000 nominal c.p. arcs £22, and for 500 nominal c.p. arcs £16 each per annum. *h* Exclusive of output sold under contract and yielding £128 to revenue. *i* Including £128 from electricity sold under contract; number of units not given. *j* Includes £21 to insurance and £19 to auditing. *k* After adding profit from installation work, £1,003. *l* Being a dividend of 8 per cent. on the

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Telephone: 949 Holborn. *Telegrams:* "ELECTRICIAN NEWSPAPER LONDON."

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COPPER STANDARDS.

Considering the universally expressed desire during the past few years for the adoption of an effective system of standardisation in all pertaining to the electrical industry, it cannot be said that endeavours in this direction have always been eminently successful, at all events in this country. Thanks to the Order in Council of August 21, 1894, we have an Imperial ohm, ampere, and volt; but since this necessary piece of standardisation, involving the gradual death of the once useful B.A. ohm and reducing by two years the allotted life of the superfluous "legal" ohm of the 1886 Paris Congress, very little advance has been made towards uniformity of standards. The Standard Wire Gauge, adopted some years before this date, has never held undisputed sway. Before the old Birmingham Wire Gauge was quite forgotten, a large number of cable buyers began to word their specifications in terms of sectional areas, and this necessitated the employment of wires of intermediate size almost as frequently as those of standard gauge. The three editions of wiring rules issued by the Institution of Electrical Engineers, in the endeavour to produce a single code of regulations accepted by all concerned, were each in their turn pronounced excellent, but each failed to attain their prime object; and to-day there are more sets of wiring rules existing than ever before. A committee appointed by the Council of the Institution, to consider the question of uniformity in electrical engineering practice, has as yet published nothing but the brief recommendation as to standard frequencies issued last March; but we hope that their labours will soon bear another crop of fruit, and that when the final report is published more attention will be paid to it than was done in the United States to a lengthy report on standardisation recently issued by a committee of the American Institute of Electrical Engineers.

In another column of this issue will be found the latest attempt at standardisation, and although this is in a direction where a standard is much needed, and where even a quite arbitrary standard, chosen by a recognised body such as the Institution of Electrical Engineers, could have been generally accepted without hardship or even inconvenience, it is doubtful whether the recommendations of a self-constituted committee will meet with approval in every quarter. The Post Office has

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been in the habit of issuing a certain specification for india-rubber covered wire, the terms of which were not viewed with approval by certain manufacturers of this class of material. Having on at least one previous occasion (it may have been in connection with the requirements of a sister service to the telegraphs) put their heads together to their mutual benefit, the same association of rubber cable manufacturers agreed to disagree with the specification of copper resistance. The conductivity of copper in this Post Office specification was, in fact, different to the standards usually worked to by the different manufacturers, but as these standards also differed among themselves, it was evident that in order to secure uniformity some sort of agreement must be come to between the cable makers. At the suggestion, we believe, of Mr. A. H. HOWARD (of Messrs. W. T. GLOVER and Co.), who was subsequently chosen as honorary secretary to the Committee, it was decided to grapple with the broader question of copper specifications generally, instead of confining the discussion to the point which had arisen in connection with the Post Office specification, and the Institution of Electrical Engineers and the engineering department of the Post Office were asked to send delegates to represent them on the committee. These two bodies acceded to the request, but by an unfortunate oversight the same invitation was not extended to three of the leading cable manufacturers, who, even if they do not make india-rubber covered cables, are just as interested in the specifications for copper. Nor were representatives of the National Telephone Co. or of the submarine cable companies consulted in the matter, although among the greatest buyers of copper wire. No one will dispute the necessity of uniformity in choosing a standard for the conductivity and specific gravity of copper, or of having conventional rules as to the effect the "loss in lay" may be said to have upon weight of resistance of stranded cables, and as to similar matters; but since in their nature such conventions must be more or less arbitrary or empirical, it is only fair that everyone interested should be allowed to have their say in the matter before they are definitely chosen.

Let us now examine the proposals of the committee one by one, in order to see how far they approximate to the standards already adopted by the various copper suppliers and users. MATTHIESSEN, whose standard is so often quoted, did not publish one particular standard test of the conductivity or resistance of copper wire. In his various Papers will be found the results of quite a number of tests taken at different temperatures and under different conditions. Some cable manufacturers may, for instance, have been in the habit of supplying "98 per cent. copper" based on MATTHIESSEN'S standard for hard-drawn copper, which would correspond to about 96 per cent. conductivity of the standard for "pure annealed" copper wire usually worked to. The value implied by the majority of cable manufacturers when quoting MATTHIESSEN'S standard is that for pure annealed copper wire, cited as follows in the earlier as well as the present editions of MUNRO and JAMIESON'S pocket-book:—0·1516 (B.A.) ohms per 100in., weighing 100 grains at 60°F. The figure proposed by the committee is 0·150822 standard ohms for the resistance of a wire one metre long, weighing one gramme at 60°F. There is a difference of about one-third of 1 per cent. between these two figures when reduced to the same standard of comparison. The standard for hard drawn copper wire chiefly concerns the wire-drawers and practically the only users in this country, the Post Office and the National Telephone Co. A definite standard is certainly needed, and since the Post Office consider the proposed one as suitable, perhaps others interested will agree to adopt it. It would have been more logical, however, if these others had taken the place of the rubber cable manufacturers in the Committee for the determination of this figure. The same may be said of the actual definition of hard-drawn copper wire. Coming next to the question of specific gravity, we cannot for the moment remember any determination of it at 8·912. The figure usually employed in the cable trade is 8·89 or 8 9, and the specific gravity of good electrolytic annealed copper wire has generally been assumed to lie between these two figures. An alteration of a small fraction of 1 per cent. is not of great moment, any more than in the case of MATTHIESSEN'S standard; it will merely affect the last figures of practically all the published resistance and weight tables, for it must be remembered that the specific gravity has to be made use of in calculating the resistance of wires of given diameter from the metre gramme, 100in. 100-grain, or foot grain standard. Resolution No. 6 should meet with approval, but for the ordinary tests of inland and telegraph and telephone wires it would make little difference whether MATTHIESSEN'S original temperature corrections or Messrs. CLARKE, FORDE and TAYLOR'S more recent ones be taken. The companies manufacturing and using submarine cable are most concerned in this. Although the majority of them will probably consider the new tests reliable and accurate, we wonder whether their opinion was taken. The sixth resolution is not clear as it stands, but is explained in the subsequent notes. It is concluded that the increased length of the conductors in a standed cable, on account of the special course of the individual strands, shall be deemed to *increase* the resistance of the cable in the same proportion as the increased weight, instead of to *decrease* it, the latter effect having been assumed by certain cable manufacturers because of the increase in the actual area of the copper on a section at right angles to the length of the cable. A rule for the average "lay" is given in the next resolution, and its effect is worked out in the appendix to the report for cables having different numbers of strands. The ratio of length of "lay" to diameter of pitch circle as 20 is an average figure, but we hardly think that it can be taken to imply that the makers who have adopted it employ this same ratio whatever the size of the cable and whatever the purpose for which it is intended. The last two resolutions are perhaps most open to criticism. No one would seriously maintain that the allowable percentage increase in resistance or weight per unit length of a conductor over the theoretical would be the same whether the conductor passes through one or ten machines in the process of manufacture. A margin of 2 per cent. is as excessive in the case of single bare wires as it is inadequate for heavy cables of many strands. Besides, if such a margin is to be allowed in the case of light cables and wires, why state a standard of resistance to six significant figures, and an arbitrary specific gravity to an eighty-ninth of 1 per cent. accuracy? The extra indulgence of 1 per cent. allowed to those manufacturers whose process of insulation necessitates that the conductors be tinned is unreasonable.

The above criticisms of the report before us are not made in an antagonistic spirit. We would not suggest for a moment that the proposals have not been made in absolute good faith by the members of the Committee, or that any other motive than a desire to benefit impartially all cable makers and buyers has prompted them. But enough has been said to show that, although general standards for copper wire are needed, these particular resolutions are not of a nature to be accepted without further consideration by a large section of the electrical profession which was neither adequately represented on the Committee nor asked to give evidence before it.

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REVIEWS.

(Copies of any of the undermentioned works can be had from *The Electrician* office post free, on receipt of published price.)

The Manufacture of Carbons for Electric Lighting and Other Purposes. By FRANCIS JEHL, M.Am.I.E.E. (London: *The Electrician* Printing and Publishing Co. (Ltd.) 1899.) 10s. 6d.

To the author of this work and to its publishers is due great credit for the preparation and issue of the first work dealing with the subject of practical carbon manufacture in a complete manner. We have in this book a very comprehensive description of the process of carbon making as generally practised by the Continental manufacturers. The greatest amount of consideration is devoted to lighting carbons: the subject of carbons for electrolytic and smelting work and carbon brushes is but briefly dealt with, though it will be found that carbons really suitable for the various modern electro-chemical processes are by no means so simple to make in a commercial way as the author implies.

The work opens with a short section on the physical properties of carbon, with allusion to Moissan's researches with the electric furnace. Chapter II. is devoted to a fairly complete history of the development of the arc light carbons. The author rightly attributes to Carré due credit for his work in 1876. The reviewer thinks that the late M. Carré may well be looked upon as the father of the carbon industry.

Those interested will find full accounts of the early work of Curmer, Jacquelain, Peyret, Archerau, Carré, and Gaudoin in Fontaine's "L'Eclairage Electrique." Jablochkoff's and Weston's patents for use of the core are referred to, and the later German patent of Louis Siemens. To Reynier is rightly attributed the idea of increasing the life of carbon rods by electroplating them with metal, and this was the object of a provisional patent in 1878. The enclosed arc is then explained, which in primitive form was first used by Sir Humphrey Davy himself. Pritchard's experiments in carbon making, published in *The Electrician* about ten years since, are then described.

Some facts concerning carbons are then given in a short chapter. Here and elsewhere the author makes light of the difficulties of the carbon maker, but the reviewer is at direct issue with him on this point. Every stage of the selection and preparation of material and the subsequent manufacture of the carbons requires attention and close supervision if a high-grade carbon of regular quality is to be produced at a profit.

We proceed in chapter IV. to the modern process of manufacture. After giving proportions of mixtures which he has used for different grade carbons and carbon brushes, the author describes the raw carbon breaking stamp and the crushing mill. The latter is an edge-runner mill of a design much used on the Continent, and the reviewer takes this opportunity of pointing out the superiority of this design of grinding mill to the usual English design. Each runner can rise and fall independently in a true vertical plane, being pulled round its path by a crank rising and falling vertically against the side of the centre block, the crank pin carrying the runner itself. This construction results in a very easy running mill, in which there is little vibration and a high grinding efficiency. The fine-grinding mill described is of the single roller type sometimes used in flour milling.

The reader is then taken through the mixing room and press room, the machines therein being described and illustrated. The process of bundling for the kiln is then explained, and the advantage of continuous regenerative gas-fired kilns pointed out. A full description of the kiln is reserved for a special chapter later in the book.

No reference is made by the author to a practice at one time considerably used for burning on the Continent—that is the two-kiln system. In the first kiln, which was of the muffle type, heated by a hand-fired furnace, the carbons, after being packed in fireclay saggers, received a preliminary baking; they were then sorted and the wasters removed, the rest being packed in large plumbago saggers, each of which was lowered into a circular coke-fired furnace, similar to the usual brass melter's furnace. The burning being completed here at a very high temperature.

An automatic sorting machine is suggested to select the bent from the straight carbons. This, however, has the disadvantage that it requires an attendant to remove every bent rod rejected by the machine. Machines for cutting, squaring, and pointing burnt carbons are then illustrated. The author recommends a larger cone angle for the points than that generally adopted, with which recommendation the reviewer entirely agrees. A process of coring follows. The instructions for this vitally important stage of manufacture are, however, somewhat vague; and the reviewer can hardly agree with some of the author's remarks and recommendations. The author impresses upon his readers the importance of careful use of the coring machine, but the method of preparation of the core is not treated in a complete manner by any means.

The author opens a paragraph of Hints to electric light engineers with a very imaginative description of a carbon manufacturer's methods of dealing with a complaining customer. It is ridiculous to suppose that a responsible manufacturer would adopt such means. With him complaints are the exception, and are usually traced to some special conditions under which the carbons have to burn, of which particulars have not been furnished by the consumer. These conditions must be investigated by the manufacturer. This chapter concludes with a brief section on "Electrodes," which might with advantage have been much more extensive. A brief reference is made to tests of various electrolytic carbons made at the instigation of *The Electrician*, and published in that journal May 28, 1897. The reviewer has found some very interesting tests of electrolytic carbons by Dr. Zellner published in the *Zeitschrift für Elektrochemie*, April 6, 1899.

Chapter V. contains much of a useful and interesting nature. First are given sizes of carbons chiefly used for continuous and alternating current on the Continent. Unfortunately for the manufacturer, however, very little has yet been done towards the standardisation of carbons and arc lamps. Then follows a description of the necessary equipment for carbon test-room and method of testing. Chapter VI. is mostly devoted to a description of an unsuccessful endeavour by a carbon manufacturer to utilise coal as a raw material. A very brief reference to Acheson's method of producing material for electrodes concludes this chapter.

The gas generator is the subject of the next chapter, and the author has drawn largely from the works of Ledebur and Stegmann in its compilation. Various forms of producers are illustrated and explained. Then follows a long chapter on kilns, with descriptions of kilns by Mendheim, Escherich, and Meiser, and a consideration of the relative advantages and disadvantages of what may be called the down-draught chamber system and the horizontal-draught ring system. Also a description of continuous regenerator and periodical furnace by Mendheim and a tunnel furnace by the author. Saggers for packing the carbons for burning are also described. Chapter IX. is devoted to a description of the Prof. Seger's very interesting and simple method of estimating high temperatures. Gas analysis forms the subject of chapter X.

We have now reached the section dealing with cost of equipping a carbon factory and the probable profits to be made. As a manufacturer, the reviewer is hardly free to criticise the figures given as he might; he may state, however, that the rates of wages paid for labour in this country would be considerably higher than those given in these estimates. The factory considered is one capable of producing the equivalent of 40,000ft. of carbons of 13mm. diameter per 10-hour day.

Chapter XII. deals with the cost of manufacture of electrodes on a small scale by the consumer. The next chapter is devoted to the laying out and construction of the factory. Chapter XIV. introduces the interesting subject of lamp-black or soot, and is devoted chiefly to the theory of its production. The proposal by the author to reduce the size of soot chambers by spraying water on to the smoke and then drying the sludge produced is not a new one. The necessary conditions for the production of good soot are laid down, and some figures given for the yield to be expected. The final chapter is devoted to descriptions of soot factories,

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largely taken from the works of Dr. Köhler and Thenius. First is described the primitive conical-topped factory at one time much used. Following which we have illustrated descriptions of chamber systems of construction for liquid and solid fuel. The lamp system is described, with a special lamp of the author's design, and also the Thalwitzer machine for continuous production of soot from gas obtained by the distillation of heavy mineral oils. Many readers of this interesting section of the book will not fail to realise that the Continental lampblack manufacturer is considerably ahead of the manufacturers of this country. The reviewer has had good reason to know it.

An appendix contains Fisk's Paper before the Canadian Electrical Association, 1892, describing the American process of carbon making.

The author has not thought it necessary to describe a copper-plating equipment. For ordinary purposes the plated carbon is no more, but any manufacturer who is acquainted with the requirements of our Government departments will know that coppering is still necessary for some of the projector carbons. No detailed description of the manufacture of carbon brushes, battery plates and cylinders, carbon resistances, or agglomerate plates and cells is to be found.

The book, however, is full of information, is fairly well arranged, and has a good index, and will prove interesting and instructive reading to all carbon makers and users, and both author and publishers are to be congratulated on such a production. T. G. Littleboy.

La Téléphonie. By Emile Piérard. 2nd edition. (Liège: Charles Desoer. 1899.) 10fr.

This book is well worth a place in the library of the telephone engineer. It is no mere catalogue of telephonic apparatus, neither is it a dry text-book on the subject, written in professorial style. In it the ground is fairly well covered, while at the same time minute technical detail is not so much insisted upon as to make the volume uninteresting reading.

A few pages on non-electrical telephones, the elementary principles of acoustics, and the early music-transmitting instruments, lead up to what the author terms "pantéléphones"—a hideous word suggested by M. Mercadier for telephones suitable for the transmission of *all* kinds of sounds. A good selection of ancient and modern instruments is chosen for description, and this section is followed by chapters on calling apparatus, batteries, and complete telephone sets. By a peculiar arrangement, however, although the principles underlying the design of transmitters and receivers are dealt with to some extent previously, it is in the following chapter on "special pantéléphones," in the midst of a consideration of the interesting speaking condenser of Cornelius Herz, that the reason for the polarisation of the core of a Bell receiver is given.

The chapter on line construction is one of the longest and at the same time one of the most interesting in the book. Particular attention is devoted to bronze wire, and with regard to this material some of the data given and experience recorded are most valuable. Insulators are next dealt with. After trying insulators of different colours, the Belgian telephone administration has found that a slate colour offers the least temptation to stone-throwers, that coloured insulators have as high an insulation resistance as white ones, and that a minimum of 2,000 megohms is the correct specification for the insulation resistance of a double-lipped insulator, whatever its hue. The pages on the design of iron posts, roof poles, and derricks are well worth study. Various methods of revolving overhead wires are given; and the author puts himself to some trouble to prove mathematically that the revolution of the wires is not indispensable, finishing with the remark, however, that the conditions assumed in the proof only apply when the inducing circuit as well as those subjected to its influence possess precisely the same conditions of insulation resistance and capacity from one end to the other. For submarine work the author prefers to use as many cables as conductors. With regard to the effect of self-induction and the other line constants on the design of long distance or submarine lines, he quotes the following remarkable formula, published by Vaschy in 1888 in the *Annales Télégraphiques*: $L/CR^2l^2 = 1/16$, where L, C, and R represent respectively the inductance, capacity, and resistance per unit length, and l the total length of the circuit. If this relation is fulfilled, he says, the curve of current received corresponds rigorously with that of the current transmitted, with a mere time-lag!

In a short chapter on translators the results of a long experimental research by Prof. Reding (published in the *Journal Télégraphique*) are summarised. The efficiency of a translator diminishes with the length of the line, and capacity of the line appears to be particularly hurtful. A translator whose efficiency was 79 to 80 per cent. when in series with an induction-less and capacity-less resistance of 300 ohms, for frequencies of 125 to 750 has only a useful efficiency of 12·5 to 16 per cent. when some 0 01 microfarad condensers were shunted to the same circuit.

One of the most valuable features of the book is the excellent treatment of the question of simultaneous telephony and telegraphy over the same wire. A thorough description of the Van Rysselberghe system is given, its drawbacks are discussed, and modifications to it are mentioned. Belgium has certainly given this system a fair trial, and it would seem, as a final result of the experience in that country, that the method has been found economical and of great utility for lines above a certain length, without too many intermediate offices, and on which fast-speed telegraphic apparatus is not required. The Picard and Cailho system are briefly described. The latter, which is employed in France, has, the author thinks, some advantages over the Van Rysselberghe system, not the least of which is greater simplicity. "Duplex" telephony is but briefly dealt with, and more space is given to "phono-multiplex telegraphs," in which the Langdon-Davies phonopore is included.

The chapter on switchboards calls for little comment. M. Piérard considers that a non-multiple board will still do for 1,500, 1,600, or even 2,000 subscribers. Lamp visuals and central battery boards are merely mentioned, without descriptive details, and in the section on junction and trunk working no mention is made of automatic clearing signals, which it appears are not employed in Belgium. It must be remembered, however, that the trunk lines in that country being largely duplexed with telegraph lines on the Van Rysselberghe principle, the addition of visual signals might introduce too much complication. Automatic calling is not employed even on the transfer boards, and the multiple boards are all on the series jack system up to the present. In passing, we note with satisfaction the number of English and American words which have been assimilated into the French of telephone technics—élément gravity, microphone solid-back, jack, branching jack, test-line, cross-connecting board, &c.

In a section on protection against induction disturbances the author describes an attempt of his own to evade the necessity of employing an independent metallic circuit for each line. A common return wire is provided of similar section to one of the subscribers' lines. As ringing currents through this common return would produce disturbances in all the circuits, the subscriber's switch hook is so arranged that earth is used as return for the ringing currents, and the common return for speaking currents only. The possibility still remains of cross-talk between two circuits, if there are any leakages, and each subscriber is therefore given a switch enabling him to make use of an earth return should he "fear indiscretions," and prefer the buzz induced by traction currents to the lack of privacy. This system has been employed to a certain extent in Brussels and Liège, it is said with success. It would hardly be deemed sufficient by the majority of British telephone users.

The book concludes with a description of arrangements of theatrophone or electrophone apparatus, and a brief sketch of the present state of the development of telephony in Belgium.

We have said so much in praise of M. Piérard's work that we do not apologise for offering a few words of criticism on small but not unimportant matters which may easily be rectified in future editions. The abbreviations O for ohms, Mo for megohms, H for henries, and μM for microfarads, are, to say the least, unusual, as it is also to see Mr. Preece's once

cherished KR law symbolised as CR. There are also a number of aggravating printers' errors: *di* for *dt* in a mathematical investigation on page 259; l'influence *novice* de la capacité, for l'influence *nocive*; the articles written by Oliver Heaviside in *The Electrician* are referred to as having been contributed by H. O. Heaviside to our esteemed contemporary *L'Electricien*; and other printers' errors of less importance. The print and paper are good, but the book is worthy of a better binding than one of flimsy paper, and of better finished blocks than many of the poor woodcuts.

Matter, Energy, Force, and Work. By SILAS W. HOLMAN. (London: Macmillan and Co., Limited.) 10s. 6d.

This book, which the author tells us was written during a period of enforced quiet, and which therefore, it is to be presumed, he issues to the public as representing his best and maturest thought, comes as a disappointment from one of Prof. Holman's position as the professor of physics (*emeritus*) at the Massachusetts Institute of Technology. His object in writing it is, he says in the preface, to provide engineers and members of the technical professions, as well as students and teachers generally, with "an aid to clearer thinking," by presenting "in a plain and logical manner some fundamental ideas and definitions of physics." An admirable and worthy object this, but one which the author entirely fails to attain in the volume before us. Instead of clear definitions of the elementary physical conceptions, followed by a precise statement of the fundamental physical laws and a consideration of their consequences, we find the subject treated in an involved manner, tending frequently to confuse rather than to elucidate. There is nothing in the author's method to justify his departure from the orthodox lines in training the student's mind to receive and appreciate the ideas forming the basis of physical science.

PROPOSED STANDARDS FOR COPPER SPECIFICATIONS.

The following circular has been sent us for publication:—

The advantages of standardising are being largely advocated for almost all classes of engineering products, but copper conductors have hitherto not been included in the list, as everyone has assumed that they were already standardised, and that Matthiessen had settled the resistance and temperature coefficient of copper in his researches nearly 40 years ago. This assumption is far from being true, and the catalogues of various electrical cable makers as published before 1899 show considerable discrepancies in the resistance and weight of nominally the same cables, while the Post Office issued a specification differing from all of the others. In order to remedy this confusion, a committee was formed of those interested, to determine a standard, and the Institution of Electrical Engineers, the General Post Office, and the principal manufacturers of rubber insulated cables sent representatives. Meetings were held early in 1899, and the report given below was adopted by the following delegates:—

For the General Post Office: Sir W. H. Preece, K.C.B., F.R.S. (chairman), Mr. J. Gavey, and Mr. H. Hartnell.

For the Institution of Electrical Engineers.—Prof. W. E. Ayrton, F.R.S., Mr. W. M. Mordey, and Mr. Herbert A. Taylor.

Representatives of Cable Manufacturers.—Mr. J. W. Connolly (Connolly Bros.), Mr. R. J. Hatton (Henley's Telegraph Works), Mr. W. E. Gray (India Rubber, Gutta Percha and Telegraph Works), Mr. A. Paterson (Johnson and Phillips), Messrs. F. Jacob and J. S. Huddlestone (Siemens Bros.), and Mr. A. H. Howard (W. T. Glover and Co.).

The Telegraph Manufacturing Co. and the London Electric Wire Co. also co-operated in forming the committee, and have adopted its recommendations.

The report of the committee is as follows:—

1. Resolved that Matthiessen's standard of 0·153858 standard ohms resistance for a wire 1 metre long, weighing 1 gramme at 60°F., be taken as the standard for hard-drawn high conductivity commercial copper.

2. Hard-drawn copper to be defined as that which will not elongate more than 1 per cent. without fracture.

3. Resolved that Matthiessen's standard of 0·150822 standard ohms resistance for a wire 1 metre long, weighing 1 gramme at 60°F., be taken as the standard for annealed high-conductivity commercial copper.

4. Copper to be taken as weighing 555lb. per cubic foot at 60°F., which will give a specific gravity of 8·912.

5. Resolved that Messrs. Clarke, Forde and Taylor's temperature coefficient, as published in their pamphlet dated February 20, 1899, be adopted, and that the average coefficient of 0·00238 per degree F. be adopted for commercial purposes.

6. Resolved that the resistance and weight of conductors be calculated from the actual length of the wires.

7. Resolved that a lay of 20 times the pitch diameter be taken as the standard for the calculation of tables.

8. Resolved that 2 per cent. variation of resistance or weight be allowed in all conductors.

9. Resolved that an allowance of 1 per cent. increased resistance as calculated from the diameter be allowed on all tinned copper between Nos. 22 and 12 gauges inclusive.

Note to 1 and 3.

The figures inserted have been calculated for 60°F. from the figures 0·1469 per metre gramme for hard-drawn, and 0·1410 for annealed, at 32°F. by Matthiessen's formula:—

$$R_{t^\circ} = \frac{R_{32^\circ}}{1 - 0{\cdot}00215006\,(t-32) + 0{\cdot}00000278\,(t-32)^2}$$

A. H. HOWARD, Honorary Secretary.

From the above data the following figures and formulæ have been calculated, and were sent us as an appendix to the report, together with the notes that succeed them.

Solid Wires.

Copper weighs 555 lb per cubic foot at 60°F. Specific gravity = 8·912.

The resistance, in standard ohms, of annealed high-conductivity commercial copper is:—

Resistance	per cubic inch	0·00000066788
Ditto	per cubic cm.	0·00000169639
Ditto	of 100in. weighing 100 grains	0·150158
Ditto	per mile	0·042317/(area in sq. in.)
Ditto	per yard	0·000024044/(area in sq. in.)
Ditto	per mil foot	10·2944

The resistance, in standard ohms, of hard-drawn high-conductivity commercial copper is:—

Resistance	per cubic inch	0·000000681327
Ditto	per cubic cm.	0·00000173054
Ditto	of 100in. weighing 100 grains	0·153181
Ditto	per mile	0·0431689/(area in sq. in.)
Ditto	per yard	0·0000245277/(area in sq. in.)
Ditto	per mil foot	10·4099
Weight	per mile	2·0350 × area in sq. in.
Ditto	per yard	11·5625 × area in sq. in.

Cables.

A lay of 20 times the pitch diameter is adopted as a standard, and the resistance in parallel of the wires is taken as the resistance of the cable.

Resistance of	3-strand	cable	= 0·33742	×	resistance of each wire.
Ditto	4	ditto	= 0·253065	×	ditto
Ditto	7	ditto	= 0·1443557	×	ditto
Ditto	12	ditto	= 0·084355	×	ditto
Ditto	19	ditto	= 0·0532424	×	ditto
Ditto	37	ditto	= 0·0273493	×	ditto
Ditto	61	ditto	= 0·0165911	×	ditto
Ditto	91	ditto	= 0·0111222	×	ditto
Weight of	3-strand	cable	= 3·03678	×	weight of each wire.
Ditto	4	ditto	= 4·04904	×	ditto
Ditto	7	ditto	= 7·07356	×	ditto
Ditto	12	ditto	= 12·1471	×	ditto
Ditto	19	ditto	= 19·2207	×	ditto
Ditto	37	ditto	= 37·4414	×	ditto
Ditto	61	ditto	= 61·7356	×	ditto
Ditto	91	ditto	= 92·1034	×	ditto

The above formulæ give the standards, but a variation of 2 per cent. in resistance or weight is allowed for losses in manufacture.

These figures have been adopted by all of the parties represented, and it is hoped that they may become the universal standard for Great Britain.

The measurements made by Dr. Matthiessen were for the purpose of determining the best metal to use for a standard resistance, and the permanence of the resistance was of more importance than the actual numerical value.

The specific gravity of the copper was not taken, and as the results are given by length and weight, they afford no means of determining the resistance of a wire of any given diameter. In addition, B.A. units have been confounded with standard ohms, so that discrepancies have arisen from both causes.

The resistance of a stranded conductor varies according to the lay of the wires. Some makers use a lay of 12 times the pitch diameter, while others go so high as 30 times the pitch diameter; 20 was adopted as an average figure, and the resistances calculated from the actual length of the wires—viz., 1·01226 times the length of the cable for all except the centre wire.

As the Post Office specifications will be issued in accordance with the above report, and as all of the manufacturers mentioned will include the same figures in their catalogues, there seems little doubt that these standards will be adopted throughout Great Britain.

We comment on this matter in our leading article.

BOOKS RECEIVED.

(Copies of any of the undermentioned works can be had from *The Electrician* office post free, on receipt of published price.)

Judges' Report on the Motor Trials of the Liverpool Self-Propelled Traffic Association at Liverpool, July 31st to August 2nd, 1899. Edited by E. Shrapnell Smith. (Liverpool: Winstanley and Watkins.) Price 5s.

The Official Gazette of the United States Patent Office. Nos. 9 and 10, Vol. LXXXIX. Published by authority of Congress (Washington: Government Printing Office.)

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ON THE MASSES OF THE IONS IN GASES AT LOW PRESSURES.*

BY J. J. THOMSON, M.A., F.R.S.

(Concluded from page 259.)

To calculate n we begin by finding the volume of water deposited in consequence of the expansion in each cubic centimetre of the expansion. In my previous Paper I show how this can be determined if we know the ratio of the final to the initial volumes and the temperature before expansion. In the present experiments the final volume was 1·36 times the initial volume, and the temperature before expansion was 18·5°C. It follows from this that 50×10^{-7} cubic centimetres of water were deposited in each cubic centimetre of the expansion chamber.

If a is the radius of one of the drops, the volume of a drop is $4\pi a^3/3$, and hence $n'=\frac{3\times50\times10^{-7}}{4\pi a^3}$; here n' is the number of ions per cubic centimetre of the expanded gas.

If v is the velocity of fall

$$v=\frac{2}{9}\frac{ga^2}{\mu}.$$

Since for air $\mu=1\cdot8\times10^{-4}$, we find

$$a=\frac{v^{\frac{1}{2}}}{1\cdot1\times10^3},$$

and

$$\frac{4}{3}\pi a^3=3\cdot14v^{\frac{3}{2}}\times10^{-9},$$

$$n'=\frac{5{,}000}{3\cdot14v^{\frac{1}{2}}}.$$

This is the number in 1 cubic centimetre of the expanded gas; the number in 1 cubic centimetre of the gas before expansion is $1\cdot36n'$. To find n the number of ions we must subtract from $1\cdot36n'$ the number of drops which are formed when the ultra-violet light does not fall on the plate. With an expansion as large as 1·36, Mr. Wilson has shown that a few drops are always formed in dust-free air, even when free from the influence of Röntgen rays or ultra-violet light. If V be the velocity with which these drops formed in the absence of the light fall, then the number of drops due to these nuclei is

$$\frac{1\cdot36\times5{,}000}{3\cdot14\,V^{\frac{1}{2}}}.$$

Subtracting this from $1\cdot36\,n'$, we find

$$n=2\cdot07\times10^3\left\{\frac{1}{v^{\frac{1}{2}}}-\frac{1}{V^{\frac{1}{2}}}\right\}.$$

In making this correction we have assumed that the clouds form round these nuclei even when the negative ions due to the ultra-violet light are present. If the cloud formed more readily about the negative ions than about the nuclei, the ions would rob the nuclei of their water, and we should not need the correction. The following table gives the result of some experiments; in making the observation on the cloud the same potential difference between the plate and the water was used as when observing the value of d/D: v_0 was determined by Prof. Rutherford as $1\cdot5\times3\times10^2$, and A was $\pi(1\cdot6)^2$ throughout the experiments.

b.	C.	d/D.	v.	V.	$e\times10^{10}$.
1·2	62	0·0017	0·13	0·3	7·9
1·2	62	0·0019	0·11	0·3	7·3
0·9	50	0·0012	0·14	0·3	5·3
1·2	65	0·0035	0·08	0·3	7·3
1·2	50	0·0018	0·11	0·3	6·0
1·2	40	0·0018	0·14	0·3	7·0

The mean value of e is $6\cdot8\times10^{-10}$. The values differ a good deal, but we could not expect a very close agreement unless we could procure an absolutely constant source of ultra-violet light, as these experiments are very dependent on the constancy of the light; since the electrical part of the experiment measures the average intensity of the light over 30 seconds, while the observations on the cloud measure the intensity over an interval of a small fraction of a second.

The value of e found by me previously for the ions produced by Röntgen rays was $6\cdot5\times10^{-10}$: hence we conclude that e for the ions produced by ultra-violet light is the same as e for the ions produced by the Röntgen rays; and as Mr. Townsend has shown that the charge on these latter ions is the same as the charge on an atom of hydrogen in electrolysis, we arrive at the result previously referred to, that the charge on the ion produced by ultra-violet light is the same as that on the hydrogen ion in ordinary electrolysis.

The experiments just described, taken in conjunction with previous ones on the value of m/e for the cathode rays (J. J. Thomson, *Phil. Mag.*, Oct., 1897), show that in gases at low pressures negative electrification, though it may be produced by very different means, is made up of units each having a charge of electricity of a definite size; the magnitude of this negative charge is about 6×10^{-10} electrostatic units, and is equal to the positive charge carried by the hydrogen atom in the electrolysis of solutions.

In gases at low pressures these units of negative electric charge are always associated with carriers of a definite mass. This mass is exceedingly small, being only about $1\cdot4\times10^{-3}$ of that of the hydrogen ion, the smallest mass hitherto recognised as capable of a separate existence. The production of negative electrification thus involves the splitting up of an atom, as from a collection of atoms something is detached whose mass is less than that of a single atom. We have not yet data for determining whether the mass of the negative atom is entirely due to its charge. If the charge is e, the apparent mass due to the charge supposed to be collected on a sphere of radius a is $\frac{2}{3}e^2/\mu a$ [where μ = magnetic permeability of the medium]: hence m/e in this case is $e/3\mu a$. Substituting the values of m/e and e found above, we find that a would be of the order 10^{-13}cm.

We have no means yet of knowing whether or not the mass of the negative ion is of electrical origin. We could probably get light on this point by comparing the heat produced by the bombardment by these negatively electrified particles of the inside of a vessel composed of a substance transparent to Röntgen rays, with the heat produced when the vessel was opaque to those rays. If the mass was "mechanical," and not electrical, the heat produced should be the same in the two cases. If, on the other hand, the mass were electrical, the heat would be less in the first case than in the second, as part of the energy would escape through the walls.

Hitherto we have been considering only negative electrification; as far as our present knowledge extends, positive electrification is never associated with masses as small as those which invariably accompany negative electrification in gases at low pressures. From W. Wien's experiments on the ratio of the mass to the electric charge for the carriers of positive electrification in a highly exhausted vacuum-tube (*Wied. Ann.*, LXV., p. 440), it would seem that the masses with which positive electrification is associated are comparable with the masses of ordinary atoms. This is also in accordance with the experiments of Elster and Geitel (*Wied. Ann.*, XXXVIII., p. 27), which show that when positive ions are produced by an incandescent platinum wire in air they are not affected to anything like the same extent as negative ions produced by an incandescent carbon filament in hydrogen.

It is necessary to point out that the preceding statements as to the masses of the ions are only true when the pressure of the gas is very small, so small that we are able to determine the mass of the carriers before they have made many collisions with the surrounding molecules. When the pressure is too high for this to be the case, the electric charge, whether positive or negative, seems to act as a nucleus around which several molecules collect, just as dust collects round an electrified body, so that we get an aggregate formed whose mass is larger than that of a molecule of a gas.

The experiments on the velocities of the ions produced by Röntgen or uranium rays, by ultra-violet light, in flames or in the arc, show that in gases at pressures comparable with the atmospheric pressure the electric charges are associated with masses which are probably several times the mass of a molecule of the gas, and enormously greater than the mass of a carrier of negative electrification in a gas at a low pressure.

There are some other phenomena which seem to have a very direct bearing on the nature of the process of ionising a gas. Thus I have shown (*Phil. Mag.*, December, 1898) that when a gas is ionised by Röntgen rays the charges on the ions are the same whatever the nature of the gas: thus we get the same charges on the ions whether we ionise hydrogen or oxygen. This result has been confirmed by J. S. Townsend ("On the Diffusion of Ions," *Phil. Trans.*, 1899), who used an entirely different method. Again, the ionisation of a gas by Röntgen rays is in general an additive property—*i.e.*, the ionisation of a compound gas, AB, where A and B represent the atoms of two elementary gases, is one-half the sum of the ionisation of A_2 and B_2 by rays of the same intensity, where A_2 and B_2 represent diatomic molecules of these gases (*Proc. Camb. Phil. Soc.*, Vol. X., p. 9). This result makes it probable that the ionisation of a gas in these cases results from the splitting up of the atoms of the gas, rather than from a separation of one atom from the other in a molecule of the gas.

These results, taken in conjunction with the measurements of the mass of the negative ion, suggest that the ionisation of a gas consists in the detachment from the atom of a negative ion, this negative ion being the same for all gases, while the mass of the ion is only a small fraction of the mass of an atom of hydrogen.

From what we have seen, this negative ion must be a quantity of fundamental importance in any theory of electrical action; indeed, it seems not improbable that it is the fundamental quantity in terms of which all electrical processes can be expressed; for, as we have seen, its mass and its charges are invariable, independent both of the

* Communicated by the author to the December number of the *Phil. Mag.* Read at the Meeting of the British Association at Dover.

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processes by which the electrification is produced and of the gas from which the ions are set free. It thus possesses the characteristics of being a fundamental conception in electricity; and it seems desirable to adopt some view of electrical action which brings this conception into prominence. These considerations have led me to take as a working hypothesis the following method of regarding the electrification of a gas, or indeed of matter in any state.

I regard the atom as containing a large number of smaller bodies which I will call corpuscles; these corpuscles are equal to each other; the mass of a corpuscle is the mass of the negative ion in a gas at low pressure—*i.e.*, about 2×10^{-26} of a gramme. In the normal atom this assemblage of corpuscles forms a system which is electrically neutral. Though the individual corpuscles behave like negative ions, yet when they are assembled in a neutral atom the negative effect is balanced by something which causes the space through which the corpuscles are spread to act as if it had a charge of positive electricity equal in amount to the sum of the negative charges on the corpuscles. Electrification of a gas I regard as due to the splitting up of some of the atoms of the gas, resulting in the detachment of a corpuscle from some of the atoms. The detached corpuscles behave like negative ions, each carrying a constant negative charge, which we shall call for brevity the unit charge; while the part of the atom left behind behaves like a positive ion with the unit positive charge and a mass large compared with that of the negative ion. On this view, electrification essentially involves the splitting up of the atom, a part of the mass of the atom getting free and becoming detached from the original atom.

A positively electrified atom is an atom which has lost some of its "free mass," and this free mass is to be found along with the corresponding negative charge. Changes in the electrical charge on an atom are due to corpuscles moving from the atom when the positive charge is increased, or to corpuscles moving up it to when the negative charge is increased. Thus, when anions and cations are liberated against the electrodes in the electrolysis of solutions, the ion with the positive charge is neutralised by a corpuscle moving from the electrode to the ion, while the ion with the negative charge is neutralised by a corpuscle passing from the ion to the electrode. The corpuscles are the vehicles by which electricity is carried from one atom to another.

We are thus led to the conclusion that the mass of an atom is not invariable: that, for example, if in the molecule of HCl the hydrogen atom has the positive and the chlorine atom the negative charge, then the mass of the hydrogen atom is less than half the mass of the hydrogen molecule H_2; while, on the other hand, the mass of the chlorine atom in the molecule of HCl is greater than half the mass of the chlorine molecule Cl_2.

The amount by which the mass of an atom may vary is proportional to the charge of electricity it can receive; and as we have no evidence that an atom can receive a greater charge than that of its ion in the electrolysis of solutions, and as this charge is equal to the valency of the ion multiplied by the charge on the hydrogen atom, we conclude that the variability of the mass of an atom which can be produced by known processes is proportional to the valency of the atom, and our determination of the mass of the corpuscle shows that this variability is only a small fraction of the mass of the original atom.

In the case of the ionisation of a gas by Röntgen or uranium rays, the evidence seems to be in favour of the view that not more than one corpuscle can be detached from any one atom. For if more than one were detached, the remaining part of the atom would have a positive charge greater than the negative charge carried by each of the detached corpuscles. Now the ions, in virtue of their charges, act as nuclei around which drops of water condense when moist dust-free gas is suddenly expanded. If the positive charge were greater than the individual negative ones, the positive ions would be more efficient in producing cloudy condensation than the negative one, and would give a cloud with smaller expansion. As a matter of fact, however, the reverse is the case, as C. T. R. Wilson (*Phil. Trans.*, 1899) has shown that it requires a considerably greater expansion to produce a cloud in dust-free air on positive ions than on negative ones when the ions are produced by Röntgen rays.

Though only a small fraction of the mass of an atom can be detached by any known process, it does not follow that the part left behind does not contain more corpuscles which could be detached by more powerful means than we have hitherto been able to use. For it is evident that it will require a greater expenditure of energy to tear two corpuscles from one atom than to tear two corpuscles from each of two separate atoms: for when one corpuscle has been torn off from an atom the atom is positively electrified, and it will be more difficult to tear off a second negatively electrified corpuscle from this positively electrified atom than it was to tear the first from the originally neutral atom. A reason for believing that there are many more corpuscles in the atom than the one or two that can be torn off is afforded by the Zeeman effect. The ratio of the mass to the charge, as determined by this effect, is of the same order as that we have deduced from our measurements on the free corpuscles; and the charges carried by the moving particles, by which the Zeeman effect is explained, are all negatively electrified. Now, if there were only one or two of these corpuscles in the atom, we should expect that only one or two lines in the spectrum would show the Zeeman effect, for even if the co-ordinates fixing the position of the moving corpuscles were not "principal co-ordinates," though there might be a secondary effect on the periods of the other oscillations due to their connection with these co-ordinates, yet we should expect this secondary effect to be of quite a different order from the primary one. As, however, there are a considerable number of lines in the spectrum which show Zeeman effects comparable in intensity, we conclude that there are a considerable number of corpuscles in the atom of the substance giving this spectrum.

I have much pleasure in thanking my assistant, Mr. E. Everett, for the help he has given me in making the experiments described in this Paper.

MEANS OF ATTAINING LARGE PHASE DIFFERENCES, AND THEIR APPLICATION TO VARIOUS MEASURING INSTRUMENTS.*

BY JOHANNES GÖRNER.

In alternate-current work we know that differences of phase of 90 or more degrees cannot be obtained by the employment of a simple inductance on a single condenser. Much more complicated apparatus is required. I shall therefore describe some arrangements adopted by Hartmann and Braun, of Frankfurt a/M., for the construction of instruments in which such displacements of currents or fields are necessary.

Generally speaking, magnetic fields which are strongly displaced with respect to the E.M F. of the alternate current may be divided into two classes. In the first class the field and the current have

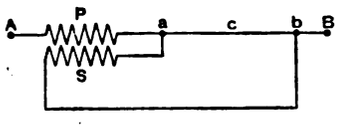

FIG. 1.

the same phase. In the second case the field is more or less displaced with regard to the generating current. The former kind requires the magnetising current to have the same phase displacement as the field is to have. For many types of instruments this is a necessity, especially if, as in dynanometers, we have to deal with highly mobile systems in which no iron is used. In Fig. 1 is sketched a system of connections which satisfies the condition perfectly. A and B are the terminals to which the alternate E.M.F. is applied, P being the primary and S the secondary coil of a transformer. The conductor *a c b* is that part of the circuit in which the current is to flow with the high phase displacement required. The diagram (Fig. 2) illustrates the electrical occurrences in this system. If the current i_1 flows in the coil P, and the current i_2 in the coil S, the primary ampere turns are represented by the vector Oa_2, and the resultant Oa_m gives the ampere turns really acting upon the iron core of the transformer, and upon their direction both the self-induction OE′ of the coil P

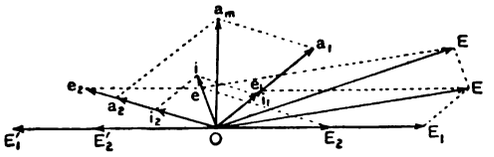

FIG. 2.

the secondary E M F. OE'_2 must stand as normals in the direction of retardation. In both cases an equal and opposite component OE_1 and OE_2 must be furnished at the terminals by the source, and these, together with the ohmic losses due to i_1 and i_2, make up the total E.M.F. OE. By vector addition of OE_1 and the ohmic loss Oe the terminal E.M.F. of P is obtained as the vector OE; and by a similar addition of OE_2 and Oe_2 is obtained the E.M.F. Oe at the points *a b* in Fig. 1. By further adding OE and Oe, we obtain OE, the total E.M.F. between the terminals A and B. It is easily seen from the diagram that the current *i* in the wire *a c b* may be displaced by 90 or more degrees, since the E.M.F. Oe which produces it is also displaced by 90 or more degrees. The magnitude of *i* is obtained from the vector addition of i_1 and i_2. The phases and currents of the whole system may be easily regulated by adjusting the resistance in the secondary circuit of the transformer.

* From the *Elektrotechnische Zeitschrift* of Oct. 26, 1899.

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Since certain secondary expenditures of energy, as in eddy currents and hysteresis, are not considered in the diagram, the phase displacement of the individual currents depends to a slight extent upon the magnitude of the E.M.F. But this fault can be rectified by using the arrangement sketched in Fig. 3. In this system the transformer of Fig. 1 has been split into two, so that the current i_1 becomes independent of i_2. By varying the ratio of the secondary work in the two transformers it is easy to obtain a nearly perfect independence of the E.M.F. As already mentioned, these connections are of value in

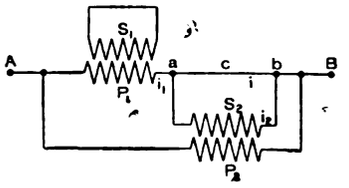

Fig. 3.

instruments in which no iron can be used in the moving system. Messrs. Hartmann and Braun use them, for instance, in direct-reading phase meters.

In apparatus such as alternate-current meters, in which a rotating field is used for driving the movable armature, it is possible, as a rule, to put a good deal of iron into the strongly displaced secondary field, and in this case the displacement may, as a rule, be attained in

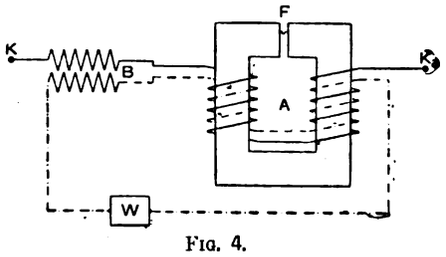

Fig. 4.

a simple manner with the aid of connections in which the field and the generating current are not of the same phase. Such connections have been used by various makers, but I shall only describe those adopted by Hartmann and Braun.

In Fig. 4 a small transformer B is connected with both its coils in series with another A, provided with a gap F, with the high phase difference required between its poles. A small regulating

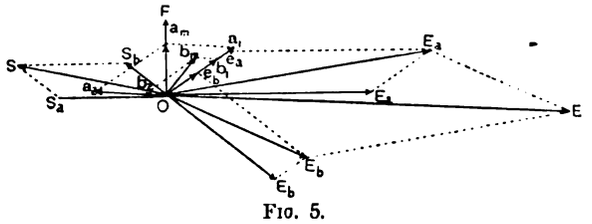

Fig. 5.

resistance W is inserted in the secondary circuit. The phase conditions are easily recognised from the diagram, Fig. 5. Oa_1 is the primary and Oa_2 the secondary ampere-turn number of the transformer A; they compound into a resultant Oa_m, coinciding in direction with the field F of the transformer. Ob_1, Ob_2, and Ob_m are the corresponding exciter ampere-turns of the transformer B. The secondary E.M.F.s produced, OS_a and OS_b, are in the direction

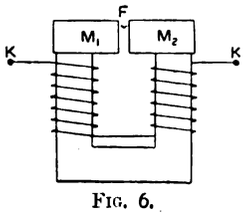

Fig. 6.

of retardation, and normal to Oa_m and Ob_m respectively. Their resultant is the total effective secondary E.M.F. The total E.M.F. at the terminals K_1 and K_2 is equal to the sum of the primary terminal E.M.F.s of both transformers, and is represented by OE, the resultant of OE_a and OE_b. The last two are obtained by vector addition of the primary inductances and ohmic losses of the transformers taken separately, and their genesis is easily understood from diagram. It is also seen that the field OF is displaced more than 90deg. with regard to the total E.M.F. OE, and by altering W in Fig. 8 this phase displacement may be adjusted at will.

Yet another method of producing strongly displaced fields, not coincident with the exciting current, is represented in Figs. 6 and 7.

Fig. 6 shows an electromagnet not constructed with uniform material, the pole-pieces M_1 and M_2 being solid, and the core laminated. If this electromagnet is inserted in an alternate-current circuit, a field is produced in the gap F which, according to the rate of alternation, may be displaced considerably more than 90deg. The phase may be readily regulated by choosing the resistance in accordance with the winding, inserting an inductionless resistance when necessary.

The method illustrated in Figs. 4 and 5 is employed by Messrs. Hartmann and Braun for their motor watt-hour meter for alternating currents, and has been found to work well in practice. The speed of

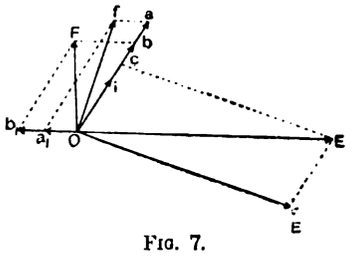

Fig. 7.

a metallic body revolving in the rotating field of such a meter is, as we know, proportional to the sine of the phase angle between the two alternating fields. If one of the fields is produced by the supply current J and has the same phase, and the other field is produced by a secondary current i displaced considerably with regard to the supply current, and if, in addition, the lines of force of both are normal to each other and to the axis of rotation of the armature, the speed of rotation of the latter is

$$v = \frac{C\,F f n \sin\phi}{(kf)^2 + (k_1 F)^2}$$

where n is the rate of alternation, ϕ the phase angle between the fields F and f, and C, k, and k_1 are constants. The two quadratic terms are the dampings of the meter itself due to the fields F and f.

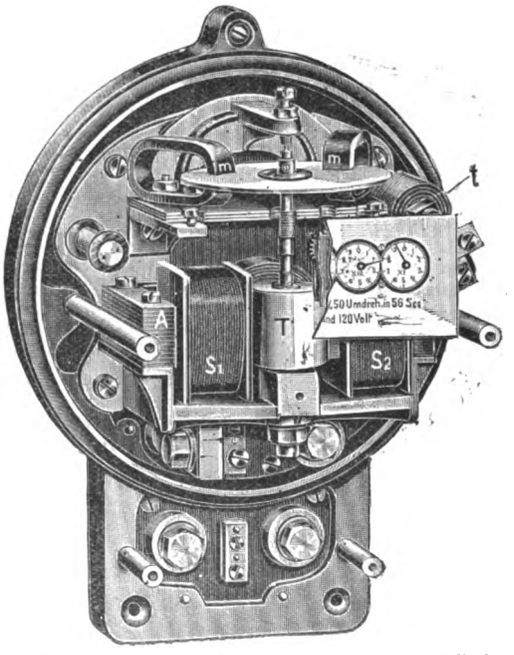

Fig. 8.—Hartmann and Braun Meter. Quarter full size.

Since F is proportional to the current J, and f proportional to the supply E.M.F. E, the equation may be written in the form

$$v = \frac{C^1 J E n \sin\phi}{(k^1 i)^2 + (k^1_1 J)^2 + D}$$

where D is a damping term increasing linearly with the velocity, such as might be due to the action between permanent magnets and a rotating disc.

If, further, matters are so arranged that the self damping is as constant as possible for various E.M.F.s and constant work, and is also small in comparison with D, and if n is constant, the speed is very approximately

$$v = K J E \sin\phi.$$

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If for the field f a connection is adopted which displaces it by 90deg. against E, ϕ will also be 90deg. If the main current has also a displacement $\pm\psi$, we shall have $\phi = 90\text{deg.} \mp \psi$. Then the speed becomes

$$v = KJE \sin(90\text{deg.} \mp \psi),$$

or

$$= KJE \cos \psi.$$

But the work consumed in the alternate-current circuit is

$$A = JE \cos \phi.$$

Hence there exists a proportionality between the speed and the work, and the meter is a true wattmeter under all conditions.

All the above quantities are taken into consideration in the meter placed on the market by Messrs. Hartmann and Braun. The calibration curve does not sensibly deviate from the straight line, even when strong variations of E.M.F. and large phase displacements are at work. The meter itself is shown in Fig 8. T is the drum-shaped aluminium armature, while A is the magnet of the secondary circuit, and consists of laminated iron. The main current coil lies behind the aluminium drum. Towards the right lies the small transformer t for attaining the phase displacement of 90deg., while to the left is mounted a resistance for adjusting it. The damping device, consisting of permanent magnets m and an aluminium disc, is in the upper portion of the meter.

ELECTRICAL TIME SERVICE.*

BY F. HOPE JONES.

The subject of this Paper has, I believe, never before appeared in the *Proceedings* of the Institution of Electrical Engineers, presumably because electric clocks have until quite recently been considered little more than interesting toys, or at any rate have not achieved that measure of success which alone makes the wholesale distribution of time possible: the electrical engineering profession as such has consequently had no occasion to deal with it. In the first place, let there be no mistake as to the importance of the subject. The advantages of an organised service of uniform and accurate time make an apology for giving it an evening at the Institution quite unnecessary, provided it is not a mere dream, but, as I maintain, within our reach. Time-keeping is essentially one of those things that can be done much better by a municipality or a company than by the individual. What is everyone's business is nobody's. There is not an argument in favour of the public supply of such commodities as electricity, gas, or water which does not apply with equal or even greater force to the distribution of time. Anything like correct measurement of time is a delicate operation, so difficult indeed that absolute accuracy is impossible even with the aid of carefully compensated seconds pendulums in our observatories. How, then, can we expect to do it for ourselves in every room and in every office, with clocks in which the length of the pendulum and the quality of the works are sacrificed to the ornaments of the cases? Yet we grumble at them unjustly, and go on using them—so true is it all the world over, but particularly, I fear, in England, that in the trivial and common things of daily life we are content with inefficiency, and submit to many of "life's little worries" through thoughtlessness or the want of energy and concerted action.

We have not made much progress in obtaining uniformity since Charles V. of Spain went mad in the attempt, and it seems strange that electricians have not accomplished it before, when we recollect that they have been at it since the beginning of the present reign, since the earliest days of telegraphy. Alexander Bain began to think about it in 1837. In 1846 his system was in use between Glasgow and Edinburgh, and he had an attractive showroom of electrically-driven synchronous clocks in Old Bond-street at a date when it was necessary to devote a chapter in his description of them to an "explanation of the electromagnet." Sir Charles Wheatstone and R. L. Jones' systems were almost as early as Bain's, and C. Shepherd, some of whose work may yet be seen in Greenwich Observatory, installed a time-circuit of eight dials in the offices of Messrs. J. F. Pawson and Co., in St. Paul's churchyard, in 1849. On the Continent we find that M. Paul Garnier (a veteran in the service of Time, whom I had the pleasure of meeting in Paris last year) devised a system in 1850 which was applied to 18 clocks in the Lille railway station in 1855; and again, M. Breguet, whose ingenuity provided 72 synchronous clocks in the streets of Lyons in 1856.

With such early and creditable pioneering work before us in the middle of the century, I think we should have made more progress before its close. Of that, however, you will be a better judge than an avowed champion of the cause; and it is only for me, in this short Paper, to summarise and dispassionately review the various systems forming the steps in that advance, to point out carefully the conclusions which a study of their theory and a practical acquaintance with their working leads me to form, and, finally, to describe my contribution to the subject and the system which I advocate. In substantial agreement with Drs. Tobler and Schellen, M. Favarger, and other authors on the subject, I adopt the following general classification of electric clocks:—

1. Independent, self-contained, self-wound clocks.
2. Systems of clocks connected together by a line.

In such systems a "regulator," "controller," or "master" clock (whether self-wound or key-wound) is invariably used to send out electrical impulses (*a*) correcting or synchronising ordinary clocks, or (*b*) directly propelling the hands of "subsidiary," "secondary," "receiver" or "indicator" dials.

In class 1 the main object is to save us the trouble of winding our clocks up once a week. When properly applied, electricity performs this operation better than we can do it, for a clock is an organism which likes its feed of power in small and equal instalments meted out to it with perfect regularity. The first self-wound clocks were by Bain and Jones, who applied electromagnetic attachments to the bob of the pendulum, which, in obedience to contacts connected to the pendulum itself, attracted it to and fro. The wheel work of the ordinary clock was retained, but the escapement modified to enable the pendulum to drive it instead of the wheel-work driving the pendulum. In addition to the theoretical objection that the free action of gravity is interfered with when the impulses are applied to the lower end of the pendulum, there is the practical difficulty of obtaining a satisfactory working contact off the moving pendulum, and the fact that fluctuations of battery necessarily varied the impulse.

In 1856 M. Foucault devised a most ingenious method of obtaining a firm contact from each vibration of the pendulum, which device was improved upon and adapted to a self-wound clock by Dr. Hipp in the same year, and has since become well known as Hipp's "electric escapement." It consists of a little pallet pivoted upon the pendulum and swinging freely over a pair of contact springs. The upper spring is provided with a notched block which catches the pallet and is depressed by the pendulum when the arc of its vibration has fallen too low. An armature is fixed to the lower end of the pendulum, and the contact momentarily completes the circuit of a magnet placed immediately underneath it. I show you an example of this in one of the earliest instruments made by Dr. Hipp and in the latest improved form devised by Mr. T. J. Murday for the self-winding integrating meter of Messrs. Johnson and Phillips.* The same device has doubtless had many other applications since. I last saw it in use as a gas-engine regulator. Hipp's electrical escapement satisfactorily disposes of the first difficulty I mentioned—that of obtaining a good contact off the pendulum, and almost meets the second objection by increasing the frequency of the impulses automatically and in exact proportion to their lack of strength. It is so successful that many Continental observatories use it in preference to key-wound regulators for accuracy of time-keeping.

A more common form of self-wound clock is that in which an ordinary eight-day timepiece has electromagnetic power periodically applied to its wheel-work in place of a spring or weight, the electromagnet or motor being controlled by a contact operated by one of the wheels of the clock train. I show you the works of an American self-wound clock invented by H. Chesters Pond as typical of this class. It is driven by a toy electro-motor which winds up a spring every hour. One naturally doubts the stability of its contact made off the going train when the spring power is at its weakest, the efficiency of such a small motor and its silence after running for a few months; and perhaps faults of this nature were contributory causes to the failure of the English company which was formed to put it on the market in this country in 1885. Sir William Preece presented one of them to the Institution in 1888, and we may safely assume that the reason it is no longer in use is that the replenishing of the battery and the attention to the contacts has been found in practice to be more troublesome than weekly winding.

Other self-wound clocks which should be mentioned are those of Shepherd, Breguet, Victor Reclus of Paris, Van der Plancke of Brussels, Werner of Waterbury, U.S.A., Lord Kelvin, Dr. Lippman and Dr. Aron of Berlin, but we shall have occasion to refer to them later on under class 2 *b*. To these I could add the names of many other inventors, the evidence of whose ingenuity is only to be found in patent specifications. With my notes before me of some 200 British patents on the subject applied for during the last 30 years, it would seem that the idea of self-wound clocks was fatally alluring to the dreamer in search of perpetual motion, who has done so much to swell the revenue of the Patent Office. These inventions, however, do little more than save us the trouble of winding up our clocks, and, except in the case of electric meters, I should not be surprised were you to class them all—even the best of them—as misapplied ingenuity. It is true that in the case of Hipp and one or two others greater accuracy of time-keeping incidentally results, but if that cannot be communicated to and represented upon a number of dials its benefit is very limited. Inasmuch as it is impossible to make an absolutely accurate timekeeper, whatever expense and care may be lavished upon it—and its error is necessarily cumulative—

* Paper read before the Institution of Electrical Engineers, Dec. 14th.

* See *The Electrician*, Vol. XLIII., p. 604.—ED. *E.*

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it will not suffice merely to improve the standard and quality of our ordinary clocks; we must strike at the root of the evil—*their independence.*

We therefore turn to class 2, which sinks the individuality of a group of clocks by making them subservient to one master. Let us take first those methods in which the controller sends out an impulse on a line to (*a*) correct or synchronise existing clocks. R. L. Jones accomplished this in 1858 by making contact every second in the master clock to control the vibration of subsidiary pendulums by means of electro-magnetic attachments to their bobs; and this method, improved upon and made by Messrs. James Ritchie and Son, of Edinburgh, is in regular use in many of our observatories. It is, however, found incapable of application to a number of clocks in one circuit, though well adapted for keeping a small group of high-class regulators in sympathy, beat for beat. In this system it is necessary that the pendulums which are to be synchronised be regulated in the first place to considerable accuracy; as, of course, the more they are out of sympathy, the more will the electro-magnet be required to interfere with the free action of gravity. A temporary cessation of the seconds synchronising currents often allows a pendulum to get so far out of phase that when re-established the electrical impulses directly oppose its swing and bring it to a standstill. After several years' trial with a clock at London Bridge, controlled from Greenwich in this way, the late Mr. C. V. Walker gave it up as impracticable.

Another class of synchronisers, far more suitable for wholesale application, is that in which a standard clock sends out impulses at longer intervals, usually every hour, to forcibly pull the hands of independent clocks into synchronisation by the armature of an electro-magnet fitted to each. Bain employed the stabbing action of a V-shaped notch (operating upon a pin on the minute-hand at each hour) for this purpose in 1843, and it is fully described in a pamphlet of that date, "On the Application of the Electric Fluid to the Useful Arts." Ritchie revived this method in 1876, but renounced it in favour of giving the clocks to be synchronised a permanent going rate, and stopping their hands or their scape-wheels by armatures interposed 30sec. before the hour and liberated exactly at the hour. In the meantime, however, Lund was patenting a variety of devices for correcting the hands, and his name will always be associated with the electro-magnetic clip, which, in response to an impulse transmitted every hour, grips the minute-hands of a number of clocks, pulling them forward if slow and backward if fast. An exhaustive Paper on this subject was read by him before the Society of Telegraph Engineers in 1881, and we have to thank the Standard Time Co. (Ltd.) for the survival of this, the fittest system. Their central station at 19 and 21, Queen Victoria-street, E.C., is equipped with two steel and mercury regulators of the highest quality, which are kept very close to time by daily comparison with a special Greenwich time signal. Both of these regulators make a contact of one second duration every hour, but only one of them takes the load, the other being held in reserve and automatically switched in by a sentinel clock in the event of the working regulator stopping. The hourly contacts operate relays, which send out impulses in all directions over London correcting a large number of clocks, deflecting galvanometer needles, or ringing single-stroke bells. If it were not for this service we should have nothing but the Greenwich time signals supplied to a few of the leading clockmakers and disseminated to the principal provincial post offices over the telegraph lines from St. Martin's-le-Grand at 10 a.m. or 1 p.m. Since the inauguration of the company in 1886, I understand that their rentals have been steadily increasing in spite of the difficulties incidental to overhead lines. As I shall have something to say later on in criticism of synchronisation in general, it is fitting that I should express the obligation we are under to this, the only system of public time distribution in London.

It will be observed that in all synchronisers the complete key-wound clock is retained, the sole use of the line being to correct its errors periodically. The one advantage in such systems is that each dial has a life of its own and will continue to go if the line breaks down. But this argument in their favour only applies in these degenerate days when we value truth so little that we prefer a clock which goes even inaccurately to a stopped one. The greatest objection against synchronisation is the small use to which the lines are put. In telegraphy our energies have for years been almost exclusively concentrated upon increasing the transmitting capacity and the load factor of the line. Of course no such problem occurs in the electrical distribution of time, for we are not likely under any circumstances to require signals of greater frequency than 15sec., but the commercial argument is the same. Why use the line only once an hour to correct key-wound clocks, instead of using it every minute, half-minute, or quarter minute to directly propel the hands, thereby dispensing with clock-works and the necessity of winding them up?

It is this consideration which forces us to the conclusion that for practical and wholesale distribution of time we must look to that class of electric clocks referred to as 2*b*, in which a controller sends out frequent impulses to directly propel the hands of large numbers of indicator dials. Let us now consider the work that has been done on these lines. One would think that no mechanical problem could be more easy than that of rotating pointers synchronously in response to periodic contacts. Surely a simple step-by-step movement, consisting of a magnet pulling a lever against a spring and a click on the lever engaging a ratchet wheel so as to pick up one tooth at each vibration, would suffice. Yet it is not so. This has been the most difficult problem in the whole subject; in fact, it is one of the principal rocks upon which so many systems have split, leaving the shores strewn with the wreckage of fruitless inventions and failures, resulting in a deep-rooted prejudice against this use of electricity.

The simplest form of electromagnetic time counter or "dial movement" is shown in Fig. 1, in which A is the ratchet wheel to be propelled carrying the minute-hand, B the rocking armature lever, C the propulsion click, and D the backstop. This movement fails because there is nothing to prevent the wheel A shooting forward more than one tooth. The momentum of a minute-hand is considerable, and its velocity is greatest at the end of its journey; it is therefore necessary to provide a "stabbing" click to prevent it overshooting, which is shown in dotted lines at E. The time counters of Messrs. Alex. Bain, Paul Garnier, Reclûs, Froment, Robert-Houdin, Detouche, Mildé, Colin, Liais, Warner, Joyce, Potts, Stockall, Gent, and others are, with slight variations, identical in principle with Fig. 1. Theoretically this method is correct, but it has met with so little practical success that we must conclude it is a form ill-adapted for wholesale manufacture. I believe the difficulty lies in the mechanical accuracy necessary to make three pallets exactly in phase with the teeth of a ratchet wheel when they are placed widely apart on the circumference. That there are difficulties which, rightly or wrongly, were considered insurmountable seems clear from the number of less simple devices that have since been invented to obtain the same result. If it were not for this, surely the intricate and costly hydro-pneumatic system of Mayrhofer would never have been devised, nor even the Charles A. Popp pneumatic system of Paris, for we cannot seriously admit the rivalry of pneumatics for transmitting small impulses to long distances. And again, innumerable complicated electrical step-by-step movements have since been devised,

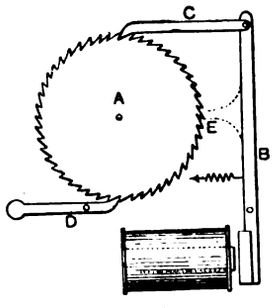

Fig. 1.

such as those containing the double impulsion clicks with reversed motions of MM. Nollet, Breguet, and Detouche, and the weighted flywheel of Van der Plancke. In the latter system—the property of La Précision Cie., of Brussels, and in this country from 1893 to 1898 of the Electrical Time Recording Co. (Ltd.), a sample of whose instruments is shown—the armature of an electro-magnet hits with a percussive blow an unevenly weighted balance-wheel, causing it to make one complete revolution, which is geared down through a train of wheels to produce a half-minute movement of the minute hand.

Assuming that simplicity is commonly revered for it own sake, we must suppose also that the difficulties of making a step-by-step movement of this simple form that would neither trip nor overshoot yet would be safely operated by a periodic current sent in one direction, drove some inventors to use polarised or rotary armatures and currents alternately reversed. Sir Charles Wheatstone in 1840, recognising also the difficulty of making reliable periodic contacts, generated alternate current by means of the pendulum bob of his controlling clock, which was, in fact, a magneto-electric machine driven by an enormously heavy weight wound up by hand. The armatures in his dials revolved once for every complete vibration of the pendulum of the master-clock, and were geared to the minute-hand through a train of wheels. Truly this was an ideal system. Absolute uniformity of 50 clocks, only one of which requires winding up, and no battery is needed! But it was built upon a foundation of sand. It required that a time-keeping pendulum should serve also as a magneto-electric generator, and unfortunately that was impossible.

Bain operated subsidiary dials from his self-wound clocks on similar lines, but with this important difference, that he recognised the necessity of a battery as the source of power; and Ritchie also, in 1873, used alternate currents to propel subsidiary pendulums, which revolved the hands upon their dials. The rotary armature has, however, survived in the system Grau, commercialised by C. Theod. Wagner, of Wiesbaden, which has received considerable

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support on the Continent, and is now represented in this country by the General Electric Co. (Ltd.), to whom I am indebted for the models which I show you. Another alternate system which has had its share of success is that of Dr. Hipp (whose self-wound pendulum has already been noticed), commercialised by Peyer, Favarger and Cie., of Neuchatel. In this system the dials are provided with a polarised armature, which rocks an ordinary pallet staff engaging with a crown wheel as in a verge escapement.

Advocates of systems in which the direction of the current is alternately reversed will perhaps demur at my suggestion that their method had its origin in the difficulty of designing a satisfactory single-acting step-by-step motion. Two arguments in their favour can be advanced—(1) that the receiver dials are not readily susceptible to intermittent contacts should any such occur in the controlling clocks; and (2) that no special care is required to make the action silent, owing to the movement of the armature being slow and not suddenly arrested by a fixed stop. I admit these advantages, but they constitute no argument against the more simple form of counter, provided a reliable one can be designed and a safe and non-intermittent contact can be obtained to operate it.

The production of such a contact has been another great stumbling-block, and innumerable methods have been devised whereby the wheel-work of a master-clock shall perform the duty. The difficulty of course lies in the fact that at the scape-wheel end of the clock train there is very little power available for such a purpose, and what there is can ill be spared from the primary and all-important duty of imparting equal impulses to the pendulum. In some cases, notably in this regulator movement of Wagner, a separate train of wheels supplies the power required to send out the contacts, this

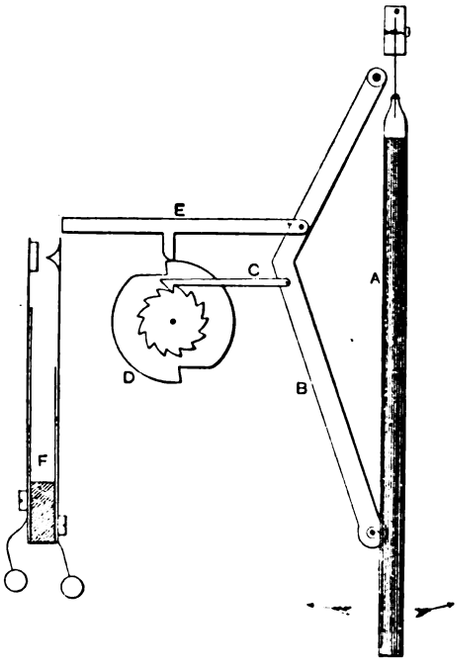


Fig. 2.

train being let off by the going train at its side much in the same way as a striking gear is operated in an ordinary clock. The best method of obtaining a contact at regular periods off a pendulum clock that I have ever met with is an unpublished invention of Mr. T. J. Murday, and I have his permission to describe it. In Fig. 2, A is a pendulum, whose vibrations are maintained by any means, whether electrical or mechanical does not now concern us, and B is a gravity arm bearing against it and carrying a pawl, C, which rotates the disc D one step at each vibration. The free arm E is normally supported by the disc D, on which it rides backwards and forwards with each swing of the pendulum, until the notch in the disc allows it to fall, then it charges full tilt into the contact springs F with the whole weight of the pendulum behind it.

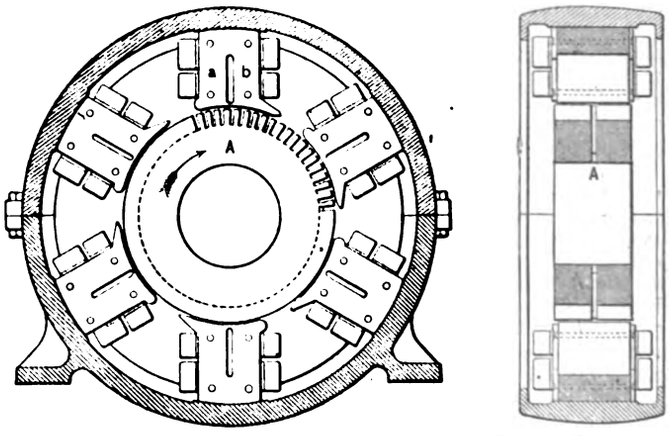
Having now reviewed the work of others and given, I hope, a clear idea of the progress achieved and the difficulties that still have to be overcome, I must here express my opinion as to which of the many suggested methods is destined, perhaps after further patient improvement, to give us house-to-house time service. I consider that the case for "one-wheel" step-by-step dials operated by a central clock is overwhelming on the grounds of simplicity and economy, provided that a good contact for transmitting the impulses and a reliable dial movement of that simple form can be secured, and my contributions to the subject lie in this direction.

(*To be concluded.*)

THE LUNDELL GENERATOR.

In the discussion on Mr. W. M. Mordey's Paper "On Dynamoes," two years ago—the Paper in which Mr. Mordey described his system of chord winding—Mr. R. W. Weekes sketched a device, due to Mr. Robert Lundell, for reducing the effect of armature reaction in a multipolar dynamo. This device is now incorporated in the new type of generator manufactured by the Sprague Electric Co., and is described as follows in a recent issue of the *Electrical Review* of New York:—

The effect of armature current in its reaction upon the magnetic poles of a dynamo is well understood. While the demagnetising tendency of this current can be amply compensated by compounding, the distorting action shifting the line of commutation cannot easily be offset in this way. Perhaps the most practical solution has been the employment of very strong fields, but this necessitates the consumption of much material in the construction of the machine, and involves necessarily wasteful and expensive design. Figs. 1 and 2 show cross sections of the new dynamo. It will be



Figs. 1 and 2.—Cross Sections of Lundell Continuous Current Dynamo.

seen that the pole pieces have a peculiar shape, a horn running down in the direction of rotation of the armature, while the pole-piece itself is nearly cut in two by a deep slot parallel with the lines of magnetic flux. The core on the side toward the shoe has a much larger area facing the armature than the other. Hence, under a given magnetising force, the core on that side will become saturated first and remain at a practically steady magnetisation. Hence, if the machine is so proportioned that the following side of the field poles is saturated

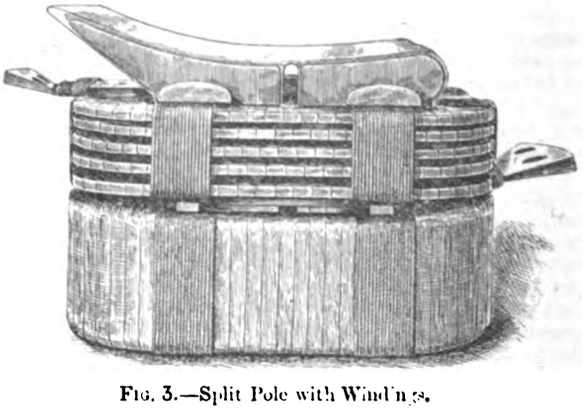


Fig. 3.—Split Pole with Windings.

from the shunt coils, the effect of increasing magnetisation, due to the series coil, will practically be confined to the pole-piece having the least face. This tends to pull back the centre of flow of magnetic induction in a way that compensates exactly for the distorting effect of the armature current. The machines are said to run with no perceptible sparking, and to regulate admirably under highly difficult conditions of use.

Calcium Carbide Works in Sweden.—The calcium carbide manufacture in Sweden is rapidly increasing. Not only is the Trollhättan factory, which for some time was the only one in Sweden, being extended, but, according to *Engineering*, new works have been erected at Alby, Mansbo, and Brattfors, the first of which has already commenced operations. This will bring the annual production up from 1,000 to 6,000 tons. As the home consumption in Sweden is only about 100 tons this year, the bulk of the calcium carbide is intended for export, although no doubt the requirements of Sweden herself are likely to increase materially.

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CORRESPONDENCE.

HIGH VOLTAGES AND LONG-DISTANCE TRANSMISSION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Referring to the leading article in your issue of December 15th, the following statement is made:—

In the present condition of cable manufacture many firms would willingly undertake the production of cables for this higher pressure; and here again the radial thicknesses of insulation employed for 10,000 volts would not have to be greatly increased to withstand 15,000.

It is generally understood by manufacturers that the following B.O.T. regulation applies to all voltages above 3,000, although "extra high pressure" is not mentioned:—

Every high-pressure conductor shall be continuously covered with insulating material to a thickness of not less than one-tenth part of an inch, *and in cases where the extreme difference of potential in the circuit exceeds 2,000 volts*, the thickness of insulating material shall not be less in inches or parts of an inch than the number obtained *by dividing the number expressing the volts by 20,000.*

For 10,000 volts the thickness is therefore 0·5in., for 15,000 volts 0·75in., and for 20,000 volts 1·0in., which are very considerable differences indeed. The London Electric Supply Co.'s 10,000 volt main has a dielectric thickness of 0·5in.—Yours, &c., F. E. A.

Woolwich, Dec. 19.

[According to the definition of "high pressure" in the Board of Trade regulations, this rule is only intended to apply for pressures up to 3,000 volts. The employment of higher pressures is subject to special regulations, and it does not follow that the same law for radial thickness of insulation would be laid down.—ED. *E.*]

LIGHT (ELECTRIC) RAILWAY APPLICATIONS.

In our last issue we gave some particulars of the 43 applications for light railway orders which were lodged with the Commissioners in November. We give below a complete list of the 32 electrical schemes; the remaining 11 specify steam as the motive power. In May there were 40 applications, of which 21 specified electric traction, and in November, 1898, the figures were 54 and 34 respectively.

Of the list given below extensions have been found necessary at Aldershot, Barnsley, Cheltenham, Spen Valley, and Peterborough, the original schemes for all but the last-named of which appeared in the November, 1898, list. The Spen Valley original scheme was brought forward in May last, and the present application is for extensions. In the case of the County of Middlesex, this is now sponsored by the Middlesex County Council only, whereas the 1898 project was the joint application of the Middlesex County Council and the Metropolitan Tramway and Omnibus Co., and was a more ambitious project, the present application being for a line of 12 miles, while in 1898 the length of line was 25½ miles. In the case of the Blackpool and Garstang order, which was in the May, 1899, list, and was withdrawn, it will be seen that the line is now 16¼ miles in length, against 14½ miles previously; also that while "mechanical" traction was specified in May, the present scheme is electrical. In May last the application for Bath and district was by a group of private promoters, whereas the application is now by the Bath Corporation. The length of track is about the same as in the earlier project, which failed owing to the opposition of the Corporation, which now promotes its own bill.

Title.	Promoters.	Engineer.	Mileage.	Gauge. ft. in.	Agents.
Aldershot and Farnborough (ext.)	Power and Traction	G. Hopkins & Sons	½	3 6	Baker, Lees and Co., 54, Parliament-st, London, S.W.
Barnsley and District (extension)	British Electric Traction Co.	S. Sellon	½	3 6	S. Morse, 37, Norfolk-st, London, W.C.,
Blackpool and Garstang	Blackpool and Garstang Electric Light Railway Co.	J. J. Myres	16¼	4 8½	Sherwood and Co., 7, Gt. George-st, London, S.W.
Blyth and District	British Electric Traction Co.	S. Sellon	1½	3 6	S. Morse, 37, Norfolk-st, London, W.C.
Cheltenham and District (exten.)	T. Nevins	T. Nevins	2¼	3 6	Winterbotham and Gurney, Cheltenham
Cinque Ports (Kent and Sussex)	D. Cook	D. Cook and J. T. Rossiter	67¾	3 6	Wingfield and Blew, 52, Queen Victoria-st., London, E.C.
*City of Bath	Bath Corporation	C. R. Fortune and G. F. Metzger	18	4 0	Warwick Webb, Bush-lane House, Bush-lane, London, E.C.
County of Hertford, No. 1	Hertford C.C. and the Metropolitan Tramways and Omnibus Co.	V. B. D. Cooper	5¾	4 8½	H. C. Godfray, 42, Finsbury-sq., London, E.C.
Ditto No. 2	Ditto	Ditto	2	4 8½	Ditto ditto
Ditto No. 3	Ditto	Ditto	9	4 8½	Ditto ditto
Ditto No. 4	Ditto	Ditto	3½	4 8½	Ditto ditto
County of Middlesex, No. 2	Middlesex County Council	H. T. Wakelam	12	4 8½	Sir R. Nicholson, 2, Princes-st, Storey's-gate, London, S.W.
Gloucester and District	City of Gloucester Tramways Co.	J. Clifton Robinson	8	3 6	Stanley, Washbrough & Doggett, Bristol
Hayling Island	W. Paynter, H. R. Trigg, & E. Belfield	Knowles & Russell	4¾	4 8½	Angove and Bromwich, 14, Gt. Winchester-st, London, E.C.
Kingston, Surbiton and District	Greenwood and Batley	A. H. Rowan	4¾	4 8½	Sherwood and Co., 7, Gt. George-st, London, S.W.
Llanelly and District	Llanelly and District Elec. Light. Co.	R. Wilson	7¾	3 6	Baker, Lees and Co., 54, Parliament-street, London, S.W.
London County (Archway-road, Highgate)	London County Council	Sir A. Binnie	½	4 8½	W. A. Blaxland, County Hall, Spring-gardens, London, S.W.
London County (Clapham, Wandsworth and Kingston Road)	Ditto	Ditto	5½	4 8½	Ditto ditto
London County (Deptford, Shooters Hill and Woolwich)	Ditto	Ditto	5½	4 8½	Ditto ditto
London County (New Cross, Lewisham and Eltham)	Ditto	Ditto	4¼	4 8½	Ditto ditto
Loughborough and District	Loughborough & Dis. Elec. Trac. Synd.	C. H. Gadsby	8¼	3 6	Rees & Frere, 5, Victoria-st, London, S.W.
Mansfield and District	J. Fell, J. Lewis, and W. J. Kershaw	Ditto	5¼	3 6	Wm. Webb and Co, 37 and 39, Essex-st, Strand, London, W.C.
†Mid-Anglian (Norfolk and Suffolk)	C. T. Molineux-Montgomerie and B. M. Kilby	Jeyes and Godden	39¾	4 8½	W. H. Smith and Son, 252, Gresham-house, Old Broad-st, London, E.C.
Morley and District	British Electric Traction Co.	S. Sellon	10	4 8½	S. Morse, 37, Norfolk-st, London, W.C.
Oldham, Ashton-under-Lyne, Hyde and District (extensions)	Oldham, Ashton, and Hyde Electric Tramway Co.	Ditto	4¼	4 8½	Ditto ditto
Peterborough and District (exten.)	British Electric Traction Co.	Ditto	1	3 6	Ditto ditto
Spen Valley (extensions)	Ditto	Ditto	12	4 8½	Ditto ditto
Wakefield and District	J. Fell, J. J. Gittings, E. Horton, and W. J. Kershaw	Pritchard and Co.	10	3 6	Wm. Webb and Co., 37 and 39, Essex-street, Strand, London, W.C.
Warrington and Northwich	A. Anderson, J. Hesketh, & A. Brown	R. H. Scotter	13¼	4 8½	Baker, Lees and Co., 54, Parliament-street, London, S.W.
West Hartlepool (extensions)	Hartlepool Electric Tramways Co.	S. Sellon	1¾	3 6	S. Morse, 37, Norfolk-st., London, W.C.
Wigan	Wigan and District Tramways Co.	Ditto	7¾	3 6	Ditto ditto
Windermere and District	British Electric Traction Co.	Ditto	6½	3 6	Ditto ditto

* "Mechanical traction." † "Steam or electric traction."

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LEGAL INTELLIGENCE.

Pyke, Harris Co. (Ltd.) v. the Gwynne Electrical Close Tube Co. (Ltd.).

In the Westminster (London) County Court, on Tuesday, plaintiffs, a firm of electrical engineers, sought to recover £31 for making an electric alternator for defendants. Plaintiffs said the machine was made from a rough sketch by Messrs. Easton, Anderson and Goolden, and their charge was £28. 4s. 6d. Plaintiffs charged a profit on that, but they would withdraw that amount. Defendants had paid £15 into court. It was agreed that it was possible to make a similar machine for £15, but then this machine had to be made from a rough sketch only. The cost book of Messrs. Easton and Anderson showed that labour amounted to £12. 9s. 11d., establishment charges to £9. 7s. 1d., materials £2. 15s., establishment charges thereon 2s. 7d. For the defence evidence was given that £15 was a fair price, and that the work was roughly done.

Judgment for plaintiffs for £25. 3s. 6d. and costs.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers, or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London :—

NOW READY.

"The Electrician" Electrical Trades' Directory and Handbook for 1899.—The *Second Edition* of the "Big Blue Book" for 1899 is now ready. The volume contains the large Sheet Tables of Electricity Supply Stations and Electric Railways and Tramways. The price of the Directory and Handbook is now reduced to 5s. post free 5s. 9d. ; abroad, post free, 6s. 6d. (United States 7s. 6d.).

"Submarine Cable-Laying and Repairing."—By H. D. Wilkinson, M.I.E.E., &c., fully illustrated; price 12s. 6d. This work gives a detailed technical summary of modern practice in manufacturing, laying, testing, and repairing submarine telegraph cables.

"Practical Notes for Electrical Students."—By Messrs. A. E. Kennelly and H. D. Wilkinson. Price 6s. 6d., post free. The authors give in a clear and concise manner a good summary of the general principles of electrical science.

"Magnetic Induction in Iron and other Metals."—By Prof. J. A. Ewing. Price 10s. 6d., post free. *New Edition nearly ready.*

"The Incandescent Lamp and its Manufacture."—By Gilbert S. Ram. Price 7s. 6d., post free. The principles underlying the manufacture of the incandescent lamp are carefully and fully dealt with in this volume.

"The Steam Engine Indicator and Indicator Diagrams."—Edited and enlarged by W. Worby Beaumont. Price 3s. 6d., post free. This work is a concise guide to the objects, construction, and use of the steam engine indicator and to the interpretation of indicator diagrams.

"The Art of Electrolytic Separation of Metals."—A second issue of Dr. Gore's book is now ready, price 10s. 6d., post free. The author treats fully both the theoretical principles of the art of electrolytic separation of metals and the practical rules and details of technical application on a commercial scale. The work is adapted to the use of the manufacturer as well as the student.

"The Manufacture of Electric Light Carbons." — A Practical Guide to the establishment of a Carbon Manufactory. Fully illustrated, price 1s 6d. ; post free, 1s. 9d. In this work the author gives useful hints as to the manufacture of electric light carbons, including the preparation of material, firing, saturating, and coring, together with a description and estimate of cost of the plant required.

"The Centenary of the Electric Current, 1799-1899."—By Dr. J. A. Fleming. Price, paper covers, 1s. net, post free 1s. 3d.; strong cloth, 2s. 6d., post free.

"Localisation of Faults in Electric Light Mains."—By F. C. Raphael. Price 5s., post free. The book deals with the important subject of localising faults in electric light and power cables; and the various methods of insulation testing are here collected and discussed.

"Motive Power and Gearing for Electrical Machinery."—By E. Tremlett Carter, C.E., M.I.E.E. Price 12s. 6d., post free. In this comprehensive work an account is given of the scientific principles and modern practice in the use of engines for dynamo driving, not only for isolated power plants, but also for public electric lighting and power stations. The various forms of gearing in the power station and for electric motors are also dealt with ; and the book contains, in addition, numerous tables giving exact data of the equipment and working of electric power stations.

"The Manufacture of Carbons for all Electrical Purposes."—by Francis Jehl. 10s. 6d., post free. This is a practical handbook, giving a complete description of the art of making carbons for electric lighting, electrodes, &c., with particulars of the various gas generators and furnaces used in carbonising. The work also contains particulars of the cost, &c., of erecting and working carbon works, and plans of a model factory.

"Drum Armatures and Commutators," by Mr. F. Marten Weymouth. also ready. Price 7s. 6d., post free. Propsectus on application. This is a complete treatise on the theory and construction of drum winding, and of commutators for closed coil-armatures, together with a *résumé* of the principal points involved in their design, and an exposition of armature reactions and sparking.

"Electric Motive Power," by Albion T. Snell, contains the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. Price 10s. 6d., post free ; abroad, 11s.

"Electrical Testing for Telegraph Engineers."— By J. Elton Young, M.I.E.E. The scope of the book aims at furnishing a fuller treatment of the subject, from the standpoint of the Telegraph Engineer, than it has hitherto received, whilst it endeavours to facilitate a thorough comprehension of the theory of testing as applied to electrical lines in general. Demy 8vo, fully illustrated. 10s. 6d., post free.

"The Potentiometer and its Adjuncts": A Universal System of Electrical Measurement.—By W. C. Fisher. Fully illustrated. Price 6s, post free.

"The Students' Guide to Submarine Cable Testing."—A new edition of this book, by Messrs. H. K. C. Fisher and J. C. H. Darby, is now ready, price 6s. nee ; abroad, 6s. 3d. This work is intended to serve as a guide to operators already in the telegraph service, and to those who desire to enter that service. The great cable companies now insist that their operators and probationers shall pass certain examinations in electrical subjects. The book is very fully illustrated.

"Electro-Chemistry."—By Dr. G. Gore. Third Edition Price 2/., post free.

"Wireless Telegraphy: Signalling across Space without Wires by Electric Waves." A Review of the Work of Hertz and his Successors.—By Dr. O. J. Lodge, with a large number of illustrations. ***New and Enlarged Edition ready Jan. 5.***

"Electromagnetic Theory."—By Oliver Heaviside. *Vol. I.*, 12s. 6d. *Vol. II.*, 12s. 6d.

"Bibliography of X-Ray Literature and Research."—A valuable compilation. Being an attempt to classify the data relating to X-Ray work. This work contains a quantity of general as well as special information bearing upon the whole subject of electrical discharge research. Edited by C. E. S. Phillips. **Price 5s., post free.**

"Electrical Engineering Formulæ," a pocket-book, by Messrs. W. Geipel and H. M. Kilgour; price 7s. 6d. ; by post, 7s. 9d. ; abroad, 8s, *New Edition in the press.*

"The Alternate Current Transformer."—By Prof. J. A. Fleming, M.A., D.Sc., F.R.S. Vol. *I.*—*New Edition*. Price 12s. 6d., post free, Vol. II., price 12s. 6d. post free, is also ready.

"Electric Lamps and Electric Lighting," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is handsomely bound, and full of original illustrations. designs, initials, &c. *New and Cheaper Edition now ready.* 6s., post free.

TENDERS INVITED.

The Corporation of the city of Melbourne require tenders for the supply and delivery of plant and the superintendence of its erection, and the carrying out of the work in connection with the electric lighting of the city. The specifications include (1) boilers; (2) steam engines, dynamos, equaliser, booster, and switchboard ; (3) feeders, mains, and arc light leads ; (4) accumulators. An advertisement elsewhere gives further particulars, and copies of the specifications, &c., can be obtained from the Agent-General for Victoria, 15, Victoria-street, London, S.W., on and after 28th inst. The specifications and drawings can also be seen at but not obtained from the office of Dr. A. B. W. Kennedy, 17, Victoria-street, S.W. Further information as to local conditions, &c., can be obtained up to Jan. 3 from Mr. A. J. Arnot (city electrical engineer of Melbourne), First Avenue Hotel, London, W.C.

The *Salford* School Board invite tenders for the electric lighting of their new schools in Grecian-street North, Lower Broughton. An advertisement contains some particulars, and further information may be obtained from the offices of the consulting engineers (Messrs. Lacey, Clirehugh and Sillar), 78, King street, Manchester, and 2, Queen Anne's-gate, London, S.W. Tenders (addressed chairman of the Board) must be delivered to the clerk (Mr. Ogilvie Duthie) not later than noon of Monday, Jan. 8.

The *Newcastle-upon-Tyne* Corporation invite tenders for the construction of about 11 miles of double track tramway — rails, fastenings and poles being supplied by the Corporation. An advertisement gives further particulars, and specifications, &c., may be inspected at the offices of the city engineer after Jan 3. Tenders (addressed New Tramways committee) must be in by noon of Jan. 24.

The *Tunbridge Wells* Corporation invite tenders for surface condensing plant for their electricity supply station An advertisement contains further particulars, and specifications can be obtained from the office of the borough electrical engineer (Mr. Horace Boot). Tenders to town clerk (Mr. W. C. Cripps), Town Hall, Tunbridge Wells, not later than Jan. 15.

The *St. Pancras* (London) Vestry invite tenders for condensing plant. Specifications, &c., can be obtained at the electricity department, 57, Pratt-street, Camden Town, N.W., and tenders must be sent to the Vestry clerk (Mr. C. H. F. Barrett), Town Hall, St. Pancras, N.W., by noon of Tuesday, Jan. 9. An advertisement contains further particulars.

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The *Bedford* Electric Light committee invite tenders for the supply of a 420 b.h.p. inverted compound double-acting engine and a 250 kw. alternator. Tenders to town clerk (Mr. T. S. Porter), by Jan. 5.

The District Council of *Burgess Hill*, Sussex, invite proposals for the establishment of electricity supply works. Further particulars can be obtained of the clerk to the Council. See advertisement.

The *Dublin United Tramways Co.* invite tenders for the supply of general stores, particulars of which are set out in an advertisement. Forms of tender can be obtained at the company's offices, 9, Upper Sackville-street, Dublin, from 18th to 30th inst., and tenders (addressed to the chairman) must be lodged with the secretary (Mr. R. S. Tresilian) not later than Monday, Jan. 1.

The *Gloucester* Electricity Supply committee invite tenders for (*a*) one Lancashire boiler and accessories and mechanical stokers; (*b*) one 300-kw. steam dynamo and accessories, steam, exhaust, &c., pipes, valves, &c.; (*c*) extensions of switchboard; and (*d*) condensing plant. Tenders to Mr. G. Sheffield Blakeway, Guildhall, Gloucester, before Dec. 28.

The *Hull* Electric Lighting committee invite tenders for the supply and erection of plant at their Sculcoates electric lighting works. Tenders to chairman of Lighting committee, Town Hall, Hull, by noon of 28th inst.

The *Bermondsey* (London) Vestry invite tenders for the construction, supply, and erection of a dust destructor, with furnaces, flues, water-tube boilers, economiser, fans, and forced draught appliances. Tenders to Mr. Frederick Ryall, Vestry clerk, Town Hall, Bermondsey, before noon of Jan. 13.

The Urban District Council of *Barnes* are prepared to receive tenders for the supply and erection of: (*a*) Boilers; (*b*) steam dynamos and switchboards; (*c*) storage batteries; (*d*) cables, &c. Tenders to Mr. J. Eustace Anderson, High-street, Mortlake, London, S.W., by 12 noon of Jan. 9.

The Tramways committee of the *Manchester* Corporation require tenders for the supply of 450 electric tramcar bodies. Tenders (addressed chairman of Tramways committee, Town Hall, Manchester) by 30th inst.

Accrington Corporation invite tenders for switchboards, wiring, &c., for the electric lighting of the Town Hall. Tenders Jan. 10.

Blackburn Corporation require supply and delivery of overhead line equipment. Tenders to Mr. Robert E. Fox, Town Hall, Blackburn, by Dec. 23.

Glasgow Corporation require a cast-iron cable tunnel, water storage tanks, travelling cranes for outside coal storage, mechanical stokers, coal and ash conveyors, and steel flues. Tenders to Sir J. D. Marwick by 1 p.m. Jan. 6.

Hackney (London) Vestry invite tenders for accumulators. Tenders to Mr. George Grocott, Town Hall, Hackney, by 4 p.m. of Jan. 2.

Birkenhead Corporation require tenders for new electric tramway generating station. Tenders by Jan. 16.

It is stated that the consideration of the applications recently received by the *Bombay* municipality for concessions to lay cables under the streets of the city in connection with electricity supply has been deferred, to afford other firms of standing an opportunity to send in their applications.

The municipal authorities of *Utrera* (Spain) invite tenders until Jan 16 for the electric lighting of the town by 100 16 c.p. and 300 10 c.p. lamps. Particulars from and tenders to el secretario del Ayuntamiento.

TENDERS RECEIVED AND ACCEPTED.

The following tenders were received by the Portsmouth Corporation for the supply and delivery of 40, 60, or 80 electric tramcars:—

60 Electric Tramcars.

Dick, Kerr and Co. (*accepted*)	£34,382 11 6
R. W. Blackwell and Co.	37,218 10 0
British Westinghouse Co.	36,091 15 0
Brush Co.	34,572 8 0

Macartney, McElroy and Co. submitted a tender for 40 cars at £22,931.

The following tenders have been received by the St. Pancras (London) Vestry for the supply of two dryback marine boilers and feed-water heaters for their Regent's Park electricity station:—

Boilers.

E. Danks and Co. (*accepted*)	£2,645	J. Fraser and Son	£3,400
S. Hodge and Sons	3,825	Fraser and Fraser	2,991

Feed-Water Heaters.

W. Boby (*accepted*)	£1,495	Edwards and Barnes	£889
J. E. and S. Spencer	1,017		

The St. Pancras Electricity committee received five tenders for the supply of condensing plant, but four of these did not comply with the specification, whilst the amount of the fifth was considered too high. It has consequently been decided to invite fresh tenders, as set out on another page.

The Liverpool Corporation have accepted the tender of Messrs. R. W. Blackwell and Co. for the electrical equipment of 10 miles of electric tramway. The Corporation have also accepted the tender of Messrs. E. Green and Son for the supply of two economisers for the Lister Drive power station at £513 each.

The tender of Messrs. R. W. Blackwell and Co. has been accepted by the Bradford Corporation for the supply of trucks and trollies for 25 electric tramcars, and that of the Brush Co. for the supply of tramcar bodies.

The Hammersmith (London) Vestry have accepted the tender of Messrs. Marshall, Fleming and Jack for supply of a 25 ton overhead traveller for the electricity station, at £540.

The Swansea Council have accepted the tender of Messrs. Yates and Thom for the supply of boilers, steam piping, &c., for their electricity supply works, at £10,800.

The tender of Messrs. Pryor and Co. has been accepted by the Hampstead (London) Vestry for wiring the Public Baths, Finchley-road, at £210.

The contract for the supply of a battery of accumulators for the Purdysburn Asylum, Belfast, has been given to the Tudor Accumulator Co.

The tender of Messrs. Coates and Son, Belfast, has been conditionally accepted for the electric lighting of the Cork District Lunatic Asylum at £795. 6s. 7d.

The Bury St Edmunds Corporation have accepted the tender of Messrs. Laurence, Scott and Co. for wiring and fitting the public buildings for the electric light at £107. 5s.

The Bury St. Edmunds Corporation have aloo accepted the tender of the British Thomson-Houston Co. for the supply of 70 electricity meters of from 5 to 25 ampere capacity.

APPOINTMENTS VACANT AND FILLED.

The Brighouse Corporation invite applications for the position of consulting electrical engineer to the borough. Applications must be sent in, addressed to the town clerk (Mr. James Parkinson), Municipal Offices, before Jan. 10. See advertisement.

The Bradford Corporation invite applications for the position of electrical engineer to take charge of their electricity department. Salary £500 per annum. An advertisement contains further particulars, and applications must be sent in to the town clerk (Mr. Frederick Stevens) not later than Thursday, Jan. 4.

An assistant engineer is required for the Wandsworth station of the County of London and Brush Provincial Electric Lighting Co. An advertisement contains further particulars, and applications must be sent to the chief engineer, Moorgate-court, Moorgate-place, London, E.C., before 29th inst.

The Gloucester Electricity Supply committee requires a chief assistant electrical engineer and a cable jointer. Further particulars are given in advertisements, and applications must be sent to the town clerk (Mr. Geo. Sheffield Blakeway) by 10 a.m. on Jan. 3.

A demonstrator in physics is required for the University of Sydney, N.S.W. Salary £350 per annum. Applications to Sir Julian Salomons, 9, Victoria-street, London, S.W., by Jan. 1.

The National Boiler and General Insurance Co. (Ltd.) require additional inspectors of electrical plant, who must be electrical engineers. Some further particulars are given in an advertisement.

Junior assistants are required by the Wireless Telegraph and Signal Co. See advertisement.

A mains superintendent is required to take charge of laying and jointing complete systems of lead-covered cables. See advertisement.

The Dover Corporation require an electrician for their tramways department. Applications by 29th inst.

The Chair of Engineering at University College, Bristol, is vacant, owing to the appointment of Dr. Ryan as principal of the Woolwich Polytechnic. Applications to secretary by Jan. 16.

The Eccles Electric Light committee recommend the appointment of Mr. James Moss, of Derby, as borough electrical engineer, in place of Mr. L. H. Combe, who recently resigned.

Mr. Edward Calvert, of Burley-in-Wharfedale, has been appointed resident electrical engineer to the Buxton District Council.

Mr. A. C. Hanson, of the Smithfield Markets Electric Supply Co., has been appointed resident electrical engineer by the Stirling Police Commissioners, at a salary of £200 per annum.

Mr. E. A. Barker, of Hull, has been appointed assistant engineer at the Llandudno electricity works.

Mr. T. Rees has been appointed clerk of works in connection with the erection of the Swansea electricity station building.

Mr. Walter T. Kerr, of Glasgow, has been appointed to take charge of the house installations, meter and testing section of the Greenock electricity department.

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BUSINESS NOTICES.

The London telephone number of the Electrical Power Storage Co. (Ltd.) is now 1,253 London Wall.

Messrs. Christy Bros., of Chelmsford, notify that Mr. William Middleton, A.M.Inst.C.E., of Leeds, has joined the firm, which becomes Christy Bros. and Middleton. Mr. Middleton was recently awarded a "Miller" prize by the Institution of Civil Engineers for his Paper on "Electrical Driving of Workshops."

We have been unable to obtain confirmation in London of a report that the well-known business of Felten and Guilleaume, Mulheim-on-Rhine, Germany, has been converted into a joint stock company, with a capital of £1,500,000. The report is therefore given with all reserve.

BANKRUPTCIES, LIQUIDATIONS, &c.

A first and final dividend of 6d. is payable on Jan. 1, at 8, Princess-street, Huddersfield, in the failure of J. E. Stott (trading as J. E. Stott and Co.), electrician, Huddersfield.

The discharge of the partners in Wright's Patent Heater Condenser Co. has been granted, subject to judgment being entered against debtors as follows: W. S. Wright, £150; Grace E. Wright, £10; H. H. Wright, £400.

A receiving order has been made against F. B. de Foe Paynter, electrical engineer, 2, Faversham-road, Catford, late of 5, Romanr ad, Bedford Park, Chiswick.

The public examination was concluded on Tuesday last, at the London Bankruptcy Court, of E. A. Max Winter, electrical engineer, trading at Amberley House, Norfolk-street, London, W.C., under the style of the Imperial Electric Light and Power Co. Debtor returned his gross liabilities at £1,550, and his only asset a bad debt of £157. 10s. He stated that his idea was to obtain a number of concessions from public bodies and others for the supply of electricity, and to then convert the business into a limited company; but this truly brilliant idea had to be abandoned because, although he travelled all over the United Kingdom, he only obtained one concession. A profit of £2,000 was made over that transaction, but generally speaking the returns had been small in comparison with the expenses. To that fact and to pre sure by creditors he attributed his insolvency.

The Brook Time Checking Clock Co. is to be wound up voluntarily. Mr. O. Avison, Cloth Hall-street, Huddersfield, is liquidator.

Plant for Sale.—The Taunton Corporation electricity works have for sale a 30 kw. Thomson-Houston compound wound alternator. Tenders by Jan. 13 to town clerk. See advertisement.

Johnson and Phillips' Cables.—A well printed large sheet table, giving details of pure copper conductors arranged in order of carrying capacity, has just been issued by the Johnson and Phillips Cable Works, Old Charlton, Kent. The table is well arranged, and the figures bold and easily read off.

B. T. H. Plant.—Pamphlets Nos. 50 and 51, just issued by the British Thomson-Houston Co., deal with polyphase induction motors and the G. E. 58 traction motor. Both pamphlets are well illustrated.

Personal.—Mr. Arthur E. Cotterell, district manager for Birmingham of the National Telephone Co., has been promoted to the position of assistant provincial superintendent for the Midlands. The Midland province, of which Mr. A. Coleman is superintendent, extends from Sheffield to Northampton, and from the east to the west coast, including North Wales. Mr. Cotterell will take up his new duties from Jan. 1, and the position which he vacates will be filled by Mr. J. W. F. Ashwin, at present district manager to the National Co. at Edinburgh.

Burglary.—The business premises of Mr. A. P. Lundberg, Bradbury Electrical Works, London, N., were broken into on the night of 17th inst. He desires us to notify correspondents that, should they fail to receive acknowledgment of any communications sent about this time, they will please send particulars. The attention of the unwelcome visitors appears to have been confined to a small amount of cash and to the letter-box.

"Engineering Magazine."—The contents of the December issue include "Electrolytic Processes in Industrial Operations," "The Steam Engine for the Electric-Traction Power House," "Works Management for the Maximum of Production," "The Revolution in Machine Shop Practice," "Standardising in Engineering Construction," "South African Questions from an Engineering Standpoint," "The Strength and Weakness of the Trust Idea," and "Mechanical Transport Appliances in Engineering Work."

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Dec. 13 to Dec. 19, with the ports of destination:—

Africa—Alexandria, £120; Cape Town, £85; Durban, £1,235 (including £79 telegraph material); Port Elizabeth, £19. *Australasia*—Adelaide, £130; Auckland, £100; Launceston, £37; Melbourne, £176; Port Chalmers, £216 (including £200 telegraph material); Sydney £305 (including £98 telegraph material); Wellington, £106. *Belgium*—Ostend, £48. *Burma*—Rangoon, £100. *Canada*—Halifax, £2,500 (telegraph apparatus). *Ceylon*—Colombo, £127. *France*—Boulogne, £34; Havre, £30. *Denmark*—Copenhagen, £38. *Germany*—Hamburg, £30. *Gibraltar*, £31. *Holland*—Amsterdam, £68. *Hong Kong*, £520. *India*—Bombay, £95; Calcutta, £336; Madras, £211. *Japan*—Tokio, £73. *Madeira*, £43. *Malta*, £13,707 (including £13,690 telegraph cable). *Norway*—Christiania, £453. Total, £20,973, against £6,933 in the corresponding week last year (Dec. 14 to Dec. 20).

MUNICIPAL, FOREIGN, AND GENERAL NOTES.

Aberdeen.—The Woodside electric tramway route was officially inspected by Mr. A. P. Trotter on Friday. The line has now been opened for traffic.

Airdrie-Coatbridge Electric Tramway Scheme.—A difficulty having arisen in connection with the preliminary expenses of the proposed joint scheme by the Airdrie and Coatbridge Councils for the construction of an electric tramway between the two burghs, it has been decided to drop the bill. The New General Traction Co. are, however, proceeding with their bill, and a committee has been appointed by the Coatbridge Council to watch the interests of the burgh and, if advisable, to enter into negotiations with the company. The question of opposing the British Electric Traction Co.'s bill has been postponed.

Banbury.—The proposals of the Electrical Power Distribution Co. for electricity supply have been accepted by the Council, and application for a provisional order is being made by the company.

Barnsley.—In moving the adoption of the Park and Highways committee this week, Councillor Brady explained that, owing to the delay in the erection of the electricity buildings, they would not be ready to supply current for three or four weeks.

Belfast.—At a specially convened meeting of the Corporation it has been decided to rescind the previous resolution in favour of purchasing the undertaking of the local tramways company and for promoting a bill for that purpose.

Bradford.—The Electricity committee presented a report to the Corporation last week recommending that the resignation of the city electrical engineer (Mr. A. H. Gibbings) be accepted with regret, the resignation to take effect on March 31st next, and that a successor be advertised for at a salary of £500 per annum (see official announcement on another page). The committee also recommended that Mr. Gibbings be retained as consulting engineer to the Council, at a salary of £350 per annum. The report was adopted, with the exception of the latter recommendation, which was withdrawn for further consideration.

Bristol.—The Sanitary committee have decided to recommend the erection of 313 additional arc lamps in various thoroughfares. The annual cost of lighting the streets in which it is proposed to erect the lamps is £1,789. There are at present 306 arcs, which cost £7,038, but the charge per lamp will be reduced to £19 per lamp, making the excess annual cost of the new scheme £2,934. The length of the streets included in the extension scheme is between 12 and 13 miles.

Camborne.—The application of the Urban Electric Supply Co. for a provisional order is being supported by the Council. The company are also applying for a tramway order to construct an electric line between Camborne and Redruth.

Canterbury.—On the recommendation of the Lighting committee it has been decided to adopt the maximum demand system of charging from April 1st next, when the charge will be 7d. per unit for any number of units up to the equivalent of 100 hours' use per quarter of the maximum demand, and 3d. per unit beyond. For two years from that date consumers will have the option of being charged at the present rate of 6d. per unit. Slot meters are to be supplied to consumers without rent, but discount in these cases will not be allowed. Maximum demand indicators are also to be supplied without charge.

Dawson City.—In addition to the telegraph line from Lake Bennett to Dawson City, which is now in good working order, other evidence of the development of this district is shown in the establishment of a number of new hotels fitted throughout with electric light.

Devonport.—The Corporation have decided to purchase freehold property in Newport-street, Stonehouse, for £12,500, as a site for the proposed electricity works.

Dublin.—A special meeting of the Corporation has been called for Jan. 3, for the purpose of considering the advisability of opposing the County and City of Dublin Electric Lighting Bill.

Edinburgh.—A failure of electricity supply occurred on Monday afternoon, and caused some inconvenience to shopkeepers in the Portobello district for about two hours. Current was again available shortly after six o'clock.

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Fulham (London).—The consulting engineer (Mr. F. H. Medhurst) is to report upon the proposals of the National Electric Wiring Co. for wiring premises in the district on the "easy" system.

Great Grimsby.—The Council have rescinded the resolution extending the present lease of the tramways company, and a committee has been appointed to report upon the question of acquiring the undertaking. The company are applying for Parliamentary powers to extend their lines and adopt electric traction. It has been decided to obtain an additional 350 h.p. steam dynamo, &c., for the electricity, works at an estimated cost of £6,000.

Grenada.—In 1898 this colony expended £1,055 on its telephone department. The revenue from the telephone was about £1,100. The exchanges on the island have 157 subscribers, using 172 instruments. The maintenance of the overhead lines, owing to excessive vegetation and overhanging trees, heavy rainfall inducing landslips, and the great distances to be travelled by inspectors, render the maintenance of the system in working efficiency difficult, but the service is popular, as evidenced by the steady demand for new connections.

Hammersmith.—Owing to uncertainty in obtaining a continuous supply of Welsh coal for their electricity station the Vestry have decided to fix Gregory patent smoke consumers to one of the Babcock-Wilcox boilers for one month on trial, at an estimated cost of £18.

Hoylake and West Kirby.—An inquiry was held here last week into the application of the Council to borrow £27,000 for establishing electricity supply. The clerk (Mr. Roderick Williams) appeared in support of the application, and technical details were supplied by the consulting engineer (Mr. T. L. Miller). The generating station is to be erected in Carr-lane, near the gas works, and the buildings will be erected to the designs of the Council's surveyor. It is proposed to put down plant sufficient to supply current to the equivalent of 7,000 8 c.p. incandescents, and mains will be laid in the first instance in the business thoroughfares.

Huddersfield.—A statutory meeting of ratepayers has approved the Corporation's electric tramway bill for powers to convert the present steam tramways to electric lines and to construct tramways to Brighouse, Marsden, Mirfield, Holmfirth, Kirkburton, and other places. The total cost of the scheme is estimated at £124,426.

Hull.—The Council have definitely decided to purchase the undertaking of the Drypool and Marfleet Steam Tramways Co., and to equip the lines electrically.

Hyde.—The Hyde and Stockport Corporations have decided upon a joint scheme of municipal electric tramways. It is proposed that in the 1901 session the Hyde Corporation shall apply for a provisional order for the construction of a tramway, commencing at the borough boundary in Hyde-road, Bredbury, and terminating near the existing terminus of the Oldham, Ashton, and Hyde electric tramway at Gee Cross. The line will be constructed by the Hyde Corporation, who upon the completion of the line will grant a lease of it to the Stockport Corporation for 21 years, upon the following terms: (*a*) The rent to be an annual sum sufficient to recoup the Hyde Corporation for interest upon the capital expended, plus such an annual sum as will be sufficient to pay off 21-30ths of such expenditure during the period of the lease; (*b*) the Stockport Corporation to equip such tramway on the overhead system, with power at the end of 21 years to remove such equipment, unless the Hyde Corporation purchase at a price to be agreed upon; (*c*) the Stockport Corporation during the lease to provide an efficient service of cars between Stockport and Hyde; and (*d*) Hyde Corporation to maintain the tramway within and for 18in. on either side at a sum to be agreed upon between the two Corporations, in which case the annual sum so agreed shall be added to the rent. By this scheme Stockport borough, the district of Bredbury, and the borough of Hyde will be served. The Hyde Corporation are also in negotiation for another electric tramway from Hyde through Dukinfield, Stalybridge, and Mossley.

Ilford.—An inquiry will be held here this afternoon into the application of the Council to borrow £68,500 for electric lighting and tramway purposes. The Local Government Board have intimated that they are not aware of any statutory authority enabling the Council to provide lamps on consumers' premises, and the sum required for this purpose would therefore be excluded from the application and revised estimates would have to be submitted. The consulting electrical engineer (Mr. W. C. C. Hawtayne) has been instructed to draw up conditions for the guidance of persons who wish to wire their houses.

Keighley.—Sanction to an additional loan of £45,000 for electric lighting is being sought by the Corporation.

Kensington (London).—For some time negotiations have proceeded between the Vestry and the Kensington and Notting Hill Electric Lighting Companies as to the price to be paid for land at Wood-lane which the companies have recently acquired. The companies' surveyor (Mr. Hunt) has intimated to the Vestry that he was authorised to offer £1,600 per acre for the land, and as the Vestry consider this figure inadequate, the matter will have to be submitted to arbitration.

Kingston-on-Thames.—The Council have lodged their bill for powers to construct and equip electric tramways in the district. Power is also being sought to borrow £10,000 for wiring consumers premises.

Light Railway.—The Board of Trade have, after modification, confirmed the order made by the Light Railway Commissioners authorising the construction of the Cranbrook and Tenderden light railway.

Limerick.—The Council have obtained a further extension of six months for carrying out the terms of their provisional order, which was obtained so far back as 1892.

London County Council.—At Tuesday's meeting the following electricity supply loans were granted: £30,000 to Hackney, £13,605 to Poplar, £20,000 to Whitechapel, and £16,500 to Bermondsey.

The report of the Highways committee dealing with the drawings for the equipment of the London United Tramway Co.'s line at Uxbridge-road, Hammersmith, for electrical traction, both overhead and underground, was again before the Council, and a further report by the same committee dealt with the strong representations made by the inhabitants of King-street, Hammersmith, and the Vestry as to the inconvenience which would arise from the disturbance to the carriage-way involved in equipping the tramway with the underground system. The company had given notice of its intention to ask Parliament for such an amendment of the Act as would permit of the lines referred to being equipped for the overhead system. Without expressing any opinion at that stage with regard to this proposed amendment, the committee recommended the Council to approve the drawings submitted relating to the lines authorised to be equipped on the overhead system. This would facilitate the company's operations without prejudicing the Council's action.—Approved.

On the subject of the complaints against the Metropolitan Electric Supply Co., the Highways committee recommended "that proceedings be taken against the company to recover penalties in respect of its default in not maintaining a constant supply of electrical energy in the district included in the company's West London electric lighting order, 1889." Mr. Beachcroft pointed out that the Act said if the supply failed through negligence. The recommendation was adopted.

Manchester.—The Tramways Committee are making arrangements for the organisation and administration of the tramways department as soon as the lines fall into the hands of the Corporation. A general scheme of organisation prepared by the chairman of the committee (Mr. Boyle) has been adopted. This provides for the division of the department into two groups, one constructive and the other administrative. On the constructive side there are to be two sub-committees, one for works and the other for permanent way; and on the administrative side also two sub-committees, one for traffic and staff and the second an audit sub-committee. Under the two first sub-committees the chief officer will be the consulting engineer (Mr. C. H. Wordingham, the city electrical engineer), and under his direction will be a car works manager, a permanent way engineer, and electrical engineering assistants, who again will be in command of their respective staffs. The general manager will be answerable to the sub-committees on the administrative side, and will direct the duties of the outdoor superintendent, parcels superintendent, accountant, and chief clerk, under each of whom a special staff will operate. The Works sub-committee will undertake all the duties as to the provision of cars, car sheds, and works now in the hands of the Cars sub-committee, whilst the latter sub-committee will become the Traffic and Staff sub-committee. The following arrangements and appointments of staff have been made: Mr. J. M. M'Elroy (now secretary to committee) is to be general manager, at a salary of £400 per annum; and Mr. H. Jackson (now in tramways general office) is to be manager's clerk, at a salary of £1. 15*s.* per week. Advertisements are to be issued for an accountant at a salary of £200 per annum, a chief clerk at £150 per annum, and a chief electrical assistant. Tenders for 450 electric tramcars have already been advertised, and a contract has been placed for 5,000 tons of rails, the first delivery to be made next April, when the work of reconstructing the tramways for the overhead trolley system will be commenced. The first routes to be dealt with will be the Cheetham-hill, Bury New-road, and Rochdale-road lines.

Middlesbrough.—In order to obviate delay in loading and unloading ships, the North-Eastern Railway Co. have placed an order with Messrs. Cowans, Sheldon and Co. for the erection of about 20 electric cranes at Middlesbrough docks.

The Corporation have under consideration applications for the supply of electricity to the workhouse and also for extending the mains to Linthorpe. The workhouse extension is estimated to cost £1,510 and the other section about £4,111.

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Municipal Telephony.—A conference was held between the representatives of the special Telephone committees of the Manchester and Salford Corporations, on Tuesday, in regard to the question of deciding upon common action in connection either with the municipalisation of the telephones or the granting of a licence to a new company. A deputation from the Manchester committee left for Glasgow on Monday, and negotiations will be resumed when this committee has reported the result of its consultations with the Glasgow committee.

The Huddersfield Corporation have decided to establish a municipal telephone service, subject to the subscribers of the Corporation's system having the same facilities as the subscribers of the National Co. Representatives of the Corporation are to take part in the conference on the municipalisation of telephones.

Oswestry.—An inquiry was held here last week into the application of the Council for sanction to borrow £18,000 for purchasing and carrying out certain extensions of the Oswestry Electric Light and Power Co.'s electricity works. Mr. Vachell, for the Corporation, said they were anxious buyers, and the company were willing to sell at £11,250, which the Corporation considered was a reasonable price. The consulting engineer (Mr. W. C. C. Hawtayne) said the full value of the undertaking to the Corporation was £8,320. 16s. 4d. In reply to Mr. Graham (who opposed on behalf of ratepayers) he said that when he heard that the Corporation were to be advised by a committee of three members to pay £11,250 for the undertaking, he wrote to the town clerk "that although my valuation was £8,320. 16s. 4d., I thought the Council would be wise to acquire the undertaking if they possibly could, and they might treat the price mentioned by me as being a somewhat flexible one, and pay more than the amount mentioned rather than lose the chance of acquiring the undertaking." Asked what was the limit of his flexibility, he said he thought the word should be taken out. He admitted that his valuation was made on a calculation of the profits earned as stated by the company, and that he took an assumed profit and multiplied it by 25, which would therefore give the shareholders a 25 years 4 per cent. profit. Having adopted that method, it was important to have ascertained that the profits had really been earned. He was not aware that £780, the cost of the provisional order and the preliminary expenses, had not been written off. In his report he said it would be wise to at once reconstruct the works on a more permanent basis. He had examined the mains at the junction boxes only, and he had not tested their insulation resistance. After Mr. Wynne Corrie, the chairman of the company, and other witnesses had been called for the Corporation, Mr. Hopkinson was called for the opposition. He estimated the value of the undertaking at £6,400, and he considered that the £11,250 asked for it was a ridiculous price. It was stated that, out of the 1,111 ratepayers who had polled on the question, 515 were against the purchase.

The Council have unanimously decided not to proceed with their application for a provisional electric lighting order, pending the result of the Local Government Board inquiry into the application to borrow money for purchasing the undertaking of the Oswestry Electric Lighting Co. This means a delay of 12 months.

Portsmouth.—The Electric Light committee experience difficulty in acquiring land for extending their electricity works, and an offer of £1,450 has been made for certain property in Crown-street adjoining the station. Should this figure be declined, the committee have been authorised to instruct the sheriff to summon a jury to decide upon the price.

Richmond (Surrey).—The Corporation have given up the idea of purchasing the undertaking of the Richmond (Surrey) Electric Light and Power Co, on the ground that the valuation (£100,000) put upon the undertaking by the company is too high. Considerable discussion ensued upon the report of the committee entrusted with the negotiations for purchase, and complaint was made of the charge made for current by the company. On the motion of Councillor Thompson, it was decided to make inquiry into the manner in which the company has carried out its obligations under the order.

St. Pancras (London).—For a long time past the Vestries of St. Mary, Islington, and St. Pancras have contended as to the laying of mains in Brecknock and York-roads. A portion of these roads at present lies within the parish of Islington and the remainder in the parish of St. Pancras, and owing to the legal difficulties of the situation, residents in these thoroughfares are unable to have the advantage of the electric light. By the new boundary lines settled in the London Local Government Act, 1899, both roads will be included in the parish of St. Pancras, and this may settle the matter. A proposal at the last meeting of the St. Pancras Vestry that the roads should be immediately opened for the laying of mains was not agreed to.

St. George's-in-the-East (London).—The application for a provisional electric lighting order is to be proceeded with by the Vestry. The capital expenditure set out in the order is £42,000.

Salford.—An inquiry has been held here into the application of the Council for sanction to borrow £398,683 for electricity supply. The town clerk gave particulars of the population and rating of the borough and of the previous electric lighting loans. The demand for current had increased so rapidly during the last 12 months that the generating station established by the Corporation in Wallness-road was quite unable to cope with the demand, and after consideration the Corporation had purchased land near Strawberry-road, Pendleton, and plans and estimates had been prepared for the erection of new works at an estimated cost of £398,683, divided into three parts—£50,000 for buildings, £335,783 for machinery and plant and the underground and overhead distributing mains, and £12,900 for the extension of the low and high-tension cables connected with the existing station in Wallness-road. The lease of the tramways expired in 1901, and the Corporation had determined on its expiration to work the tramways themselves and to adopt the overhead system of electric traction. Mr. S. V. Clirehugh, consulting engineer, and Mr. C. L. Turner, resident electrical engineer, supplied technical details; and Mr. A. Haworth asked the Board's early sanction to the application, to which there was no opposition.

Southend-on-Sea.—The Council have decided not to transfer their provisional electric lighting order to Mr. A. H. Gibbings, as the Light Railways and Electric Light committee consider that the electric lighting and the lighting (electric) railway scheme can be carried out conjointly with advantage to the Council. It is estimated that by working the two schemes together a saving of about £12,000 would be effected upon the whole undertaking. Councillor Martin, in explanation of this change of attitude, said that neither he, as chairman of the committee, nor the town clerk, could agree to Mr. Gibbings' conditions, and hence they decided to carry out the provisions of the order themselves.

Telephone "Facilities" in London.—At Tuesday's meeting of the St. Luke's (London) Vestry a communication was read from the London County Council stating that the Council's attention had been called to the fact that the National Telephone Co. had lately carried out works in several parts of the metropolis without first having obtained the Council's consent to opening the roads, as required by the Telegraph Acts. Further, that the Council's endeavours to come to an arrangement with the company had hitherto proved abortive. The Council asked to be immediately informed when the company commenced any works in the district. The chairman of the Vestry (Mr. E. Howes, J.P.), intimated that the sanction of the Vestry had been given to the National Telephone Co. under an agreement to open the roads, and whatever the company had done in St. Luke's had been done openly and above-board. He supposed, however, that, in view of the letters received from the Postmaster-General and the County Council, they should give the company no further permission to lay pipes, and should notify the Council when in future any such works were commenced.

Tonbridge.—The Council have asked Mr. Robert Hammond to state the terms upon which he would prepare a report upon the electric lighting question.

Tunbridge Wells.—In reference to the report of the inquiry into the application of the Corporation to borrow £25,000 for electric lighting purposes, which appeared in our last issue, we understand that the money is to be expended as follows: To provide another 400 kw. steam alternator, main switchboard, boilers, meters, cables, transformers, sub station switchgear, condensing plant, feed pumps, public lighting, and buildings. The application was made in consequence of the rapid growth of the undertaking. It is estimated that the electricity department has now the equivalent of about 30,000 8 c.p. lamps on the mains, with 497 consumers connected. Evidence was given by the town clerk (Mr. Cripps) and the borough electrical engineer (Mr. Horace Boot) with respect to the growth of the demand. The inspector expressed himself greatly pleased with the works and with the general arrangements.

Wallasey.—An inquiry was held here on Tuesday into the application of the Council to borrow £1,265 for the electric lighting of certain public buildings.

Wellingborough.—An agreement has been entered into with the Electrical Power Distribution Co. under which the company's application for a provisional order will be supported by the Council.

Twickenham.—The application of the Twickenham and Teddington Electric Supply Co. for a provisional order is being supported by the Council, but the application of the Teddington and Twickenham Electric Lighting Co. will be opposed.

War Funds.—News from the seat of war indicates that the large funds being collected to assist wives, widows, orphans, and other sufferers by the war in South Africa will be none too large. Every effort will be needed to make these funds commensurate with the relief they will be called upon to afford. In addition to the main fund established by the Lord Mayor of London, there are the marvellously successful funds of the *Daily Telegraph* and the *Daily Mail*, whose schemes of relief are deserving of public support. The first-mentioned journal's address is Fleet-street, London, and those of our readers wishing to help a truly national cause should

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send their shillings to the editor without delay. Any number of shillings can be sent, and are duly acknowledged day by day.

Wigan.—Electric current was supplied for the first time from the temporary station on Wednesday afternoon. The switching on ceremony was performed by the mayor (Mr. J. T. Gee). At present the supply is confined to a few of the business streets.

Wingate.—This village is now lighted electrically by 43 25 c.p. incandescents. Current is supplied by the Wingate Grange Colliery.

Social Gathering.—An annual gathering of more that usual interest is that of the employés of James White, of Glasgow, which t ok place on Friday evening last, when between 800 and 900 of the staff and their friends assembled. Lord Kelvin presided, and among those on the platform were Prof. Barr, Dr. Bottomley, Mr. D. Reid, and Mr. J. Ferguson. The chairman said it was interesting to know that this was the jubilee year of the factory of James White, which was instituted in Renfield-street, Glasgow, as far back as 1849. It was not such a large factory then as it is now, but good work was done then, as good work was done at the present time. Lord Kelvin touched on the progress of marine telegraphy, and observed that the first messages ever sent under the Atlantic were transmitted and received by instruments made in James White's factory. In congratulating the employés on their fund in aid of the families of reserve men working in the factory who had been called out to the war in South Africa, his lordship expressed the hope that the war would be speedily brought to a conclusion, but patience must be exercised. The whole British nation must persevere until this outbreak had been brought to a satisfactory termination. He predicted that ten years hence, when the two Republics became part of the British empire, the Boers, freed as they would be from the terrible servitude of commandeering, would be happier than they had ever been, under a Government of liberty and as good subjects of the British crown.

PATENT RECORD.

The following list of Applications for Patents and Specifications published has been compiled for this journal by Messrs. J. C. CHAPMAN and Co., *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs, and Trade Marks may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after the acceptance of the complete Specification. The names within parentheses are those of communicators of inventions. When complete specification accompanies application, an asterisk is affixed.*

November 4, 1899.

22,081. S. SCHIFF. Manchester. Improvements in and connected with micro-telephones.*

22,088. THE BRITISH THOMSON-HOUSTON CO. (LIMITED). London. Improvements in incandescent electric lamps. (C. P. Steinmetz, United States.)*

22,091. W. FELSCH. London. Improvements relating to electric lamps.

22,092. W. E. SOTHEBY. London. The electric candle shade adaptor.

22,100. C. KELLNER. London. Improvements in and relating to electric lamps.

22,102. J. Y. BUCHANAN. London. Improvements in or relating to electric cables.

22,107. M. L. BUSH and C. F. SWAIN. London. Improvements in electric alarm water columns. (Date applied for under Patents, &c., Act, 1883, Sec. 103, April 8, 1899, being date of application in United States.)*

November 6, 1899.

22,143. E. C. H. T. LUGARD. London. Improvements in electrical accumulators.

22,163. E. SCHATTNER. London. Improvements in continuous-current electricity meters.

22,164. W. P. THOMPSON. London. Electromagnetic ignition device with revolving armature for gas, petroleum, and similar motor engines. (F. Shirm, Germany.)

22,181. E. JOHANSSON. London. Improvements in or relating to electric taxameters.

November 7, 1899.

22,212. C. WOOD. Birmingham. Improvements in electric switches.

22,267. H. HILL. London. Improvements in or relating to electric light fittings.

22,271. A. VOGT. London. Improved manufacture of electrical heating appliances of high electrical resistance capable of sustaining high temperatures.

22,291. J. G. LORRAIN. London. A new or improved system of telegraphy. (F. Bedell, United States.)

22,293. W. A. BURNS and H. E. SMITH. London. Improvements in electric traction.

November 8, 1899.

22,297. T. FOSTER. Manchester. Improvements in roller gearing and transmission dynamometers.

22,298. T. SCOTT. London. Improvements in and connected with electric railways or tramways.

22,303. I. DIXON. Liverpool. Improved means for guiding collecting trolleys on to overhead electrical conductors.

22,306. C. C. REDINGS. Birmingham. Improvements in and relating to electric arc lamps.

22,308. A. WHALLEY. Warrington: Improvements in telephone switchboard cable.

22,313. R. WILBY. Yorks. Governor relay or speed controller for steam engines, especially adapted for controlling large engines for electric light and power stations.

22,317. C. CURWEN. London. Improvements in electric arc lamps.

22,333. P. H. COLE. London. Improvements in central battery telephone exchange systems with call wire.

22,338. EVERED AND CO. (LIMITED) and S. EVERED. London. Improvements in electrical switches.

November 9, 1899.

22,384. J. POST. London. Improvements in and relating to chemical electrical excitants.*

22,395. N. CARO. London. Improvements in phonographs.

November 11, 1899.

22,517. W. R. PIDGEON. London. Electrical influence machines.

22,521. A. H. C. GIBSON and W. WRIGHT. London. Improvements relating to electric igniters.

22,525. H. J. HADDAN. London. New or improved means for placing, removing, and cleaning incandescent electric lamps (E. E. Sunnis, United States).*

22,533. THE BRITISH THOMSON-HOUSTON CO. (LIMITED). London. Improvements in systems of electrical distribution. (C. P. Steinmetz, United States.)*

22,534. THE BRITISH THOMSON-HOUSTON CO. (LIMITED). London. Improvements in means for generating alternating electric currents. (C. P. Steinmetz, United States.)*

22,535. THE BRITISH THOMSON-HOUSTON CO. (LIMITED). London. Improvements in starting rotary electric converters. (W. B. Potter, United States.)*

22,536. THE BRITISH THOMSON-HOUSTON CO. (LIMITED). London. Improvements in electric circuit changers. (E. Oxley, United States.)*

22,544. O. KIRSTEIN. London. Improvements in collectors for electric railways.

22,552. F. W. SCHROEDER, ABOUCH, and P. W. MORAN. London. Improvements in electric glow lamps.

22,554. L. GASTER. London. Improvements in processes and appliances for obtaining carbon suitable for electrical and other industrial purposes, such as the manufacture of electrodes and calcium carbide, and at the same time obtaining a superior quality of pitch.

22,555. A. GRELET and L. VIVES. London. Improvements in phonographic apparatus.

22,556. W. G. HICKS. London. Improvements in and connected with electric bell pushes and light switches and other articles.

November 13, 1899.

22,581. T. H. PARKER. Wolverhampton. Improvements in or in and relating to skates or contact-makers carried by cars for use in the surface contact system of electric traction.

22,597. G. W. GOLDRING. London. A locking device for electric incandescent lamps.

22,609. E. R. HILL. London. Improvements in the electric lighting of railway vehicles. (Date applied for under Patents, &c., Act, 1883, Sec. 103, April 14, 1899, being date of application in United States.)

22,612. G. L. HOGAN. Liverpool. Graphophones. (Date applied for under Patents, &c., Act, 1883, Sec. 103, April 15, 1899, being date of application in United States.)*

22,615. A. J. ATTERBERG. Liverpool. An improved safety device for starting switches of electric motors.*

November 14, 1899.

22,650. L. W. HEATH. Galway. A new or improved method of preventing or diminishing sparking on breaking electric circuits and apparatus therefor.

22,662. A. E. TANNER. Manchester. An improved joint for troughs for electric cables.

22,666. A. L. ANDERSON. Manchester. A new or improved chemical generator of electricity.*

22,679. J. L. CUTLER. Glasgow. Electromagnetic appliance.*

22,702. A. J. BOULT. London. Improvements in or relating to electric motors. (O. Patin, France.)

22,707. A. SWEET. London. Improvements in the distribution of electricity.

22,710. H. H. LAKE. London. Improvements in apparatus for the electrolytic extraction of zinc. (Segius Stepanov, Russia.)*

22,754. W. J. DAVY. London. Improvements in or connected with alternating arc lamps.

November 15, 1899.

22,757. W. H. WILLSON and M. S. COVEY. Kingston-on-Thames. Improvements in electromagnetic reciprocating engines.

22,762. E. W. COWAN. Manchester. Improvements in electrical switchboards.

22,784. D. MACDONALD. Kilmarnock. Improvements in telephones.

22,785. F. ROUND. Southport. A tinted film covering an electric lamp.

22,807. H. BECKMANN. London. Improved manufacture of lead peroxide and its application to electrical storage batteries.

22,829. PHELPS' METAL (LIMITED). London. A material or composition suitable for electric battery cases, insulating and other purposes, and method of manufacturing the same. (C. J. Hubbell, United States.)

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SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1898.

15,829. STEELE. Electric arc lamps of the enclosed type.
22,027. NORTHEY and ELECTRIC MOTIVE POWER CO. (LIMITED). Electricity meters.
22,070. LEVETUS. Galvanic batteries.
22,622. MARINO. Electrolytic baths.
22,699. SAYERS and MAYOR and MAYOR AND COULSON (LIMITED). Dynamo electric machines.
22,794. ANDREWS. Electric railways or tramways on a road contact or like systems.
23,155. LEIGH [Gesellschaft zur Verwerthung elektrischer und magnetischer Stramkraft (System Schiemann and Kleinschmidt) Ad. Wilde and Co.]. Electric rail brakes and electromagnets therefor.
23,306. LEVETUS. Galvanic batteries.
24,264. HIRST. Switch for incandescence or glow electric lamps in which the filament is subjected to a preliminary heating effect apart from the lighting current.
25,417. ECK. Switch for electric circuits.
25,746. CHRISTY and CHRISTY. Means for electrically heating ovens, hot chambers, rooms, and the like.
25,961. PELLENZ. Insulator brackets for electric conductors.
26,248. GIBBS. Starting switches for electro-motors or the like.
26,322. DEFOINCY. Apparatus for regulating the difference of potential at the terminals of dynamo-electric and like machines. (Date applied for under International Convention, October 7, 1898.)
26,343. BRAULT. Manufacture and production of plates or elements for secondary batteries or electrical accumulators.
26,604. FRANCIS. Telephonic or other switchboard apparatus.

1899.

537. HIGHFIELD. Pressure regulating apparatus for electric mains used chiefly in connection with storage batteries.
655. COX. Locking and releasing device for electrical switches.
656. COX. Electrical switches.
2,017. DECAM. Electric igniters for gas or oil motors.
2,748. ABEL (Soc. d'Etude des Piles Electriques). Primary electric batteries.
11,930. MICHEL, WILHELM AND RICHARD. Electrolytic apparatus.
12,353. JONES and POCKLINGTON. Conduits for electric conductors.
12,750. CERVENKA and MAHLER. Electric railways and tramways on a road contact system.
13,125. MARTIN and COLVILLE. Apparatus for registering the output of electric light and power stations and for like purposes.
14,687. VOIGT and KUSTERER. Electric magnetic brakes for railway and tramway cars.

COMPANIES' MEETINGS AND REPORTS.

Wireless Telegraph and Signal Co. (Ltd.).

The directors' report for the year ended Aug. 31st last states that 1899 must be considered as another year of experiment and development. But a foundation has now been laid, on which a sound commercial business may be expected to be built at an early date. Since the last meeting communication has been established for the Trinity Board between the East Goodwin lightship and the South Foreland lighthouse, a distance of 12 miles; and between the South Foreland and Wimereux in France, a distance of 32 miles.

Her Majesty's ships "Alexandra," "Europa," and "Juno" were fitted with apparatus, and under the personal charge of Mr. Marconi the system was made great use of during the subsequent naval manœuvres, signals being transmitted a distance of 70 miles. The results were most satisfactory, and it is expected that the company's system of wireless telegraphy will henceforth take its place as part of the equipment of H.M. ships.

The chief features of the meeting of the British Association at Dover during the year 1899 were the interchange of visits between the Association and the corresponding French society, which held its annual meeting at Boulogne; together with the immense interest excited by the company's stations at the South Foreland and Wimereux.

On Nov. 2 six assistants with apparatus sailed, under agreement with H.M. War Office, for South Africa. Naturally the experience of the company's assistants, under Mr. Bullocke, with the Marconi system for the first time in the field during active warfare, is of very great interest.

It is not intended at the meeting on the 29th inst. to do more than propose the adjournment of the meeting to a day to be fixed in January or February, when the directors will place before the shareholders fully the position of the company, which they have every reason to believe will be found satisfactory. Manufacturing premises having been obtained at Chelmsford, machinery and plant have been installed, and the works are now in running order.

The directors recommend that the name of the company should be changed into "Marconi's Wireless Telegraph Co. (Ltd.)," and will propose a resolution giving effect to their recommendation at an extraordinary meeting to be held immediately after the adjourned general meeting.

Mr. William Smith has resigned his directorship, and Major Samuel Flood Page and Mr. Henry Spearman Saunders have joined the board.

The third ordinary general meeting will be held at the offices, 28, Mark-lane, London, E.C., at noon on Friday, 29th inst. The transfer books will be closed from Jan. 1 to 15, inclusive.

CALCUTTA TRAMWAYS CO. (LTD.)—The ordinary general meeting was held on Tuesday. The chairman (Mr. E. C. Morgan) gave a history of the negotiations with the Calcutta Corporation for authority to introduce electric traction. As soon as the first report of the Corporation sub-committee was confirmed by the Commissioners on Aug. 2, the directors considered it desirable to make preparations, so as to avoid delay with the electrical equipment as soon as they were able to let the contract. They had entered into a provisional agreement with a first-class firm of local contractors, who had successfully carried out large works of a similar nature. This firm undertook to provide plans and specifications to the satisfaction of the Corporation, and thereafter to carry out the necessary conversion of the lines at net cost of materials and labour, plus 10 per cent., which was to include all expenses for engineering. The cost of the work was not to exceed a maximum sum to be named by the contractors before the definite contract was signed and to be agreed to by the company, to be subject to abatement should it be found on completion that the cost of materials and labour, plus 10 per cent., fell short of their estimate. They also undertake to maintain their lines for six months. They were not in immediate need of funds, but they proposed to put themselves into a position to take advantage of the first favourable opportunity which might offer by creating a new series of 4½ per cent. debentures for £350,000. This would redeem the existing 5 per cent. debentures for £100,000, pay for the cost of the electrical equipment, and leave them with a reserve for extensions, which would probably be called for as soon as they were able to undertake them. There was no doubt a large field for profitable extensions, having regard to the growing demand for conveyance. He had laid no special stress upon the immense advantages which would accrue to the company when the electrical equipment was complete. They had been running continuously for 20 years, during which time they had gradually created such a demand for riding accommodation, even with the very inadequate means of horse traction, that it had become impossible under the present conditions to cope with it. The traffic was there to be carried if they could only carry it, and the directors had come to the conclusion that the best method to accomplish this would be the overhead system of electric traction. By this means they would not only be able to meet all the requirements of the present traffic, but would provide for future requirements.

ELECTRICAL COPPER CO. (LTD.)—The third ordinary general meeting of this company was held on Wednesday. The chairman (Mr. A. Foulds) regretted that the results for the past financial year had not been up to their expectations, but they had to deal with the commercial application of a new process, they had had to proceed with caution, and to acquire a certain experience prior to erecting plant on a large scale. Besides the difficulties associated with the novelty of the process, the engines required for driving the plant and other portions of the machinery were not erected according to their expectations. He also regretted to say that they had had some difficulties in connection with their management, but had now taken such steps as would prevent a recurrence of the difficulties. They hoped that the new plant, erected under the direction of the experienced staff they had at their service, would lead to satisfactory results. From a technical point of view they had never been disappointed with the process.

NEW COMPANIES, STATUTORY RETURNS, &c.

CECIL WRAY AND CO. (LTD.)—This company was registered on Dec. 12, with a capital of £5,000 in £1 shares, to acquire the business carried on by Cecil Wray, and to carry on the business of metal workers, engineers, and manufacturers of electrical, optical, and other apparatus. The first directors are W. A. Thornton, C. Atkinson and Cecil Wray.

HARRY SOUTH AND CO. (LTD.)—This company was registered on Dec. 15, with a capital of £10,000 in £1 shares, to acquire the business carried on under the style of Harry South, and to carry on the business of electrical engineers, electricians, suppliers of electricity, electrical apparatus manufacturers, &c. The subscribers are M. J. Tilney (electrical engineer), H. E. Winter, J. J. Tustin, T. W. Hale, H. South (engineer), M. Harley, and C. H. Bolton. The first directors are H. South and M. J. E. Tilney (managing).

METAL ELECTRO AMALGAMATING SYNDICATE (LTD.)—This company was registered on Dec. 13, with a capital of £20,000 in £1 shares, to acquire Mr. T. H. Snyder's invention for coating metal by an electrical process, and to carry on the business of electro-platers, metallurgists, chemical manufacturers, electricians, &c. The subscribers are H. Firmin, J. E. Bennett (engineer), H. M. Johnson, J. H. Hall, J. I. Vivian, J. H. Matthew, and M. J. Morley. The first directors are H. Firmin, J. E. Bennett, H. M. Johnson, and J. H. Hall.

SAHLSTROMS (LTD.)—This company was registered on Dec 12, with a capital of £25,000 in £1 shares, to produce, manufacture, sell, and deal in ozone and all electrodes and electrical and other apparatus connected therewith, and to carry on the business of chemical manufacturers, engineers, &c. The subscribers are J. Westaway (engineer), J. E. Harris (engineer), E. F. Strong, C. G. Embleton, W. L. Williams, R. S. Darlasson, and W. H. Nex.

WINCHESTER ELECTRIC LIGHT AND POWER CO. (LTD.—The annual return to Oct. 24 has been filed. The capital is £25,000, in 4,000 £5 shares, of which 2,207 have been taken up.

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CITY NOTES.

MEMORANDA.—Bank rate 6 per cent. (since Nov. 30, 1899). Price of silver 27 1/16d. per oz. (Dec. 21). Consols (2¾ per cent.) 97 5/8—98 1/8 for money, 98 1/8—98 3/8 for account; 2½ per cent. 95—96 (Dec. 21). Stock Exchange Settling Days: Consols, Jan. 4; Stocks and Shares Continuation Days, Dec. 27 and Jan. 10; Ticket Days, Dec. 28 and Jan. 11; Pay Days, Dec. 29 and Jan. 12; Mining Share Carry-over Days, Dec. 23 and Jan. 9.

AFRICAN DIRECT TELEGRAPH CO. (LTD.)—Notice is given that the coupons on this company's four per cent. mortgage debentures, due Jan. 1, will be paid on and after that date at Parr's Bank, Bartholomew-lane, London, E.C. Debenture register is closed from 25th to 30th inst. inclusive.

AKKUMULATORENWERKE OBERSPREE AKTIEN GESELLSCHAFT (BERLIN).—This company has been formed, with a capital of 3,000,000 marks, for the manufacture of the "Majert" accumulator.

AKTIEN GESELLSCHAFT ELEKTRICITATSWERKE, STRASBURG.—This company has been formed, with a capital of 4,500,000 marks, in order to take over certain concessions from the Allgemeine Co., of Berlin.

BLACKPOOL, ST. ANNES AND LYTHAM TRAMWAYS CO. (LTD.)—The directors are contemplating the substitution of electric for gas traction.

CROMPTON AND CO. (LTD.)—An interim dividend at the rate of 6 per cent. per annum for the half year to Sept. 30 is declared, payable Jan. 15, and the transfer books will be closed from 8th to 13th prox. inclusive.

DEUTSCHE TELEPHONEWERKE R. STOCK AND CO. (G. m. b. H.)—This company has been formed to take over the undertaking of Messrs. R. Stock and Co., Berlin, and has a capital of 3,000,000 marks.

EASTERN EXTENSION, AUSTRALASIA AND CHINA TELEGRAPH CO. (LTD.)—The coupons of this company's five per cent. Australian Government subsidy debentures, due Jan. 1, will be paid on and after that date by Messrs. Barclay and Co. The directors have declared an interim dividend for the quarter ended Sept. 30 of 2s. 6d. per share, free of tax, payable Jan. 15. The share register will be closed from 6th to 13th prox. inclusive.

GREAT NORTHERN TELEGRAPH CO.—Coupons due Jan. 1 should be presented for payment to Messrs. C. J. Hambro and Sons, 70, Old Broad-street, London, E.C.

MEXICO ELECTRIC TRAMWAYS CO. (LTD.)—Coupons (No. 3 first issue and No. 1 second issue) of the five per cent. debentures, due Jan. 1, are payable at the offices, 55 and 56, Bishopsgate-street Within, London, E.C.

PACIFIC AND EUROPEAN TELEGRAPH CO. (LTD.)—The coupons on this company's four per cent. guaranteed debentures, due 31st inst., will be paid by Parr's Bank (Ltd.), Bartholomew-lane, London, E.C.

PERTH AND DISTRICT TRAMWAYS CO. (LTD.)—In their report the directors state that the Corporation desire to acquire the undertaking, but no definite proposal has yet been submitted. The directors do not therefore propose to take further steps to introduce mechanical traction.

RUSSISCHE ELEKTRICITATS GESELLSCHAFT SIEMENS AND HALSKE.—A dividend of 5½ per cent. has been declared for the year 1898-9, against 6½ per cent. in the previous year.

SOCIETA PER LE TRAMVIE ELETTRICHE DI TERNI.—This company has been formed in Rome, with a capital of £40,000, to establish an electric tramway in the town of Terni.

WESTERN TELEGRAPH CO. (LTD.) (late Brazilian Submarine Telegraph Co., Ltd.)—Notice is given that the coupons on this company's second issue of Five per Cent. Debentures, due 31st inst., will be paid at Parr's Bank, Bartholomew-lane, London, E.C.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	1899	£	£		£	£
*Birmingham Tramways.	Dec. 16	3,502	+ 345	24	99,500	+ 10,156
Blackpool Corporation...	„ 14	111	- 8	37	20,420	+ 4,358
Blackpool and Fleetwood	...	...	...	...	...	...
Bradford Corporation ...	„ 17	302	+ 61	70	23,271	...
Brisbane Trams	Nov. 1	1,669	+ 528	5	7,815	+ 2,638
*Bristol Trams & Carriage	Dec. 15	2,342	- 208	24	74,422	+ 8,331
*Buenos Ayres & Belgrano	Nov. 19	2,092	+ 666	46	99,453	+ 44,528
City & South London Ry.	Dec. 17	1,151	+ 71	25	24,801	- 32
Dover Corporation	„ 16	126	- 13	37	7,889	+ 1,030
Dublin United	„ 15	2,832	+ 147	...	...	...
Dublin Southern Dist....	„ 15	594	- 20	...	...	...
*Glasgow Corporation ...	„ 16	7,890	- 294	...	...	...
*Liverpool Corporation...	„ 9	6,801	+ 773	49	337,897	+ 40,940
Liverpool Overhead Rly.	„ 17	1,432	+ 108	24	40,370	+ 1,991
*Sheffield Tramways	„ 17	1,606	- 139	51	72,923	+ 20,367
*South Staffs. Trams.....	„ 15	527	- 76	50	33,178	+ 1,625

* Partly electrical.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	NAME.	Previous Week's Price, Dec. 13.	Price Wednesday, Dec. 20.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Dec. 20. Highest	Lowest
			TELEGRAPHS.			£ s. d.			
£110,900	100	4%	*African Direct Telegraph 4% Mort. Deb. (red.)	100 104	100 104	3 16 11	January and July	...	...
25,000	10	..	Amazon Telegraph	3 4	3 4	...	June and December	...	...
£125,000	100	5%	Do. 5 per Cent. Debentures	85 90	85 90	5 11 1	...	...	...
£875,520	Stock	15/0	Anglo-American	65 68	66 68	5 5 6	Feb., May, Aug., Nov.	65	...
£3,062,240	Stock	30/0	Do. Preferred	115½ 116½	113 115	5 5 3	„ „	116	113½
£3,062,240	Stock	18/0	Do. Deferred	16½ 17½	15½ 16	5 12 6	...	16⅞	15¼
205,993	10	3/0	Brazilian Submarine xd	14¾ 15¼	14¾ 14¾	4 14 11	Mar., June, Oct., Dec.	...	...
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1900)	107 111	107 111	4 11 6	June and December	...	...
$10,000,000	$100	$1⅛	Commercial Cable Capital Stock	198 202	198 202	3 19 9	Jan., Apr., July, Oct.	...	...
£1,332,823	Stock	4%	* Do. 4 per Cent. Debenture Stock	103 105	103 105	3 16 6	„ „	103½	102
16,000	10	8/0	Cuba Submarine Ordinary	8½ 9½	8½ 9½	8 8 5	February and August	9 1/16	...
6,000	10	10,0	Do. Preference 10 per Cent.	19 20	19 20	5 0 0	„ „	...	...
12,981	5	2/0	Direct Spanish Ordinary	4 5	4 5	4 0 0	April and October	...	...
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference	9 10	9 10	5 0 0	„ „	...	...
£30,000	50	4½%	Do. 4½ per Cent. Debentures	103⅞ 107⅞	103⅞ 107⅞	4 4 1	January and July	...	...
60,710	20	3 0	Direct United States Cable	11¼ 12¼	11¾ 12¾	5 14 3	Jan., Apr., July, Oct.	12	...
£120,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red.)	101 104	101 104	4 7 10	June and December	...	...
£4,000,000	Stock	5%	Eastern Ordinary	150 155	145 150	4 14 1	Jan., Apr., July, Oct.	154	145
£1,795,000	Stock	3½%	Do. 3½ per Cent. Preference Stock	98 101	98 101	3 9 8	„ „	100	99⅞
£1,432,268	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.)	115 120	115 120	3 6 11	May and November	116	115½
250,000	10	2/6	Eastern Extension	15 15½	14¾ 15¼	4 11 10	Jan., Apr., July, Oct.	15	10½
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	116 121	118 121	3 6 7	February and August	121	1.6
£16,200	100	5%	* Do. 5% (Austln. Gov. Sub.) Deb., 1900 (reg.)	99 103	99 103	4 17 4	January and July	...	...
£64,400	100	5%	Do. (Bearer)	100 103	100 103	4 17 1	„ „	...	...
£17,400	100	5%	*Eastern and S. African 5% Mort. Deb., 1900 (reg.)	99 103	99 103	4 17 1	„ „	...	...
£24,500	100	5%	Do. (Bearer)	100 103	100 103	4 17 1	„ „	...	...
£300,000	100	4%	* Do. 4 per Cent. Mortgage Debentures, 1909	101 104	101 104	3 16 11	February and August	101	...
£200,000	25	4%	Do. 4 per Cent. Mauritius Sub. Debs. (red.)	101⅞ 102⅞	101⅞ 102⅞	3 16 10	May and November	...	...
180,227	10	1/9	Globe Telegraph and Trust	11¼ 11¾	10¾ 11¼	4 13 4	Jan., Apr., July, Oct.	11⅜	10⅞
180,042	10	3/0	Do. 6 per Cent. Preference	15¼ 15¾	11⅞ 12⅜	3 18 8	„ „	15⅜	14¾
150,000	10	5/0	* Great Northern of Copenhagen	31 33	31 33	3 15 9	January and July	31¼	...
£86,300	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb. (red.)	100 103	100 103	4 7 5	...	...	...
17,000	25	12/6	Indo-European	48 52	48 52	4 16 2	May and November	...	...
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904	106 109	106 109	5 10 1	March and September	...	...
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.)	102 105	102 105	3 17 6	June and December	...	...
11,839	8	4/0	Reuter's	7 8	7 8	5 0 0	April and October	...	...
3,381	£100 Cert.	6%	Submarine Cables Trust	126 131	125 130	4 13 0	„ „	...	...
15,609	10	...	West African Telegraph	2½ 3½	2½ 3½	4 9 3	December and July	...	...
£200,000	100	5%	* Do. 5 per Cent. Debentures (red.)	99 102	99 102	4 18 0	March and September	98	...
30,008	2½	...	West Coast of America	¼ 1	¼ 1	...	...	...	...
£150,000	100	4%	* Do. 4 per Cent. Debentures	102 105	102 105	3 16 8	January and July	...	...
88,321	10	6d.	West India and Panama	⅞ 1⅛	⅞ 1⅛	...	May and November	1	...
34,563	10	6/0	Do. 6 per Cent. 1st Preference	9½ 9⅝	9½ 9⅝	6 3 1	„ „	...	...
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	7⅞ 8½	7⅞ 8⅛	7 1 2	„ „	...	...
£80,000	100	5%	* Do. 5 per Cent. Debentures	106 109	106 109	4 13 7	January and July	...	...
£389,731	Stock	4%	Western & Brazilian 4 per Cent. Debenture Stock	104 107	104 107	3 15 0	June and December	...	...
£158,100	100	6%	*Western Union 6 per Cent. Sterling Bonds (red.)	98 103	98 103	5 16 6	March and September	...	...

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Dec. 13.	Price Wednesday, Dec. 20.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Dec. 20. Highest	Lowest
			TELEPHONES.			£ s. d.			
44,000	£5	3/0	Chili Telephone (fully paid)	2 3	2 3	6 13 4	August	...	...
£24,850	10s.	0/1½	Consolidated Telephone Const. & Manufacturing	¼ ¼	¼ ¼	4 15 3	July	...	...
72,680	1	0/6	Monte Video Telephone Ordinary	¼ ¼	¼ ¼	5 0 0	October	...	...
86,492	1	1 0	Do. 5 per Cent. Preference	¾ 1	¾ 1	5 0 0	...	...	...
490,000	5	3/0	National	5 5½	5 5½	5 14 3	February and August	5	4¾
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Preference	14 15	14 15	4 0 0	,, ,,	14½	...
15,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference	14 15	14 15	4 0 0	,, ,,	...	...
250,000	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref.	5½ 5½	5½ 5½	4 13 0	,, ,,	5½	...
1,329,471	Stock	3½%	* Do. Debenture Stock 3½ per Cent. (red.)	100 102	100 102	3 8 8	June and December	101	100¾
171,504	1	0/4	Oriental	¾ 1	¾ 1	5 0 0	April and October	...	...
58,000	5	6/0	United River Plate	4¾ 5½	4¾ 5½	5 14 3	July	...	...
16,639	5	...	Do. 5% Cumulative Preference (£3. 10s. paid	3½ 3¾	3½ 3¾	...	...	...	...
£179,947	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	105 108	105 108	4 13 9	June and December	105½	...
			ELECTRICITY SUPPLY COMPANIES.						
100,000	1	...	Bl'okh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.)	¾ 1	¾ 1	...	...	...	...
6,000	10	7/9½	Bournemouth and Poole Elec. Supply Ord...x rights	12½ 13½	12 13	3 0 0	...	...	...
6,000	10	4/6	Do. 4½ per Cent. Cumulative Pref. ...x rights	10 11	10 11	4 1 10	...	...	...
19,661	5	2/6	Brompton & Kensington Electricity Supply Ord.	7½ 8½	7½ 8½	3 15 0	...	...	...
12,000	5	3/6	Do. 7 per Cent. Preference	9 10	9 10	3 10 0	March and September	...	...
20,000	5	...	Calcutta Elec. Supply Ordinary (£4 paid)	6½ 7	6½ 7	...	...	...	...
30,000	5	4/0	Charing Cross & Strand Electricity Supply Corp.	10 11	9½ 10½	4 5 9	February and August	10	9½
20,000	5	...	Do. (Nos. 3,001 to 50,000)	9½ 10½	9½ 10½	...	...	...	...
20,000	5	2/3	Do. 4½ per Cent. Preference	5½ 6½	5½ 6½	3 12 0	,, ,,	...	...
34,000	5	2/6	Chelsea Electricity Supply Ordinary	7½ 8½	7½ 8½	3 10 7	March	...	...
£100,000	Stock	4½%	* Do. 4½ per Cent. Debenture Stock (red.) ...xd	111 113	109 111	4 1 1	June and December	...	...
$1,200,000	$1,000	5%	Chicago Edison 1st Mort. 5% 30 years Gold Bonds (red.)	100 110	100 110	4 10 11	April and October	...	...
60,000	10	7/0	City of London Electric Lighting Ordinary	11 12	10 11	5 9 1	February and August	11½	...
40,000	10	6%	Do. 6 per Cent. Cumulative Preference	13 14	13 14	4 5 9	January and July	...	...
£400,000	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	125 130	125 130	3 17 5	June and December	126½	...
40,000	10	...	County of London and Brush Prov. Ordinary	10 11	10 11	...	...	...	...
20,000	10	6/0	Do. 6 per Cent. Cumulative Preference	13 14	13 14	4 5 9	March and September	...	...
£200,000	Stock	7/8	Do. 4½% Deb. Stock Certs. (all pd.) (red.)	111 114	110 113	...	...	...	...
15,000	5	10%	Kensington and Knightsbridge Ordinary	12½ 13½	12½ 13½	4 1 6	...	...	...
10,000	5	6%	Do. 6 per Cent. 1st Preference	7½ 7¾	7½ 7¾	3 17 5	January and July	...	...
110,000	3	...	London Electric Supply Ordinary	2½ 3	2½ 2¾	...	...	2¾	...
48,050	5	3/0	Do. 6 per Cent. Preference	5½ 6½	6 6½	5 0 0	...	...	...
£100,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures...xd	104 106	103 104	3 16 11	Mar., June, Sept., Dec.	...	...
62,500	10	5/0	Metropolitan Elec. Supply Ord. (Nos. 1 to 62,500)	13½ 14½	13 14	3 11 5	April and October	14½	13¾
22,500	10	3/7½	Do. (Nos. 62,501 to 85,000)	13½ 14½	13 14	3 10 0	...	...	...
£220,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage	117 119	117 119	3 15 7	June and December	...	...
£125,000	Stock	...	Do. 3½ per Cent. Mort. Deb. Stock (red.)	97 99	97 99	...	...	...	...
6,452	10	6/0	Notting Hill Electric Ordinary	15½ 16½	15½ 16½	3 15 0	March	...	...
10,000	5	5/0	Oxford Electric Ordinary	6¾ 7½	6¾ 7½	3 9 0	,,	...	...
300,000	1	8%	Rand Electric	¾ ¾	¾ ¾	10 13 4	...	...	...
£130,070	Stock	5%	River Plate El. Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb.	80 90	80 90	5 11 1	...	...	...
150,000	$100	$2	Royal Electric Company of Montreal Shares	160 180	160 180	4 8 11	...	...	...
£123,200	100	4½%	* Do. 4½ per Cent. 1st Mortgage Debentures	104 106	104 106	4 5 6	April and October	...	...
31,980	5	5/0	St. James's and Pall Mall Electric Ordinary	15½ 16½	15 16	4 10 3	February and August	15½	...
20,000	5	3/6	Do. 7 per Cent. Preference	9 9½	9 9½	3 13 8	,, ,,	...	...
65,000	5	...	South London Electric Supply Ordinary (fully paid)	4½ 4¾	4½ 4¾	...	...	...	...
79,900	5	5/0	Westminster Electric Supply Ordinary	14 15	13½ 14½	4 2 9	March and September	15½	15¼
			ELECTRIC MANUFACTURING, &c., COMPANIES.						
125,000	1	7½d.	Aron Electricity Meter 6 per Cent. Cum. Pref.	¾ ¾	¾ ¾	6 17 2	...	...	...
40,000	5	5/0	British Insulated Wire Ordinary	11½ 12½	11½ 12½	4 0 0	...	...	...
27,500	5	3/0	Do. Preference	6½ 6¾	6½ 6¾	4 8 11	...	...	...
90,000	2	2/0	Brush Electrical Engineering	1¾ 2	1¾ 2	5 0 0	September	...	...
90,000	2	1/2½	Do. 6 per Cent. Pref. Non-Cumulative	2¼ 2½	2¼ 2½	5 1 1	,,	...	...
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Deb. Stock	110 115	110 115	3 18 6	February and August	...	...
£50,000	Stock	4½%	* Do. 2nd Debenture Stock (red.)	104 107	104 107	4 4 11	June and December	...	...
20,000	5	5/0	Callender's Cable Construction Ordinary	13 14	12½ 13½	5 14 1	,, ,,	...	...
20,000	5	...	Do. 5 per Cent. Cumulative Preference	5½ 6	5½ 6	...	...	...	...
£90,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb. (red.)	113 116	113 116	3 18 7	November and May	...	...
300,000	1	0/9½	Castner-Kellner Alkali Co. (fully paid)	1½ 1¾	1⅜ 1⅝	5 16 5	...	...	...
60,000	1	0/7½	Chadburn's Ship Telegraph Ordinary	⅜ 1⅛	⅜ 1⅛	5 6 8	...	...	...
60,000	1	0/7½	Do. 6 per Cent. Cumulative Preference	⅜ 1⅛	⅜ 1⅛	5 6 8	...	...	...
32,098	3	2/1½	Crompton and Co. (Nos. 1 to 32,098)	3¾ 4	3¾ 4	4 10 9	January and July	...	...
£100,000	100	5%	* Do. 5 per Cent. First Mortgage Deb. (red.)	100 103	100 103	4 17 10	,, ,,	...	...
60,000	1	0/3	Davis and Timmins 6 per Cent. Cum. Pref.	¾ 1	¾ 1	...	...	...	...
99,261	5	1/9½	Edison and Swan United ("A" Shares) (£3 paid)	2 2½	2 2½	7 4 0	February and August	...	...
17,139	5	2/9½	Do. (£5 paid)	3¾ 4¼	3¾ 4¼	6 13 4	,, ,,	...	...
£314,023	Stock	4%	Do. 4 per Cent. Mortgage Deb. Stock (red.)	95 97	95 97	4 2 6	June and December	...	...
26,100	5	5/11½	Edmundson's Electric Corporation Ord. (fully pd.)	5 5½	4¾ 5½	5 14 3	Half-yearly	...	...
112,100	2	1/2½	Electric Construction Co. (Limited)	2 2½	2 2½	5 2 3	January and July	...	...
25,000	2	2/9½	Do. 7 per Cent. Cumulative Preference	2½ 3½	2½ 3½	4 6 2	July	...	...
182,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	104 107	104 107	3 15 8	January and July	...	...
91,195	1	...	Elmore's Patent Copper Depositing	⅜ ½	⅜ ½	...	...	...	...
30,000	5	...	Henley's Telegraph Works Ordinary	12 13	12 13	...	February and August	...	...
15,000	£5	...	Do. 4½ per Cent. Preference	5 5½	5 5½	4 1 10	,, ,,	...	...
£50,000	Stock	4½%	Do. 4½ per Cent. Mortgage Deb. Stock (red.)	111 114	111 113	4 0 9	,, ,,	...	...
50,000	10	5/0	India Rubber, Gutta Percha, &c., Works	21 23	21 22	4 8 11	,, ,,	...	...
£300,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	100 104	100 104	3 16 11	March and September	...	...
37,350	12	12/0	Telegraph Construction and Maintenance	36 40	36 40	4 10 1	March and July	...	...
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909	103 106	103 106	3 15 6	...	...	...
20,000	5	3/0	Do. Manufacturing Ordinary	9 10	9 10	3 10 0	...	9¾	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5½ 6	5½ 6	4 3 4	...	...	...
30,000	5	5/0	Willans and Robinson Ordinary	10½ 11	10½ 11	4 1 10	April and October	...	...
30,000	5	3/0	Do. 6 per Cent. Cumulative Preference	7 7½	7 7½	4 0 0	,, ,,	...	...
£100,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Debentures xd	104 106	104 106	4 0 2	May and November	...	...
			ELECTRIC RAILWAYS, TRAMWAYS, &c.						
12,000	10	6/0	Blackpool and Fleetwood Tramways	17 19	17 19	3 13 8	...	...	...
£167,900	100	5%	Brisbane Tramway 5 per Cent. Debentures	104 106	104 106	4 14 4	...	...	...
50,000	10	7%	Bristol Tramways and Carriage Ordinary	23 24	23 24	2 17 2	February and August	...	...
25,000	10	...	Do. Cumulative Preference (£4 paid)	4¾ 4¾	4¾ 4¾	...	...	...	...
£100,000	Stock	4%	Do. 4 per Cent. Debentures	118 119	118 119	3 7 3	...	...	...
30,000	10	9 0	British Electric Traction Ordinary	16½ 17½	15 16	1 11 3	...	15½	1 ⅛
30,000	10	6/0	Do. 6% Cum. Pref. (Nos. 30,001 to 60,000)	13 13½	12¾ 13½	4 8 11	...	13⅝	13
£200,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures	126 129	125 128	3 18 6	...	...	...
40,000	5	1/9	Buenos Ayres & Belgrano 6% "A" Cum. Pref.	5½ 5¾	5½ 5¾	5 11 7	...	5¾	...
27,500	5	...	Do. "B"	4¾ 5¼	4¾ 5¼	...	...	...	...
265,585	Stock	5%	Do. 5 per Cent. Debentures	108 111	108 111	4 10 1	...	...	...
35,250	10	3/0	Central London Ordinary	10½ 10¾	9¾ 10½	2 18 6	June and December	10⅛	10¼
178,303	10	2/4 1/6	Do.	... ...	... ...	...	,, ,,	...	...
£955,000	Stock	2½%	City and South London Railway Con. Ordinary	61 61	59 62	3 8 6	January and July	62	61
37,000	10	...	Do. (Nos. 22,501 to 60,000) (£4. 10s. paid)	3¾ 4¼	3¾ 4¼	...	...	...	...
£150,000	Stock	5%	Do. 5 per Cent. Perpetual Preference (1891)	143 148	143 148	3 8 0	January and July	...	...
£200,000	Stock	5%	Do. (1896)	135 140	135 140	3 11 11	...	...	...
£87,701	Stock	4%	Do. 4 per Cent. Perpetual Debenture	127 133	127 133	3 3 0	May and November	...	...
20,000	10	7½%	†Imperial Tramways Ordinary ...x new	23 24	23 24	...	March and September	...	...
19,000	10	6%	† Do. 6 per Cent. Preference ...x new	15½ 15¾	15½ 15¾	3 13 10	,, ,,	...	...
£200,000	Stock	4½%	† Do. 4½ per Cent. Debenture ...x new	115 116	115½ 116½	3 17 6	January and July	...	...
30,000	10	1/3	Kidd'rm'nst'r & Dist. E.L. & Tr'ct'n 5% Pref. (£6 pd.)	6 6½	6 6½	4 10 11	May and November	...	...
37,500	10	2½%	Liverpool Overhead Railway Ordinary	8⅛ 9⅛	8⅜ 8⅝	3 15 4	February and August	...	...
10,000	10	5%	Do. 5 per Cent. Preference	13½ 13¾	13 13½	3 14 1	,, ,,	...	...
125,000	Stock	4%	Do. 4 per Cent. Debenture	104 106	106 108	3 16 3	January and July	...	...
24,000	5	...	New General Traction Ordinary	3½ 4½	3½ 4	...	...	...	...
30,000	5	6/0	Do. 6 per Cent. Cumulative Preference	5 5½	5 5½	5 9 1	May	...	...
4,000	10	...	Oldham, Ashton and Hyde Elec. Tramway Ord.	19 19½	18 19	...	February and August	...	...
4,000	10	5/0	Do. per Cent. Preference	10½ 10¾	10½ 10¾	4 11 11	,, ,,	...	...
13,334	10	...	Potteries Electric Traction Ordinary	12 13	11½ 12½	...	...	...	...
20,000	10	5/10	Do. 5 per Cent. Cumulative Preference	10 11	10 11	4 10 11	...	...	...
£510,000	Stock	3%	Waterloo and City Ordinary	101 104	100 103	2 18 6	June and December	...	...

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption.

† The London Stock Exchange Committee refuses to quote these.

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THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1128. [Vol. No. 10. XLIV.] FRIDAY, DECEMBER 29, 1899. PRICE SIXPENCE (by post, 6½d.), Abroad, 8d., or 15 cents, or 80/r., or 70pf.

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NOTES.

ON Wednesday, the Glasgow Tramways Committee, after an interval of two months, once again recommended the acceptance of the National Conduit and Cable Co.'s tender to supply £151,000 worth of cable for new tramway feeders, this figure being, it is stated, £10,000 lower than the amount of the lowest tender of an English firm. It is difficult to believe that a manufacturer in New York can sell cable at a profit in Glasgow cheaper than a rival maker in this country, and one cannot but wonder whether all the facts of the case are known. If the National Conduit and Cable Co. had already a contract for other street work in Glasgow, for instance, this might afford some explanation of their present position. The matter is to come up for consideration at the next meeting of the Glasgow Corporation, and then possibly some light may be thrown upon it. We believe that the two months' delay has been in order that samples might be prepared by the various firms tendering and be subsequently submitted to an independent expert.

IN another column we publish an article on rubber substitutes by Mr. H. L. TERRY, who has on previous occasions contributed articles to our columns on the same subject. While endorsing what Mr. TERRY says on the necessity of caution in adopting these substitutes, we do not despair of a reliable one being found eventually which will combine sufficiently good electrical properties and durability with equal mechanical strength and waterproof properties. On the other hand, there are many applications in which either rubber substitutes or "seamless" rubber insulation may be tried experimentally before they are used to insulate deep-sea cables. The maintenance of a Pacific cable, even if covered with the best gutta-percha, will, if such a cable is laid, be far more difficult than the advocates of Pacific cable schemes imagine, but to handicap such an enormous experiment with the added uncertainty of a new method of insulation would be sheer folly.

OUR experience of German rubber-insulated cables does not bear out that of Mr. TERRY'S informant, but we must confess that it was not obtained in St. Petersburg. No doubt both good and bad indiarubber is made in Germany just as it is in England, and probably examples of hale and hearty 14-year-old rubber insulation may be found in England as well as in Russia when circumstances have been propitious. We hope that Mr. TERRY will continue his investigations on the subject of deterioration, and will find out to what quality of the material this is due and how this quality may be eliminated, or, at all events, its presence detected. Failing this, if deterioration is proved to be due to external influence, how may this be guarded against? We fear that his hypothesis as to the effect of resins is not complete. In order to obtain gutta-percha at its best, the resins contained in the raw material must be extracted, as was explained by the late Dr. OBACH in his Cantor Lectures at the Society of Arts two years ago. On the other hand, it will be remembered that Prof. HUGHES has found that resin oil acts as a preservative and a heater to gutta-percha cables. However, as we have pointed out on previous occasions, a rubber or gutta-percha substitute need not and should not be an imitation of either material. Although each of these may be the best insulator we possess to fulfil certain conditions, neither comes up to the ideal.

THE Bonn electricity supply station, described in another part of this issue, is the first one to employ a continuously earthed bare middle wire on a three-wire system at 2 × 220 volts pressure. Although there are many interesting particulars in this article, which is abstracted from a German contemporary, it is to be regretted that more is not said upon such details as the size and nature of the distributing cables and the methods employed in the interior wiring of the houses. In the absence of the last-mentioned information, it is reasonable to suppose that the house wiring

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is carried out with both poles insulated, and not by the bare or semi-insulated return method advocated by Prof. S. P. Thompson. Neither is it quite clear whether the feeders to the central feeding point from which the branch feeders (if we may call them so) radiate have all three conductors insulated, or only the outers. The whole drop of 2×50 volts allowed between the station and the feeding points is considerable; and, although the station has been running nearly a year, it is still not long enough to decide whether electrolysis is playing havoc with the pipes of sister services. Even with the elaborate arrangements employed for balancing the two sides of the network, the part of this 2×50 volts lost on the middle wire may reasonably be expected to exceed the seven volts which our own Board of Trade allows on uninsulated traction return circuits. On the other hand, it is convenient, for testing purposes at all events, that the telephones at Bonn are on the single-wire system, for early notice will no doubt be given at the electric supply station of undue leakage. We believe that Mr. Quin at one time found the telephone indicators of the Blackpool exchange most convenient for localising faults on his network.

A regrettable accident, reported in another column, occurred at Bolton last Friday. Three men had descended into a transformer chamber containing four transformers, with the intention of removing one of a pair which were coupled together. After switching off and disconnecting the transformer, it appears that the loose ends of the wires were left hanging, and by a mistake in switching on again these ends were made live and two of the men received fatal shocks. In the circumstances, and taking due note of the fact that the men were not authorised by Mr. Ellis, the engineer-in-chief, to carry out the work in question while the mains were charged, it is evident that no blame can attach to him for the unfortunate occurrence. In his evidence Mr. Ellis acknowledged that these chambers were a danger at Bolton, and it is gratifying to hear that they are being abolished as quickly as possible. The supply is being gradually converted from the alternating-current transformer system to the continuous-current three-wire system.

Opening of the Aberdeen Electric Tramways.—The formal opening of the first line of the Aberdeen Corporation electric tramways took place on Saturday last.

Anglo-French Telegraphic Convention.—The telegraph convention between Great Britain and France was approved by the French Senate on Saturday.

Cable Interruptions.	Date of Interruption.
Latakia—Cyprus	June 21, 1899
Cayenne—Pinhieros	Oct. 11, 1899
Zanzibar—Mombassa	Oct. 27, 1899
Mozambique—Lourenco-Marquez	Dec. 17, 1899

Lectures on Motors.—On Thursday, Jan. 10, Prof. C. A. Carus-Wilson will commence a course of lectures to the students of the Electrical Standardising, Testing and Training Institution upon "The Construction and Use of Motors."

Erratum.—In the appendix to the report of the Copper Committee, printed on p. 302 of our last issue, the last two lines in the table for solid wires should read—

Weight per mile in lbs.... 20,350 × area in sq. in.
Ditto per yard ,, ... 11·5625 × area in sq. in.

King's College, London.—The Lent term commences on Thursday, January 18th. Particulars of the course of instruction in the engineering, architecture, and applied science division of the faculty of science, &c., are given in an advertisement.

Eastern European Telegraphs.—The *Standard* announces that the Hungarian, Servian, Bulgarian, and Turkish Governments are about to erect a new and direct telegraph line from Budapest to Constantinople viâ Belgrade, Sofia, and Adrianople. This will be the shortest land-line route from West to East, and would probably be used for telegraphic correspondence between Western Europe and Constantinople, instead of the existing line viâ Roumania.

The French Académie des Sciences.—The annual meeting of the above institution was held on the 18th inst., and was presided over by the new president, M. Van Tieghem, who delivered his inaugural address. The awards and premiums for the past session were announced, among which are the following: The La Caze Prize, to M. Blondlot, for his contributions to electricity; the Wilde Prize, to Dr. P. Zeeman; and the Gaston Planté Prize, to M. Leblanc, for his investigations in single-phase and polyphase alternating currents.

Paralleling Alternators.—Our esteemed contemporary the *Engineer* publishes in its last issue a leading article describing "The Working of Electric Light Stations" for the benefit of those of their readers who are not familiar with such matters. "As the alternating current, according to such authorities as Thompson, promises soon to be the favourite form of current employed," it confines its attention to what goes on in stations generating it. In consequence, nearly half of the article is devoted to a description of the method of paralleling alternators, it being stated that from 15min. to 20min. is not an unusual time for this operation to take.

Joseph Henry's Scientific Apparatus.—The trustees of the Princeton University have been invited, says the *Electrical Review* of New York, to put on exhibition at the Paris Exhibition next year the electrical apparatus of the late Prof. Joseph Henry with which his celebrated experiments were made. These are of great value, because of the early date of their invention and use, and the trustees have decided not to allow them to be taken to Paris. The collection includes a large magnet, capable of lifting 3,500lb., the original magnet with which Henry's experiments on induction were made, the magnet and hammer of the first telegraph line ever operated, and wire spirals, insulated on glass cylinders, used for magnetising needles by electrical discharge.

Increased Use of Electrical Power in Buffalo.—Our contemporary, *Electricity* of New York, has an interesting note on the growing popularity of electrical power in Buffalo. Since November 15, 1896, when electric current was first switched on between Magara and Buffalo, the electrical power used has rapidly grown from 1,000 h.p. to 11,000 h.p. This success is all the more striking because of the low price of coal in Buffalo, which meant that one electrical horse power would have to be delivered from Niagara to Buffalo, a distance of 25 miles, at a cost not exceeding one cent, in order to compete successfully with the steam power then in vogue. Originally the Buffalo Railway was the only consumer, but now a large number of manufacturers, in addition to the City Corporation, are supplied with power by the Niagara Falls Co.

The Yukon Telegraph Line.—Some interesting information respecting the telegraph line to the Yukon is quoted by the *Electrical World* of New York as having been given by Mr. J. B. Charleson, of the Public Works Department, Ottawa, who superintended its construction. The exact distance from Bennett to Dawson is 740 miles, and the cost of the line about $137,000. There were no horses engaged in carrying on the work of construction, most of the carrying being done by scows on the river. Where the Big Salmon River enters the Yukon, the former had to be crossed, the distance being 900ft., the very rapid current preventing the laying of a cable, so the wire was strung above the river at a height of 70ft. Connection was made with Dawson at six o'clock on the evening of Sept. 28th, and on that evening $400 was taken for messages. The line has already netted the Dominion Government nearly $15,000.

The Cape-St. Vincent Cable.—It is announced that the Telegraph Construction and Maintenance Co. will not be able

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to dispatch the Ascension–St. Vincent section of the third cable connecting Great Britain with South Africa until towards the end of January. On the arrival of the ship with the cable on board, the task of paying out will occupy about 12 days, including the shore end connections. Meantime the Government has considered the possibility of both the present cables breaking down, and have chartered two 10-knot Elder-Dempster boats for service at Ascension and Sierra Leone, so that in such an emergency messages can be taken from Ascension to Sierra Leone, and then dispatched by the ordinary route to England, or *vice versâ*. In the event of the west coast cable being broken north of Sierra Leone whilst the east coast route was also down, a vessel would be available to take messages direct from Ascension to St. Vincent. This would mean a delay of at least four days even to Government dispatches.

Newcastle-on-Tyne Students' Association of Institute of Civil Engineers.—A Paper was read before the members of the above association on December 20th, by Messrs. W. Hall and E. P. Harvey, on "Some Power and Traction Stations in America." The authors, who had recently toured through America, and could therefore speak of the schemes they referred to from experience, divided their subject into three sections. (1) Electric traction in Washington: English and American traction practice were contrasted, and the power station and line of the Capitol Traction Co., of Washington, described. Reference was also made to the system of accumulator charging in the Electric Vehicle Co.'s charging station in New York, the hand labour involved being a minimum. (2) Chicago West Side Elevated Railway. This railway was opened in 1895, and last year carried 202,700,000 passengers. (3) Descriptions of some hydraulic stations, viz.: (*a*) The Lachine Rapids; (*b*) Chambley; and (*c*) Niagara.

Two New Electric Supply Stations.—The ceremony of turning on the electric light in the town of Wigan was performed on December 20th. The present station is only a temporary one, the Corporation erecting a large one under the superintendence of the consulting engineer, Mr. H. Collings Bishop. It is intended eventually to supply power for traction and for a large motor load, in addition to the lighting. The system is a three-wire continuous-current one at 2 × 230 volts pressure. The present temporary plant is capable of supplying only about 5,000 8 c.p. lamps, but the new works, which are to be opened about September, 1900, will have a considerably greater capacity.—A similar ceremony was performed in Whitechapel on December 21st, when a temporary station was formally opened prior to the erection of the larger building, on which, including the cost of the equipment, a sum of £70,000 is being spent. Mr. Arthur Wright is the consulting engineer, and Mr. W. C. Tapper the resident engineer. The work has been carried out very expeditiously, the contracts having been signed no earlier than April last, since when 31 miles of mains have been laid, the temporary power house erected, machinery and accumulators installed, and 60 public arc lamp columns put up. The total capacity of the present plant is 400 kw., not including the battery of 260 cells of 130 kw. capacity. The principal contractors are the British Insulated Wire Co., Willans and Robinson, Mather and Platt, the Tudor Battery Co., Crompton and Co., and Babcock and Wilcox.

An Electrically-Equipped Watch Factory.—One of the leading watch manufactories in the world, the Elgin National Watch Co., of Illinois, having an output of about 2,000 movements per day, has recently been equipped electrically for light and power purposes. The *Western Electrician* of Chicago in a recent issue describes this plant in some detail. Three-phase current at 220 volts is employed, the armatures being star connected. As this works out to a pressure of 127 volts between each wire and the neutral point, a fourth main is employed, on which are connected 127 volt incandescent lamps, the motors being of the induction type, and connected, of course, to the three wires in the ordinary manner. The boiler house is equipped with ten 80 H.P. fire-tubular boilers, generating steam at 90lb. pressure. The generators are of the revolving armature General Electric type, producing three-phase current at 60 ∞ per sec. Two of these generators are 12-pole, 150 kw. machines running at 600 revs. per min., and a third generator has a capacity of 50 kw., and is an 8 pole machine running at 900 revs. per min. The 150 k.w. units are belt-driven by simple horizontal Brown engines with 6in. cylinders and 42in. stroke, running at 102 revs. per min., the 50 kw. unit being driven by a 60 H.P. centre-crank, simple Ball engine. Belted to each generator shaft is an exciter having capacity of 36 amperes at 125 volts when running at 1,100 revs. per min. All told, the establishment is equipped with 33 induction motors, ranging in size from 1 H.P. to 20 H.P., the aggregate connections amounting to 231 H.P. and 4,500 incandescent lamps.

Screw Fans.—A Paper on the above subject was read by Mr. Charles H. Innes, before the North-East Coast Institution of Engineers, in Sunderland, on December 14th. He said that where a large volume of air was required at low pressure, screw fans were preferred to centrifugal fans, in spite of their lower efficiency. There were only two really efficient methods in use. In the first, guide-vanes, similar to those of a turbine, were used, giving a moment of momentum opposite to the direction of rotation. In the second method a spiral discharge chamber or volute was used, having a section similar to that of a centrifugal fan. The first method might also be modified by the use of a spiral chamber through which the air flowed to the fan. Several fans were compared in the Paper. In one form the air enters parallel to the axis, and the vanes are arranged to receive this without shock and to discharge the air with forward tangential motion. A modification of this system had also been used. The air, after discharge, enters a diffuser whose inner surface is cylindrical and outer surface the frustum of a cone. The result of a test on a ventilator of this type was given in the following table:—

Test of an Axial Fan. (*Extreme diameter of vanes, 4·69ft.*)

No. of revs. per min....	926	949	939	932	992	996	996	964	973
Water gauge in inches	1·84	1·61	1·53	1·53	1·53	1·53	1·34	1·29	1·22
Kilowatts of motor ...	10·7	9·9	9·69	9·89	10·1	10·0	9·5	9·6	9·9
Discharge in cubic ft. per second	0	137	215	296	386	396	452	474	696
Foot-pounds of work by fan per second...	0	1,156	1,705	2,390	3,030	3,170	3,180	3,180	3,461
Mechanical efficiency of fan and motor ...	0	0·16	0·24	0·32	0·41	0·43	0·45	0·45	0·47
Manometric power ...	0·26	0·21	0·229	0·21	0·19	0·19	0·18	0·199	0·14

Personal.—The German Emperor has conferred the Royal Order of the Prussian Crown of the Second Class upon Sir Henry C. Fischer, who recently retired from the Post Office telegraph service.——Dr. Thomas E. Stanton, of University College, Liverpool, has been appointed to the chair of engineering at University College, Bristol, in place of Prof. J. Ryan, who was recently appointed principal of the Woolwich Polytechnic.——At a meeting of the council of the University College of North Wales, held on Wednesday last week, a resolution was passed with reference to the death of Sir Henry Tate, who had been a life governor of the College and generous donor to its funds, giving liberal assistance in particular to the scientific and technical departments of its work. From among a number of candidates Dr. Edward Taylor Jones was appointed professor of physics in succession to Prof. Andrew Gray, who was recently awarded the chair of physics at Glasgow University on Lord Kelvin's retirement. Dr. Jones is a native of Denbigh. Already, at the age of 14, from the National School, Denbigh, he won one of the scholarships of the North Wales Scholarship Association. He entered the University College of North Wales in 1888, obtaining an entrance scholarship. The College nominated him to a research scholarship on the 1851 Exhibition foundation, and he proceeded to the University of Berlin. Here he carried on research work at the Physical Institute, receiving from the 1851 Exhibition Commissioners at the end of his two years' tenure of his scholarship a special renewal of it for a third year. In 1895 he embodied the results of his researches in a thesis on "Electromagnetic Stress," for which the authorities of the University of London gave him the degree of D.Sc. without further examinational test. In the same year Dr. Jones became assistant lecturer and demonstrator in physics at the University College of North Wales, where he has since assisted Prof. Gray in class and laboratory teaching.

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CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

Becquerel Rays in a Magnetic Field.—There is still some obscurity as to the behaviour of Becquerel rays under magnetic force. Elster and Geitel thought they had proved their non-deflection by a magnet, which would place them on the same footing as Röntgen rays. S. Meyer and E. R. von Schweidler found that in a plane normal to the field the rays are probably deflected along circular arcs, while they are not deflected at all when proceeding in the direction of the field. This would place them on a par with cathode rays. H. Becquerel himself, operating with a small quantity of radio-active barium, has succeeded in bringing out some very important and interesting magnetic properties of the rays named after him, which will aid us in forming some idea as to their nature. In one of his experiments a small piece of the radiant substance, wrapped in aluminium foil, is placed in the centre of an iron disc forming one pole-piece of a strong electromagnet. The other pole-piece carries a fluorescent screen. When the magnet is not excited, a faint and widely-dispersed luminosity is found on the screen. As soon as the magnet is excited, the luminous area contracts and becomes more intense. It is immaterial how the magnet is excited, as a reversal of the poles does not affect the result. Sensitive plates show the increase of intensity very clearly. With a distance of 15mm. between the pole pieces, a strongly-marked negative is obtained in a minute and a half. This is probably the shortest time in which a Becquerel ray impression has yet been obtained. Whether uranium rays can be concentrated in this manner remains to be seen, but if they can, a comparatively cheap source of good Becquerel rays will have been obtained. When the rays pass across the magnetic lines of force, and not along them, they behave in a very different manner. Becquerel places a bit of the substance midway between the two poles of a magnet, and a fluorescent or photographic plate across between the two poles. The result is very singular. An impression is produced just under the radiant substance, of course, but not round about it. Another impression extends in a curved line from pole to pole, curving out of the way of the substance in the middle, the convexity being towards the right in looking along the lines of force. The author believes that the rays proceeding upwards from the body are curved round like projectiles and impinge upon the plane of the screen from above. A lead screen can be placed between the source and the impression without dimming it, so long as the rays curve round it. So far as they go, the properties described are analogous to those of cathode rays.

[H. Becquerel, *Comptes Rendus*, Dec. 11, 1899.]

Magnetic Deflection of Becquerel Rays.—F. Giesel may be said to have anticipated one of Becquerel's recent discoveries. He was able to produce several negatives showing very strikingly the deflection of Becquerel rays in a magnetic field. He took flat pole-pieces and laid a sensitive plate upon them film downwards. He placed a fresh and very active polonium preparation below the film and in contact with it. On development the blackening was found to be concentrated just in contact with the substance and along a zone on one side of the line joining the poles. The exposure was about five minutes. Between the black patch and the black zone there were a number of dark traces resembling wavy hair attached to the central patch as a head and extending into the dark zone. These traces are very difficult to account for. They somewhat resemble the ramifications seen in some Lichtenberg figures. The same effects are obtained with radium preparations, though not in the same strength as in the case of polonium. The magnetic deflection of Becquerel rays must now be considered as proved. Elster and Geitel's negative result was obtained with a vacuum, and not in the open air.

[F. Giesel, *Wied. Ann.*, No. 12, 1899.]

Harmonics of Rotary Currents.—The greater the deviation of the curve of a rotary current (*drehstrom*) from the sine form, the more practically important it is to find which is the chief upper harmonic vibration and what is its amplitude with respect to the main current. J. Zenneck analyses the current, considered as a four-phase current, by means of a Braun cathode ray tube acted upon by four coils symmetrically disposed, two of which are excited by one phase, while the other two are excited by a phase displaced 90deg. with respect to it. Now, if the current is purely sinusoidal, the curve described by the spot on the fluorescent screen will be a circle. If "over-tones" are present, these will trace themselves on the circumference of the circle just as the original curve traced itself with respect to a straight line. It then only remains to count the number of maxima or minima of the radius. If there are four maxima, the secondary periodicity will be five times that of the main current, as one has to be added on account of the revolution. The ratio of the difference between maximum and minimum radius vector to the radius of the circle indicates the ratio of the two amplitudes. In one case examined the relative periodicity was 9, and the amplitudes were as 1 : 86.

[J. Zenneck, *Wied. Ann.*, No. 12, 1899.]

Double Rate of Alternation.—J. Zenneck has devised an ingenious method of doubling the rate of alternation of an alternating current by means of a stationary transformer. He does it with the aid of two "aluminimum valves," or carbon-potash-aluminium cells, which, as we know, only allow the current to pass from the aluminium to the carbon electrode. The alternating circuit is split into two branches, which are wound round the core of a transformer in opposite directions. Each of the branches contains an aluminium valve, but the valve is reversed in one branch with respect to the other. The effect of this is that one-half of the alternate current passes through one branch and the other through the other branch, but in an opposite direction, so that in reality two successive maximums act upon the transformer, instead of a maximum and a minimum. This of course amounts to a doubling of the original frequency, though the new current is no longer sinusoidal. Curves taken off the secondary coil of the transformer show such a doubling distinctly. The author has not obtained any very favourable curves that way, but his aluminium valves were imperfect, showing both leakage and distortion. He expects that, with better arrangements, perfect doubling could be obtained.

[J. Zenneck, *Wied. Ann.*, No. 12, 1899.]

Photographic Current Curves.—The Braun vacuum tube possesses several great advantages over other contrivances for demonstrating the variation of an electric current. Operating as it does with a cathode beam deflected by a magnet excited by the current under investigation, it offers a weightless lever whose displacement is practically perfectly proportional to the current strength. A. Wehnelt and B. Donath have improved the arrangement and made it available for quantitative determinations. They dispensed with the revolving mirror, as the images obtained with it were too feeble. Instead, they photographed the spot of light on the fluorescent screen on a sliding plate, and photographed, side by side with it, the sinusoidal curve of a vibrating tuning-fork, obtained by attaching a pin-hole in aluminium foil to the prong in the path of a strong beam of light. The curves reproduced are certainly very striking. Several of them show the course of the current from a Wehnelt interrupter under various conditions of capacity and inductance in the circuit. They all show the very rapid break, which practically obliterates that part of the curve altogether. One photograph shows the curves of current and E.M.F. and their relative displacement, obtained with two independent lenses and two luminescent screens at right angles to each other.

[Wehnelt and Donath, *Wied. Ann.*, No. 12, 1899.]

Wireless Telegraphy and the War.—*The Times* special correspondent telegraphs that six Marconi wireless telegraphy instruments intended for the Boers have been captured at Cape Town. The experiments at Orange River, he says, have been highly successful, the communication with De Aar, 70 miles distant, being perfect.

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THE TESTING OF HYSTERESIS IN ARMATURE CORES.

BY PROF. FRANCIS G. BAILY, M.A.

A recent article in *The Electrician** on the value of the hysteresis loss in armature cores induces me to publish some experiments which were made some years ago, as the results that were obtained relate to some of the points raised in that article.

The experiments were made on a 5-unit two-pole undertype drum dynamo built by Messrs. Siemens Bros. The dimensions of the core were: Length 10in., diameter 6⅜in., diameter of steel spindle 1⅞in., the plates fitting close over it, thickness of plate $\frac{1}{40}$in. The object of the experiments was to examine Mr. Mordey's method† of testing the hysteresis of armature cores and to try some improvements on it. The method essentially consists in determining the losses in the moving parts of the machine when excited and when not excited, the difference being assumed to be due to hysteresis and eddy currents. These are further separated by varying the speed, the hysteresis loss being assumed to be proportional to the speed and the eddy currents proportional to the square of the speed.

Some of these assumptions are now known to be true, but some are only true if due precautions are taken against errors which were found to exist.

That the hysteresis loss is proportional to the speed was shown by the writer in some published experiments.‡ That the eddy currents are proportional to the square of the speed is really obvious from theory, and in the course of the experiments detailed in this Paper the result was verified. That the mechanical losses are unchanged by the addition of the magnetic field is only true if the mechanical conditions are preserved entirely unchanged, and in this the chief source of error lies.

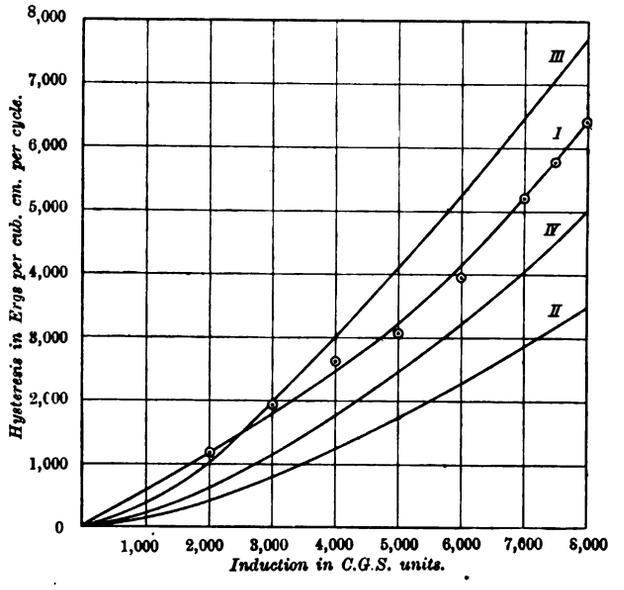
The mechanical losses are windage and bearing friction. The former is quite unchanged, since air is not appreciably magnetic, but for the latter to be constant the load on the bearings must be kept accurately constant and the lubrication must be ample and uniform. The lubrication was found to require special care, and several oils were tried before reliable results could be obtained. Moreover, the ordinary rate of feed was found to be much too slow, and the friction only remained constant when a rate of feed of at least 80 drops per minute was given.

There is a danger that the load on the bearings may be altered by the magnetisation. In the machine under consideration the makers had slightly raised the armature in the field, with a view to reduce the pressure on the bearings by the upward magnetic pull. The matter was tested by replacing one bearing bracket by a balance arm with a knife-edge at one end to support the shaft, and the weight was measured when magnetised and when non-magnetised. It was found that with an induction of 7,500 in the core about half the weight of the armature was taken up by the magnetic pull, a change which would make an appreciable error in the frictional losses, and accordingly the shaft was adjusted until no difference in the weight could be detected when the field was magnetised.

In Mr. Mordey's experiment the armature was driven by a belt passing through a power dynamometer, by which the power absorbed was measured. The removal of the magnetic field changes the pressure due to the belt by decreasing the tension on the driving side, and to avoid this the following addition was made. A small brake was fitted on a pulley at the other end of the shaft when the field was not magnetised, and the power absorbed by this was adjusted to equal that absorbed by eddy currents and hysteresis by increasing the brake friction until the dynamometer gave the same reading as before. A check reading of the dynamometer with the field again magnetised and the brake removed showed whether the bearing friction had altered during the process. In addition to keeping the belt tension constant, this method has the advantage that the absolute measure of power is given by the brake, while the dynamometer is only used as a reference, and a very simple one may be used.

Different brakes were used—a small Prony brake lubricated with water, a strap brake lubricated, and a strap brake dry. The last was found to be the only one that was satisfactory at slow speeds, and by its means a speed of 70 revs. per min. gave good readings. At this speed the eddy current losses entered only as a small correction instead of being the principal quantity to be measured, a condition which greatly improves the accuracy. The strap was a thin linen tape, held up against the pulley by two spring balances.

The load on the brake is proportional to the hysteresis and eddy current loss per revolution. The latter was found to be proportional to the speed and to the square of the induction, so that it is only necessary to determine the constant k in the expression $2\pi r W = \text{Hyst.} + knB^2$ by a few readings at low and high speed at a known induction, and all subsequent readings at low speeds can then be corrected for eddy-current losses. Besides saving readings, this has the further advantage that since the conditions that are satisfactory for slow speeds require alteration for high speeds, the eddy current constant can be determined once for all at high speed, and afterwards the slow speed conditions can be maintained unchanged.



The value of B was determined by reading the E.M.F. on the armature at a known speed in the usual way.

The following results were obtained, each series being taken with gradually increasing induction, and the mean values for the two series were finally used. Each value given is the mean of two or three readings taken consecutively. The speed was kept constant at 68 revs. per min.:—

Induction.	Weight on brake. Oz.	Correction for eddies. Oz.	Mean. Oz.	Hysteresis in ergs per c.c. per rev.
2,000	7·3 8·0	0·5	7·2	1,230
3,000	12·5 12·4	1·1	11·3	1,930
4,000	17·5 17·1	2·0	15·3	2,600
5,000	21·8 20·2	3·1	17·9	3,060
6,000	27·5 27·4	4·4	23·1	3,940
7,000	37·0 36·0	6·0	30·5	5,200
7,500	41·5 39·6	6·8	33·8	5,780
8,000	44·8 44·5	7·8	36·9	6,300

Curve I. shows the values obtained. Some irregularities may be noted, and indeed the divergence in the two sets of readings is somewhat large at some of the points, due probably to irregularity of friction in the bearings, which could not be eliminated completely. But since the whole friction was considerably larger than the low values of the hysteresis, small hanges would easily produce errors of this magnitude.

* *The Electrician*, Dec. 8, 1899.
† *Jour.* I.E.E., 1889. *The Electrician*, Vol. XXIII., p. 121.
‡ *Phil. Trans.*, 1896.

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The general shape of the curve does not differ greatly from the ordinary hysteresis curve, but it was impossible to test the same iron by the ballistic method in order to compare the absolute values. A comparison with the curve for soft charcoal iron given by Prof. Ewing, Curve II., shows a large increase, but in the course of some other later experiments (*loc. cit.*) it was found that this increase in hysteresis in the rotating field has a real existence. Curves III. and IV. show tests in a rotating and an alternating field respectively of samples from the same sheet, in which the values bear much the same proportion to each other.

The dynamo did not admit of a higher induction than 8,000, but in a ring armature the falling off in the value of the hysteresis at high inductions may be observed. Instead of the strap dynamometer, a small motor may be used to drive the armature, the brake being adjusted until the current in the motor armature is the same as in the previous reading. Although this introduces more bearings and brushes, with irregular friction, the method is more convenient.

Some points have been raised by Mr. Scott about which a few words may be added. The effect of shaking and vibration on the hysteresis in an armature core was examined by the writer (*Phil. Trans.*, *loc. cit.*), and it was found that the change produced in the hysteresis drag on the core by such excessive vibration as almost to endanger the spindle was but slight, about 5 or 10 per cent., and any ordinary vibration due to mechanical causes did not produce any important effect. But it is not impossible that, in the case say of the inductors in an inductor alternator, where the vibration is frequently severe, there may be some effect.

The question of hysteresis in a slotted armature is more complex, but some experiments made by the writer with a multiple-wound electromagnet with 12 coils and rotating brushes may throw some light on the subject. This apparatus produced a somewhat jerky or variable rotating field, and it produced in the iron core a value for the hysteresis approximating to that given by an alternating field. It is therefore quite possible that, where there is any interference with the uniformity of the field, the hysteresis will approximate more nearly to the lower value.

The case of a shallow ring armature is not quite similar to that of a nearly solid drum armature. The inner portion of the ring when under the centre of the pole piece is in a very weak field, and the change that takes place there must be more nearly akin to the cycle obtained in an alternating field. Probably the average value over the whole core will yield a hysteresis curve between the two extreme cases, but the writer hopes to put this shortly to the test.

It should be added that the above experiments were carried out in the laboratory at University College, Liverpool; and the writer wishes to acknowledge with gratitude the help received from Mr. E. H. Morgan, his assistant at that time.

OUR ELECTRIC UNITS: WHAT SHALL WE DO WITH THEM?

BY DR. J. A. FLEMING, F.R.S.

Nine out of ten electricians invited to answer the above question would say: "Let them alone; on no account tinker any more with them, and, above all things, let there be no fresh invention of names. Admittedly they may not be perfect, but we get on very well with them, and an imperfect practice is better than an impracticable perfection." From one point of view the advice is sound. Moreover, it has to be borne in mind that the final arbitrator is the man in the workshop or office. Not all the committees or congresses that ever met can compel the electrical public to adopt new nomenclature or units unless a real, but perhaps unexpressed, need has been felt for them. The resolutions of committees have no authoritative power at the back of them unless and until they recommend themselves by necessity and logic to practical workers. Hence it is that some suggestions by official bodies, such as the British Association Committee on Electrical Standards, have not found adoption, whilst those of private individuals have sometimes met with immediate acceptance. This certain fact, however, need not prevent us from considering the question, merely as a means of affording outlet for opinion, how far a nearer approach is possible to a more perfect system of electrical units than those we now possess. This discussion must proceed on practical lines. It is pure waste of time to put forward any suggestions which common sense rules at once out of the region of practical politics. There are certain reforms which are feasible and not unattainable; there are, on the other hand, many ideals which are absolutely beyond the reach of realisation. The British Association Committee on Electrical Standards when first formed had two objects in view. First, to formulate a system of electrical and magnetic units; and, secondly, to give concrete form to certain of these magnitudes. Valuable as is the work that the committee has wrought in 37 years, collectively and as individuals, it cannot be denied that it did not at first evolve either a perfect system of units or a sufficiently exact concrete representation of them. The replacement of the original B.A. unit of resistance by a more exact physical equivalent of 10^9 C.G.S. electromagnetic units of resistance in the form of the present standard or international ohm has alone involved gigantic labour, the necessity for which was nevertheless fully appreciated. It is, however, only of late years that the theoretical and radical imperfections of the British Association system of electrical units have been fully pointed out, and the way indicated towards a more satisfactory scheme.

We are indebted to Mr. Oliver Heaviside more than anyone else for this exposure, and he began to expound his system of *rational units* in the pages of *The Electrician* as far back as 1882.

Unfortunately the remedy he proposed involved changes so sweeping that the chances of its adoption were exceedingly small. Quite recently, however, an additional suggestion has been made by Prof. R. A. Fessenden,* which, taken in conjunction with Mr. Heaviside's rational units, seem to pave the way for a revision of the system of electrical units which is at once practicable and sound.

Briefly speaking, Mr. Heaviside's system starts with a new definition of the unit magnetic pole. The British Association Committee defined the unit magnetic pole as a pole which at a distance of one centimetre repels another like pole with a force of one dyne. In so defining it they committed two mistakes. They took no account of the effect of the permeability of the medium, and they created a painful chronic malady, familiarly called the 4π – eruption, which forthwith appeared and disfigured all electrical equations. Mr. Heaviside applies a radical remedy for the second defect by defining the unit magnetic pole as one which repels another like pole at a distance of one centimetre with a force of 4π dynes. In other words, the British Association pole strength is obtained from the equation

$$f = mm'/d^2,$$

and the Heaviside pole strength from equation

$$f = mm'/4\pi d^2.$$

There is no need to elaborately follow out the consequences of this change in the fundamental definition—the inquiring reader can be referred to text-books; but the result is that, starting from this new definition, Mr. Heaviside evolves a series of electrical and magnetic units, different from the British Association system units in size, but characterised by the property that there are no unmeaning constants in the equations expressing their relations. The relations of the Heaviside units to the British Association units in magnitude are as follows:—

One Heaviside unit of—

Magnetic pole	$= \frac{1}{\sqrt{4\pi}} \times$	the B.A. or C.G.S. unit magnetic pole.
Magnetic force	$= \sqrt{4\pi} \times$	the B.A. or C.G.S. unit of magnetic force.
Magnetic flux	$= \sqrt{4\pi} \times$	the B.A. or C.G.S. unit of flux (= 1 line).
Current	$= \frac{10}{\sqrt{4\pi}} \times$	the present ampere.

* See *Electrical World* of New York, December 9, 1899. "How to Get Rid of the 4π Eruption without Changing any of the Legal Units."—[This article is reprinted in another column of the present issue.—ED., *E.*]

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Electromotive force $= \sqrt{4\pi} \times$ the present volt.

Resistance $= \frac{4\pi}{10} \times$ the present ohm.

Inductance $= \frac{4\pi}{10} \times$ the present henry.

Quantity $= \frac{10}{\sqrt{4\pi}} \times$ the present coulomb.

Capacity $= \frac{10}{4\pi} \times$ the present farad.

Magnetomotive force $= \frac{10}{\sqrt{4\pi}} \times$ the present ampere-turn.

Power $= 10 \times$ the present watt.

Energy $= 10 \times$ the present joule.

The above relations may be expressed in another way. The numerical value of a given quantity is inversely as the size of the unit in which it is expressed. Hence we may write the relations of the present or C.G.S. or British Association units and the Heaviside units as follows :—

The numerical value of a given	*Measured in*	*Is equal to the product of*	*And the numerical value of this same quantity in*
Magnetic pole strength	C.G.S. units	$1 \div \sqrt{4\pi}$	Heaviside units.
Magnetic force	Ditto	$\sqrt{4\pi}$	Ditto.
Magnetic flux	Ditto	$\sqrt{4\pi}$	Ditto.
Electromotive force	Volts	$\sqrt{4\pi}$	Ditto.
Current	Amperes	$10 \div \sqrt{4\pi}$	Ditto.
Ditto	Dekamperes	$1 \div \sqrt{4\pi}$	Ditto.
Resistance	Ohms	$4\pi \div 10$	Ditto.
Ditto	Deciohms	4π	Ditto.
Quantity	Coulombs	$10 \div \sqrt{4\pi}$	Ditto.
Ditto	Dekacoulombs	$1 \div \sqrt{4\pi}$	Ditto.
Capacity	Farads	$10 \div 4\pi$	Ditto.
Ditto	Dekafarads	$1 \div 4\pi$	Ditto.
Inductance	Henrys	$4\pi \div 10$	Ditto.
Ditto	Decihenrys	4π	Ditto.
Magnetomotive force	Ampere-turns	$10 \div \sqrt{4\pi}$	Ditto.
Ditto	Dekampere-turns	$1 \div \sqrt{4\pi}$	Ditto.

From the above table it is evident that the Heaviside units are all incommensurable in size with the present B.A. units, and in six cases out of ten involve a factor 10 or 1/10 as well.

If, however, we adopt as the unit of current the *dekampere*, or 10 amperes, which is the same as the electromagnetic unit of current; and as the unit of the resistance the *deciohm*, which is the tenth part of the present ohm; and the decihenry, which is the tenth of a henry, as the unit of inductance, we then eliminate the decimal factors, and we are able to convert from numerical values in Heaviside units to numerical values in B.A. units by the use of one of four factors—4π, $1/4\pi$, $\sqrt{4\pi}$, or $1/\sqrt{4\pi}$.

Let us write these 4π, $(4\pi)^{-1}$, $(4\pi)^{\frac{1}{2}}$, $(4\pi)^{-\frac{1}{2}}$ as usual.

Let the words "ordinary reckoning" stand for the measurement or numerical value of any quantity in C.G.S. or B.A. practical units as at present conducted, with the exception that current, quantity, and capacity are measured in dekamperes, dekacoulombs, and dekafarads, and resistance and inductance in deciohms and decihenrys. Let the words "Heaviside reckoning" stand for the numerical value of the same quantity in Heaviside rational units. We then see that the factors by which we have to multiply reckoning as Heaviside units to obtain reckoning in ordinary units for the various quantities are as follows :—

Quantity.	*Multiplying factor to convert Heaviside to ordinary reckoning.*
Magnetic pole strength (in C.G.S.)	$(4\pi)^{-\frac{1}{2}}$
Magnetic force (in C.G.S.)	$(4\pi)^{\frac{1}{2}}$
Magnetic flux (in C.G.S.)	$(4\pi)^{\frac{1}{2}}$
Electromagnetic force (in volts)	$(4\pi)^{\frac{1}{2}}$
Current (in dekamperes)	$(4\pi)^{-\frac{1}{2}}$
Quantity (in dekacoulombs)	$(4\pi)^{-\frac{1}{2}}$
Magnetomotive force (in dekampere-turns)	$(4\pi)^{-\frac{1}{2}}$
Resistance (in deciohms)	(4π)
Inductance (in decihenrys)	(4π)
Capacity (in dekafarads)	$(4\pi)^{-1}$

In the next place let us consider the physical dimensions of the above magnitudes. It was formerly the custom to express the physical dimensions of the various electric and magnetic quantities in terms of length (L), mass (M), and time (T), and to ignore those of dielectric constant (K) and permeability (μ). It was, however, pointed out by Prof. A. W. Rücker* that we have no right to ignore the dimensions of K and μ. We do not as yet know their dimensions in terms of L, M, and T, and hence it is proper to insert μ and K as fundamentals of unknown dimensions.

If we express in electromagnetic units—that is, starting from the definition of a unit magnetic pole strength—the dimensions of all the other quantities, taking into account the permeability μ, it can easily be shown that the dimensions of the quantities in the above tables are as follows :—

Quantity.	*Dimensions in the electromagnetic system of measurement.*
Magnetic pole strength	$L^{\frac{3}{2}}M^{\frac{1}{2}}T^{-1}\mu^{\frac{1}{2}}$
Magnetic force	$L^{-\frac{1}{2}}M^{\frac{1}{2}}T^{-1}\mu^{-\frac{1}{2}}$
Magnetic flux	$L^{\frac{3}{2}}M^{\frac{1}{2}}T^{-1}\mu^{\frac{1}{2}}$
Electromotive force	$L^{\frac{1}{2}}M^{\frac{1}{2}}T^{-2}\mu^{\frac{1}{2}}$
Current	$L^{\frac{1}{2}}M^{\frac{1}{2}}T^{-1}\mu^{-\frac{1}{2}}$
Quantity	$L^{\frac{1}{2}}M^{\frac{1}{2}}\mu^{-\frac{1}{2}}$
Magnetomotive force	$L^{\frac{1}{2}}M^{\frac{1}{2}}\mu^{-\frac{1}{2}}$
Resistance	$LT^{-1}\mu$
Inductance	$L\mu$
Capacity	$L^{-1}T^{2}\mu^{-1}$

If we compare the last table of dimensions with the table before it of converting factors, we shall at once be struck by a very remarkable fact—viz., that *the power under which* 4π *enters as the multiplying factor to convert Heaviside reckoning to B.A. reckoning is in every case except that of magnetic force and magnetic pole strength the same as the power under which the dimension of magnetic permeability* (μ) *makes its appearance in the dimensional expression;* that is, corresponding to $\mu^{\frac{1}{2}}$ in the case of magnetic flux and electromotive force, we have $(4\pi)^{\frac{1}{2}}$. Corresponding to $\mu^{-\frac{1}{2}}$ in the case of current, quantity and magnetomotive force we have $(4\pi)^{-\frac{1}{2}}$; and corresponding to μ we have 4π for resistance and inductance, and for μ^{-1} we have $(4\pi)^{-1}$ in the case of capacity.

Now, this remarkable fact supplies at once the clue to a modification of a suggestion made by Prof. Fessenden that the rationalisation of our present units can be effected by changing the unit in which we reckon magnetic permeability. Both in the British Association and in the Heaviside system the magnetic permeability of ether or of air is taken as unity. We know nothing about its real value, hence it may just as well be taken as 10 or 100 or 1,000 as 1.

If we take the permeability of ether to be 4π† *units instead of unity, we rationalise at one stroke all our present units except the units of magnetic force and magnetic pole strength.*

In order to see that this is so, we have to notice that if the unit of permeability is changed in the ratio of 1 to 4π, then the numerical value of all reckonings in Heaviside units will be changed in a ratio which is given by multiplying them by $1/4\pi$ raised to the same power as that under which μ appears in the dimensional expression. Thus, since in the dimensions of magnetic flux the μ appears as $\mu^{\frac{1}{2}}$, the change-ratio in converting from reckoning in a system in which $\mu = 1$ to a system in which $\mu = 4\pi$ is equal to $(1/4\pi)^{\frac{1}{2}}$ or to $(4\pi)^{-\frac{1}{2}}$.

If, then, we wish to change from the reckoning of flux in Heaviside system, in which ether permeability = 1, to reckoning in another system in which ether-$\mu = 4\pi$, and then again into British Association or C.G.S. units, we have to multiply by $(4\pi)^{-\frac{1}{2}}$ and by $(4\pi)^{\frac{1}{2}}$ successively. But it is obvious that the two factors in this case destroy each other. In the same way it will be found that the factor for converting from Heaviside to ordinary reckoning is inversely as the factor for converting from an ether-$\mu = 1$ system to an ether-$\mu = 4\pi$ system, in every case except that of magnetic polarity and magnetic field or force.

* A. W. Rücker, "On the Suppressed Dimensions of Physical Quantities." *Proc.* Phys. Soc., London, Vol. X., p. 37; or *Phil. Mag.*, 1889.

† In Prof. Fessenden's article the suggestion as printed is that the permeability of the ether shall be taken as $(4\pi)^2$ instead of unity. This, however, appears to be a misprint or slip of the pen for (4π). It is clear that the permeability must be taken as 4π to effect the necessary rationalisation.

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If, however, it be agreed that the unit of magnetic force be no longer the C G.S. unit, but be a unit 4π times as large—in other words, be 10 ampere-turns per centimetre or one dekampere-turn per centimetre; and if it be agreed that the unit of magnetic pole strength be no longer the C.G.S. unit, but a unit $1/4\pi$ as large, then we can construct a perfectly rational system of electric and magnetic units as follows without disturbing to any sensible degree our practical instruments.

Let the following be the units of measurement in the new system:—

(i.) Let the permeability of the ether or air be considered to be 4π units absolutely, and not unity as in the present system.

(ii.) Let the unit magnetic pole be $1/4\pi$ times the present C.G.S. pole. This disturbs no one, because no practical electrician ever requires to measure a pole strength in absolute measure.

(iii.) Let the unit of magnetic force be the dekampere-turn per centimetre = 10 ampere-turns per centimetre = 4π times the present C.G.S. unit.

(iv.) Let the unit of electric current be the present dekampere, and let it be called the ampere, or the new ampere.

(v.) Let the unit of electric quantity be the present dekacoulomb, and be called the coulomb.

(vi.) Let the unit of electric resistance be the present deci-ohm, or 0·1 ohm, and let it be called the ohm.

(vii.) Let the unit of inductance be the present deci-henry, and let it be called the henry.

(viii.) Let the unit of magnetic flux be the present C.G.S. unit or "one line of force" as at present used.

(ix.) Let the unit of electromotive force be the present volt.

(x.) Let the unit of magnetic potential difference or magnetomotive force be the present dekampere-turn or 10 present ampere-turns.

(xi.) The unit of power will then be 10 of the present watts and the unit of energy 10 of the present joules.

(xii.) The unit of capacity will then be the present dekafarad (10 farads), and will be too large for practical use; but a fraction of it will have, as at present, to be employed, say one ten-millionth.

The above system of units is a rational system. In equations for expressing the relations of these units 4π appears only in its proper place, and the present practical system of electrical and magnetic measurement is not to any sensible extent disturbed. We shall then proceed to consider to what extent the introduction of such a modified system of practical units is desirable or possible.

(To be continued.)

SUBSTITUTES FOR INDIARUBBER.

BY H. L. TERRY, F.I.C.

"Among the uses to which the compound can be put, and for which it is eminently adapted, is that of the insulation of electric cables." This trite announcement, or something to the same effect, has appeared several times recently in circulars in which the claims of some new rubber substitute have been put forth, or in journals where the potentialities of the new body have come under discussion. It is certainly the case that at the present time an abnormal degree of inventive energy is being exhibited in order to find a body which may displace indiarubber in realms in which it has so long ruled supreme, and it may not be without interest therefore to discuss one or two points which should come prominently to the fore where it is sought to deliver judgment on these compounds. And in doing this I shall prefer to confine myself to generalities: it is not my intention to put any one of these substitutes upon the dissecting table, in order to point out to expectant students what may be disclosed by the scalpel of chemical analysis. The exact composition of the half-dozen or more newly-advertised substitutes for indiarubber may or may not be easily disclosable by chemical means, but it is foreign to my present purpose to enter into such details here, or at any rate further than seems imperative in order to make my remarks comprehensible. I would further forestall possible criticism by at once disclaiming any attempt at continuity in the scraps which have been pieced together to form my subject-matter.

Taking up my parable at deep-sea cables, a subject of enhanced interest at the present time in view of the proposed Pacific cable, it is important to note the two principal objections which have militated in the past against the employment of vulcanised rubber in place of gutta-percha. These objections are the porosity of rubber under pressure—or indeed at atmospheric pressure alone—and the fact that the coating of rubber has hitherto been put on the cable in a jointed condition, and not in the seamless state in which the gutta-percha covers the wires. These objections are of long standing, and have acted prominently in preventing the use of vulcanised rubber cables for deep sea purposes, except in comparatively short lengths, such as, for instance, in the case of cross-channel cables and port to port cables on the coast line of a country. Now, it is extremely doubtful if the porosity in rubber can be overcome except by some drastic change in the methods of manufacture, but it is interesting to find that the erstwhile difficulty of putting the rubber on in a seamless condition has now apparently been overcome. According to the *Indiarubber World* of New York, some seamless india-rubber cables were made recently by the Safety Insulated Wire and Cable Co., the rubber coating being put on by special machinery in a seamless condition, the result up to date being in every way satisfactory. This being the case, it presages an era of increased activity as regards the use of rubber insulation, and it may be predicted that to a great extent the two schools of thought, which have so long been in opposition on this matter of rubber for deep-sea work, will cease to be antagonistic.

Having thus referred to the main drawbacks of the rubber-covered cable, it is pertinent to inquire how far the new substitute for indiarubber can compare with the latter as regards these defects. The question is of course one for the buyers of the various bodies to find out practically, but, from what I have seen of one or two of these bodies, I am of opinion that they will be found less porous than is rubber, and that certainly in some cases there will be no difficulty at all in putting on the insulating mixture in the seamless condition. Other and weighty questions, of course, arise with regard to the insulating capacity and probable duration of life, the former of which can be answered without difficulty, although the latter must naturally in the case of new compounds remain for some time in the region of conjecture. On a recent occasion I referred in this journal to the inimical action which atmospheric oxygen and sunlight exerted upon india-rubber, and as these adverse influences do not make themselves felt in deep-sea cables, the conditions are altogether more favourable to longevity than obtain in respect to most rubber goods, and at any rate there seems no reason to predict such a limited life as has been the fate of so many electric light cables. It is strongly urged, from an American source, that the new Pacific cable might be made in America and insulated with rubber according to the process referred to above, though at the same time there are many people who, taking a dispassionate view of the matter, express much doubt as to whether the present resources of the States are equal to making and laying a cable of such magnitude without at least a certain amount of assistance from the old-established English firms in the same line of business. At any rate, if the project really comes to maturity, a heavy responsibility will lie on the shoulders of those who advocate the use of any but the best rubber insulation.

It may be true that, for certain purposes connected with electric lighting, excellent insulation has been obtained by the use of poor quality rubber. This view has been plausibly put forward by those who profess to have authoritative evidence, but I cannot help feeling that the discredit which has come upon rubber insulation by the failure in some of our large towns is certainly to some extent attributable to the employment of low-class insulation from motives of economy. I was assured the other day, in Germany, that a first-class rubber cable will last a period of time much in excess of what has been experienced at many of our English installations;

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and my attention was particularly directed to St. Petersburg, where cables laid fourteen years ago were said to be still giving every satisfaction. That the multiplication of cable works, with resultant competition, has acted inimically on the rubber insulation business, was an opinion which my German informant sought to impress upon me; and I must say his words hardly needed the emphasis with which they were delivered to convince me of their truth, so permeated already was my mind with the same conviction.

I have not yet seen a substitute which compared at all to good indiarubber as regards the important attribute of tensile strength or elasticity, but of course this defect is not all-important, for there are cases where this quality is not particularly necessary, as, for instance, in door-mats. At the same time, I rather demur to the very catholic view which those persons who are interested in the sale of new substitutes take with regard to the applications of these bodies. Dust is often thrown in the eyes of the purchaser by the stress which is laid on comparatively unimportant points. Thus we are told that the new body is quite free from alkali, that it is quite unaffected by oil, and that it regards the onslaught of vitriol with contempt; but desirable though all this may be, it does not suffice to make up for lack of tensile strength. With regard to insulation, it is for the cable manufacturers to determine for themselves how far the results justify the confident tone of the circulars, though the best test—that of time—is one that is apt to prove rather trying to the inventor, who is eager to recoup himself for the outlay expended on experiment. It should be mentioned that the new substitutes are by no means mere adaptations of our old friend oxidised oil, although this body is extremely prominent in more than one of them. Some, indeed, are so differently constituted to what has been before the rubber trade up to the present, that little or nothing can be asserted with regard to their behaviour under varying conditions. Turning again to tensile strength, it is clear that this is not a prominent requisite in the case of insulating rubber, so it is quite possible that some of these substitutes may be found of considerable service. At any rate, there is this to be said for them: that, being already oxidised bodies, they cannot, like indiarubber, undergo the chemical changes to which hydrocarbons are subject. In saying this I do not overlook the fact that a badly-made oil substitute may undergo alteration resulting in the production of an oily mass, but the case hardly comes into the category of simple oxidation, which is so common with respect to vulcanised rubber. A point in favour of some of the new bodies is their freedom from sulphur, which means that there need be no fear of the corrosion of the copper, which is too commonly the case with vulcanised-rubber insulation.

Resinous bodies are less favourable to the diffusion of liquids and gases than is indiarubber, and it is no doubt owing to the fact that it contains so much resinous matter that gutta-percha is less porous to water than is indiarubber. Substitutes being more nearly allied to resins than to hydrocarbons, we may naturally expect that they will prove in this respect of equal if not superior value to gutta-percha, and *a fortiori* to indiarubber. In testing substitutes it should not be overlooked that their properties may undergo profound modification in admixture with rubber or with other substitutes. Thus the bodies made from rape oil, either by the action of chloride of sulphur in the cold or of flowers of sulphur at a high temperature, are practically insoluble in coal tar naphtha; at least, it is impossible to make anything like a uniform varnish from them. In admixture with rubber, however, they can be made into perfect varnishes, as such are understood in the rubber trade—an important fact, which renders their application possible in many cases where failure to go into solution would prove fatal to their employment. There may be effects other than that of solution where the presence of rubber exerts a modifying influence, and so where tests of the properties of substitutes are being made it is important, if they are to be mixed with rubber in practice, to mix them with it in the experiments.

Chemical analysis does not afford all the information that we want, and it is absolutely necessary that such analysis should be supplemented by practical tests. Such practical tests must conform closely to the conditions likely to be experienced in the manufacture on the large scale. To give an instance where chemical analysis alone may prove faulty, it is well known that moisture in a rubber mixing is to be strictly guarded against, as likely to cause air-holes during vulcanisation. Yet in certain circumstances several per cent. of water may be present without causing the least damage. I heard of a substitute recently being condemned by a chemist because it contained a certain amount of water, and though such condemnation was only to be expected on the facts of the case, yet it was really unjustified, because it was found in practice that very satisfactory results could be obtained by the use of the substance. In saying this I do not for a moment seek to show that the care which rubber manufacturers are in the habit of taking to ensure that their materials are perfectly dry is superfluous; I merely mention the point as an instance where generalisation in such a complex manufacture as that of rubber goods may easily lead to false deductions.

JACQUES-CARTIER WATER-POWER PLANT.*

A new electrical power plant of a highly interesting nature is rapidly approaching completion at St. Gabriel, Quebec. Most of the Canadian electrical plants secure their power from large waterfalls, such as that at Niagara, but the Jacques-Cartier Water Power Co. utilises a fall of 30ft. only in the St. Gabriel River, which occurs in a rapid 200 yards in length. The electric current to be generated will be transmitted to Quebec, 18 miles distant, at 20,000 volts, and there applied to lighting and power purposes. A dam, 300ft. in length, of stone foundations and abutments, with a wooden superstructure, has been constructed near the head of the rapids. A penstock carries the water for a distance of 200ft. below the dam to the power house, which has been built in a depression near the river.

Two 750-kw. Westinghouse, three-phase, alternating-current generators will be directly-connected to water-wheels. The generators are wound for a normal electromotive force of 2,000 volts and a frequency of 120 ∿ per sec. when run at a speed of 150 revs. per min. The arrangement of circuits is so designed that the two generators may be run in parallel, as well as independently. The permissible rise in temperature during a 24-hour run is 35°C. for a normal output of 750 kw., or 45°C. for a 938 kw. output. The armatures are so constructed that individual coils or group of coils, may be readily replaced, and the armature, as a whole, is accessible for cleaning and inspection without requiring the use of a crane. The terminals of the armature circuits have been especially insulated and protected against risk of contacts. The insulation of the armature is such that it is capable of resisting between the copper conductors and the iron core the application of 10,000 volts of alternating current. The commercial efficiency of each generator is guaranteed to be at full load 94 per cent., at three-quarter load 93 per cent., and at one-half load 92 per cent. At 50 per cent. overload the commercial efficiency is not to fall below 93 per cent.

There have been provided for exciting purposes two 37-½kw. Westinghouse, multi-polar generators, of 125 volts, at 350 revs. per min, directly connected to smaller water wheels. Each of these machines is designed to excite the fields of both generators fully when they are developing 938 kw. each, at a power factor of 90 per cent. When running at full-rated load continuously, the temperature of the exciters, at any part except the commutators, may not rise more than 35°C. above the temperature of the surrounding air.

The transformer room runs along the entire width of the power house, having a depth of 24ft. 10in., and will contain 250-kw., Westinghouse self-cooling, oil-insulated transformers, to raise the 2,000 volts from the generators to 20,000 volts, three-phase at a frequency of 60 ∿ per sec. The transformers are designed to run at their full normal output continuously for 24 hours, with a maximum rise of temperature of 45°C. in any part.

Two generator panels, two circuit panels, and one exciter panel make up the switchboard. The board is to be mounted on a gallery which extends from a wall running across the full width of the building, directly in the centre of the power house, so that it is placed very favourably with regard to connections with the generators and exciters, reducing to a minimum the length of cables and offering short direct paths, which should greatly facilitate the wiring. The cables will be run through ducts built in the cement floor. The generator panels carry two automatic alternating-current circuit breakers, three ammeters, two indicating wattmeters, three single-pole double-throw washer switches, a rheostat, voltmeter, and the usual field plugs, pilot lamps and brackets, and ground detector plugs and receptacles. The feeder panels carry two automatic alternating-current circuit-breakers, three ammeters, a polyphase integrating wattmeter, three single-pole double-throw washer switches,

* Abstract from the *Western Electrician*.

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and the usual pilot lamps and brackets. The exciter panels carry two direct-current ammeters, a direct-current voltmeter, two rheostat hand-wheels, two double-pole, double-throw, washer-type switches, a voltmeter, field voltmeter plugs and receptacles. The electric plant will be protected by 12 Wurtz non-arcing metal lightning arresters and choke coils, three to be installed at each end of each of the two three-wire transmission circuits.

The line overhead to Quebec is to be constructed in two distinct circuits, each of three wires, for three-phase transmission, with the three wires being equally distant one from the other, and the spacing between being 18in. In Quebec the sub-station to which the transmission lines will carry current will contain four 375-kw. Westinghouse transformers of the oil-insulated and self-cooling type, to step down from 19,000 volts to the voltage required for the distributing circuits. The transformers will be arranged in two groups of two each, connected on the Scott system, to receive three-phase current from the secondaries, and deliver two-phase to the consumers.

Work at the St. Gabriel power house is being rapidly pushed. The water-wheels are already in place and the electrical machinery is in course of erection. It is anticipated that everything will be completed for the transmission of current to Quebec by January 1st.

TESTS OF EDISON-BROWN RAIL BONDS.

We have received the following account of tests made at the meeting of the American Street Railway Association in Chicago last October. They were carried out evidently by those interested in the success of this particular type of bond, but the results were so good that they are worth recording :—

Joint of 80lb. Tee rail unbonded, connected in series with a joint of 70lb. the rail having one Edison-Brown solid copper bond under each angle plate. With a current of 2,000 amperes through the 80lb. joint the drop was 0·423 volts. As a bond could not be put in the proper place and removed quickly enough for purposes of demonstration, contact spots were amalgamated on the top of each rail at inner ends. A 0000 solid copper bond was then laid upon these amalgamated spots so as to bridge the joint. The drop with 2,000 amperes was 0·018 volts ; the drop of 1in. of this rail with the same current was 0·00223 volts. The bond merely laid on top of the rail held in contact by nothing but its own weight was equal in resistance to but 8¼in. of rail.

The drop on 70lb. tee rail joint, with 2,000 amperes through the joint and bonds, was 0·01946 volts. With an extra bond laid on top of this rail, the drop with same current was reduced to 0·00762 volts ; and with 2,000 amperes the drop in one inch of this rail was 0·00286 volts ; the resistance of the bond was therefore equal to that of 7in. of rail. As there were no track tools at hand, this joint was made up with a 14in. monkey wrench, and was therefore not as tight as it should have been for service.

Two of the leading types of copper bonds were sent in for test by one of the Chicago railways under the same conditions, both being the 0000 size and applied in the proper manner to the rails. The loss on one with 1,000 amperes was 0·425 volts, and with 2,000 amperes 0·75 volts. With the other bond the drop was 0·22 and 0·37 volts. In each case the bond became red hot in the short time required to make the test.

The following tests of bonds after long use are also interesting :—

Edison-Brown bonds put in on October 28, 1896, between expansion joints of the Metropolitan West Side Elevated Railway in Chicago, showed a drop of 0·0010 to 0·0015 volts. Measured under same conditions, October 24, 1899, the drop was 0·0010 to 0·00122 volts.

ELECTRICITY WORKS ACCOUNTS.

Sheffield Municipal Electric Supply Works.

Because owned by the Sheffield Corporation since December 31, 1897, we have headed this undertaking as a municipal concern, yet apparently to all intents and purposes the administration has been in the hands of the late Sheffield Electric Light and Power Co. (Ltd.) up to the end of last year, when the undertaking was transferred over to the Corporation. During the year 1898 the undertaking was managed by the company on behalf of the Corporation in consideration that the company should be paid a remuneration equivalent to a dividend of 10 per cent. upon the capital. Judging from the results, the arrangement appears to have worked well, and to have been to the interest not only of the company but also of the Corporation. Inasmuch as the accounts for the year 1898 are returned according to the Board of Trade form for company undertakings, it seems fairer to regard the results in comparison with company concerns.

During the year the additional capital expenditure has been heavy, the total having been more than doubled, and the plant capacity having also been raised from 925 kw. to 1,725 kw.

An excellent advance of nearly 31 per cent. is shown by the output, while the equivalent lamp connections have increased from 55,988 to 73,853, or 33·7 per cent.

It is very gratifying to find that the already low total costs of 1·55d. which obtained in 1897 have been improved upon. All the items of works costs except that of "oil, waste, water, and stores" have shown diminution. The result is that as a station under company control Sheffield takes a place of priority amongst those concerns whose accounts are yet analysed by us, not only in the fuel item but also in respect of generating, works, and total costs. In the matter of fuel charges, those of Sheffield in 1898 at 0·30d. per unit, are less than half the average in company-controlled stations, while the generating costs at 0.93d. are about 0·32d. below the average at the output.

The result of the year's operations was a working profit of £12,704, as compared with £11,477 in 1897, and this in spite of a very substantial reduction in the total average revenue per unit. After satisfying the interest charges, amounting to £1,660, there was available for distribution a balance of £11,044.

The dividend of 10 per cent. secured to the company by agreement absorbed £9,712, leaving a balance to carry forward of £1,381.

Stafford Municipal Electric Supply Works.

With such an excellent showing in the matter of costs as Stafford makes, it comes quite as a surprise to note further down in our table that the net result of the year's business is a loss of £514. Such a result is, however, largely accounted for when we note also the low load factor of 7·3 and the meagre output, which now, for the third completed year of working, only amounts to 67,908 units sold. Still, the fact that under these disadvantageous conditions the cost sheet displays the very moderate figures it does is greatly to the credit of the management. During both years Stafford has the honourable position of having the lowest fuel costs of any station in the United Kingdom on a comparable basis with it. At 0·247d. per unit the fuel item is little more than a third of the mean fuel charge common to municipal stations.

The year's working profit amounted to £672, being at the rate of 3·36 per cent. of the mean capital expended. £587 was put aside for the redemption of debt, and £579 paid as interest on loans. The resulting deficit of £514 was reduced to £82 by £432 brought forward from the preceding year.

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared :—

Aberdeen (Municipal)	Jan.	6, 1899	Lancaster (Municipal)	Oct.	21, 1898
Ayr (Municipal)	Sept.	22, ,,	Leeds (Municipal)	Dec.	1, 1899
Bedford (Municipal)	May	19, ,,	Leicester (Municipal)	Jan.	20, ,,
Belfast (Municipal)	Sept.	15, ,,	Leyton (Municipal)	Sept.	8, ,,
Birmingham (Company)	Sept.	15, ,,	Liverpool (Municipal)	June	9, ,,
Blackpool (Municipal)	Sept.	29, ,,	Manchester (Municipal)	Aug.	11, ,,
Bournemouth (Company)	April	28, ,,	Newcastle and District (Co.)	Oct.	6, ,,
Bolton (Municipal)	Nov.	24, ,,	Newcastle-upon-Tyne (Co.)	April	14, ,,
Bradford (Municipal)	April	14, ,,	Newport (Mon.) (Municipal)	Dec.	15, ,,
Brighton (Municipal)	May	12, ,,	Northampton (Company)	Oct.	20, ,,
Bristol (Municipal)	July	14, ,,	Norwich (Company)	Nov.	17, ,,
Burnley (Municipal)	Aug.	25, ,,	Notting Hill (Company)	Mar.	17, ,,
Burton-upon-Trent (Mun.)	April	21, ,,	Nottingham (Municipal)	July	21, ,,
Bury (Municipal)	Sept.	22, ,,	Oldham (Municipal)	Dec.	1, ,,
Cambridge (Company)	Mar.	10, ,,	Oxford (Company)	May	19, ,,
Cardiff (Municipal)	Dec.	15, ,,	Pontypool (Company)	May	5, ,,
Charing Cross (Company)	Mar.	17, ,,	Portsmouth (Municipal)	July	14, ,,
Chelsea (Company)	Mar.	31, ,,	Prescot (Company)	Dec.	8, ,,
Cheltenham (Municipal)	Nov.	10, ,,	Preston (Company)	Sept.	29, ,,
Chester (Municipal)	June	23, ,,	Reading (Company)	Oct.	13, ,,
City of London (Company)	May	12, ,,	Richmond (Company)	Oct.	13, ,,
Clerkenwell (Company)	Aug.	18, ,,	Scarborough (Company)	Nov.	3, ,,
Derby (Municipal)	Dec.	9, 1898	St. Helens (Municipal)	Dec.	8, ,,
Dewsbury (Municipal)	Nov.	24, 1899	St. James' & Pall Mall (Co.)	Feb.	24, ,,
Dover (Company)	June	2, ,,	St. Pancras (Vestry)	May	26, ,,
Dundee (Municipal)	Nov.	4, 1898	Sheffield (Company)	Dec.	16, 1898
Eastbourne (Company)	July	22, ,,	Shoreditch (Vestry)	Oct.	27, 1899
Edinburgh (Municipal)	Nov.	17, 1899	Southampton (Municipal)	Nov.	10, ,,
Exeter (Municipal)	Aug.	5, 1898	Southport (Municipal)	July	7, ,,
Glasgow (Municipal)	Sept.	1, 1899	South Shields (Municipal)	July	7, ,,
Guildford (Company)	May	5, ,,	Stafford (Municipal)	Oct.	21, 1898
Halifax (Municipal)	July	21, ,,	Sunderland (Municipal)	July	28, 1899
Hammersmith (Vestry)	May	26, ,,	Taunton (Municipal)	June	16, ,,
Hampstead (Vestry)	Aug.	25, ,,	Tunbridge Wells (Mun.)	Sept.	1, ,,
Hanley (Municipal)	April	28, ,,	Wakefield (Municipal)	Dec.	1, ,,
Harrogate (Municipal)	Oct.	20, ,,	Walsall (Municipal)	June	23, ,,
Harrow (Company)	June	16, ,,	Wandsworth (Company)	Aug.	19, ,,
Hast'gs & St. Leonards (Co.)	April	29, 1898	Westminster (Company)	Feb.	24, ,,
H'use-to-H'useCo. (K'ns'gt'n)	Mar.	31, 1899	Whitehaven (Municipal)	July	28, ,,
Hove (Company)	Mar.	10, ,,	Windsor (Company)	Dec.	22, ,,
Huddersfield (Municipal)	Oct.	6, ,,	Woking (Company)	Dec.	22, ,,
Islington (Vestry)	Oct.	27, ,,	Wolverhampton (Municipal)	June	30, ,,
Kensington & Knightsbr' (Co.)	Mar.	3, ,,	Woolwich (Company)	Jan.	13, ,,
Kingston-upon-Hull (Mun.)	June	9, ,,	Worcester (Municipal)	April	7, ,,
Kingston-on-Thames (Mun.)	April	21, ,,	Yarmouth (Municipal)	Nov.	3, ,,

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	SHEFFIELD.		STAFFORD.	
Undertaking Worked by	Sheffield Corporation.[f]		Stafford Corporation.	
Date of Commencement of Supply	March, 1893.	[and houses.	October, 1895.	
System of Supply	Alternate-current transformers in sub-stations		Three-wire continuous-current.	
Chief Engineer	W. Johnson.		J. F. Bell.	
YEAR ENDED	DEC. 31, **1897.**	DEC. 31, **1898.**	MAR. 31, **1898.**	MAR. 31, **1899.**
QUANTITIES—				
Units generated	1,043,428	1,378,292	76,937	91,134[e]
„ SOLD (TOTAL)	747,063	978,088	55,542	67,908
„ sold to consumers	747,063	978,088	52 231	64,703
„ sold for public lighting, &c.	—	nil	3,311	3,285
„ used on works	—	—[h]	3,773	5,508
UNITS SOLD PER 8 C.P. LAMP CAPACITY	25·8	18·2	8·96	11·0
Maximum supply demanded	887 kilowatts	1,073 kilowatts	80 kilowatts	106 kilowatts
Number of public lamps	—	—	4 arc	4 arc
Number of consumers	504	688	71	89
Connections to mains in 8-c.p. lamps	55,988	73,853	6,200	7,346
CAPACITY OF PLANT IN 8-C.P. LAMPS	28,900	53,900	6,200	6,190
CAPACITY OF PLANT IN KILOWATTS	925	1,725	198	198
CAPITAL—	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.
AUTHORISED (TOTAL)	— / —	— / —	£20,000 / £101	£20,000 / £101
Share	£280,000 / £303	— / —	— / —	— / —
Loan (including Debenture charges)	—[a] / —	— / —	20,000 / 101	20,000 / 101
RECEIVED (TOTAL)	112.975 / 122	£299,500 / £174	20,000 / 101	20,000 / 101
Share	87,975 / 95·1	— / —	— / —	— / —
Loan (including Debenture charges)	25,000 / 27·0	299,500 / 174	20,000 / 101	20,000 / 101
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	— / —	— / —	— / —	— / —
Share (unissued)	182,000 / 197	— / —	— / —	— / —
Share (uncalled)	10,025 / 10·8	— / —	— / —	— / —
Loan (including Debentures)	— / —	— / —	— / —	— / —
REPAID (TOTAL)	— / —	— / —	1,272 / 6·42	1,858 / 9·38
RESERVE OR SINKING FUND	2,689[b] / 2·91	— / —	— / —	— / —
DEPRECIATION FUND	6,643[c] / 7·18	— / —	— / —	— / —
EXPENDED (TOTAL)	123,023 / 133	299,324 / 174	19,177 / 96·9	19,620 / 99·0
Lands and buildings	30,559 / 33·0	32,014 / 18·6	6,668 / 33·7	6,963 / 35·2
Plant	49,011 / 53·0	63,631 / 36·9	9,616 / 48·6	8,959 / 45·2
Mains	40,880 / 44·2	48,905 / 23·3	2,827 / 14·3	2,932 / 14·8
Miscellaneous	2,573 / 2·78	154,774[g] / 89·7	66 / 0·333	766 / 3·87
BALANCE OF CAPITAL ACCOUNT	−10,048[d] / −10·9	176 / 0·102	823 / 4·16	380 / 1·92
REVENUE—	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.
TOTAL	£16,307 / 5·242d.	£18.902 / 4·640d.	£1,293 / 5·590d.	£1,435 / 5·075d.
Revenue from supply	14,319 / 4·600d.	16,715 / 4·103 l.	1,113 / 4·810d.	1,253 / 4·430d.
„ meters, &c.	307 / 0·099d.	416 / 0·102d.	66 / 0·285d.	76 / 0·269d.
„ public lighting	— / —	— / —	90 / 0·389d.	90 / 0·318d.
„ sale of lamps, &c.	1,596 / 0·513d.	1,572 / 0·386d.	— / —	— / —
„ miscellaneous sources	85 / 0·027d.	199 / 0·049d.	24 / 0·104d.	16 / 0·057d.
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	£4,829 / 1·552d.	£6,197 / 1·520d.	£739 / 3·193d.	£784 / 2·770d.
WORKS COSTS	3,420 / 1·100d.	4,149 / 1·019d.	553 / 2·390d.	584 / 2·065d.
Generation of electricity	*3,063 / 0·985d.*	*3,787 / 0·930d.*	*449 / 1·941d.*	*451 / 1·594d.*
Fuel (including cartage, &c.)	1,003 / 0·322d.	1,228 / 0·302d.	74 / 0·320d.	70 / 0·247d.
Oil, waste, water, stores	190 / 0·061d.	444 / 0·109d.	9 / 0·039d.	14 / 0·050d.
Wages at station	1,367 / 0·440d.	1,499 / 0·368d.	314 / 1·357d.	342 / 1·210d.
Repairs and maintenance at station	504 / 0·162d.	616 / 0·151d.	51 / 0·220 l.	25 / 0·088d.
Distribution of electricity	*357 / 0·115d.*	*362 / 0·089d.*	*94 / 0·406d.*	*120 / 0·424d.*
Wages, &c.	207 / 0·067d.	362 / 0·089d.	94 / 0·406d.	120 / 0·424d.
Repairs, renewals of mains, &c.	150 / 0·048d.			
Public lighting	— / —	— / —	*10 / 0·043d.*	*13 / 0·046d.*
Attendance	— / —	— / —	10 / 0·043d.	13 / 0·046d.
Renewals	— / —	— / —		
MANAGEMENT AND PROPERTY CHARGES	1,409 / 0·453d.	2,048 / 0·503d.	186 / 0·804d.	200 / 0·708d.
Royalties	— / —	— / —	— / —	— / —
Rent, rates, taxes	*364 / 0·117d.*	*548 / 0·135d.*	*130 / 0·562d.*	*133 / 0·470d.*
Management	*1,045 / 0·336d.*	*1,500 / 0·368d.*	*56 / 0·242d.*	*67 / 0·237d.*
Salaries	550 / 0·177d.	951 / 0·233d.	8 / 0·035d.	8 / 0·028d.
Stationery, &c.	95 / 0·031d.	77 / 0·019d.	15 / 0·065d.	1 / 0·004d.
Establishment charges	199 / 0·064d.	195 / 0·048d.	7 / 0·030d.	4 / 0·014d.
Law charges, &c.	200[e] / 0·064d.	277[i] / 0·068d.	26[a] / 0·112d.	54[d] / 0·191d.
FINANCIAL RESULTS—	Total / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded
WORKING PROFIT FOR YEAR	£11,477 / 10·93%	£12,704 / 6·01%	£553 / 2 92%	£652 / 3·36%
Sum carried to Depreciation Fund	— / —	— / —	— / —	— / —
Sum carried to Reserve or Sinking Fund	— / —	— / —	435 / 2·30%	587 / 3·03%
Net interest on loans (incl. Debenture charges)	1,209 / 1·151%	1,660 / 0·786%	556 / 2·93%	579 / 2·98%
BALANCE FROM LAST ACCOUNT	100 / 0·095%	— / —	898 / 4·74%	432 / 2·23%
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	10,368 / 9·889%	11,044 / 5·23%	459 / 2·42%	— / —
Deficit	— / —	— / —	— / —	*82 / 0·423%*
ORDINARY DIVIDEND PAID	12½% / —	10%[j] / —	— / —	— / —
PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE	29·6%	32·8%	57·1%	54·6%
Expenditure per kilowatt capacity	£5. 4s. 5d.	£3. 11s. 10d.	£3. 14s. 7d.	£3. 19s. 2d.
REVENUE PER KILOWATT CAPACITY	£17. 12s. 7d.	£10. 19s. 0d.	£6. 10s. 8d.	£7. 5s. 0d.
Expenditure per 8-c. lamp capacity	3s. 4d.	2s. 3½d.	2s. 4½d.	2s. 6½d.
REVENUE PER 8-C.P. LAMP CAPACITY	11s. 3½d.	7s. 0¼d.	4s. 2d.	4s. 7¼d.
REVENUE PER 8-C.P. LAMP CONNECTED	5s. 10d.	5s. 1½d.	4s. 2d.	3s. 11d.
Price charged for lighting, per unit	5d.	4d. net	7d. to 3d.[b]	7d. to 3d.[b]
Price charged for power, per unit	4d.	2d. net	3d.	3d.
Price charged for public lighting	—	—	4d. per unit.	4½d. per unit.

SHEFFIELD.—REMARKS—*a* Not limited. *b* Includes £1,000 from the 1896 working profits, and £1,689 voted out of premium realised through issue of shares. *c* Includes £1,903 voted out of premium realised by issue of shares. *d* Over-expended. *e* Includes £54 to auditing, £88 to bad debts, and £23 to insurance. *f* The undertaking was taken over by the Sheffield Corporation at December 31, 1898, and had been worked up to that date, since the purchase, by the late company on behalf of the Corporation. *g* Includes premium account £143,686, and trading accounts including amounts written back, £6,260. *h* Included in units sold and charged against revenue. *i* Includes £22 to insurance and £21 to auditing. *j* Secured to the company by agreement for working the undertaking during the year.

STAFFORD.—REMARKS—*a* To insurance. *b* By max. demand system (one hour). *c* 79,679 units being the output from station 'bus bars. *d* Includes electric fittings £34, and insurance £20.

The Electrician.

The Oldest Electrical Journal (established as a weekly Journal 1861—1878)

Published every Friday, Price Sixpence; Post Free, Sixpence-Halfpenny
Editorial, Publishing and Printing Offices,

1, 2 & 3, SALISBURY COURT, FLEET ST., LONDON,

Telephone: 949 Holborn. *Telegrams:* "Electrician Newspaper London."

All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher "The Electrician," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "The Electrician" *Printing and Publishing Company, Limited, and be crossed "Coutts and Co."*

All Editorial letters to be addressed to The Editor.

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"The Electrician" *is published every Friday morning, in time for the morning mails. It is on sale at the railway bookstalls throughout the Kingdom on Friday morning, and can be obtained of all Booksellers and Newsvendors; or direct from the Publishing Offices, as above*

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United Kingdom	26s. 0d.	13s. 6d.	7s. 0d.	Post free, payable in advance.
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POPULARITY OF THE ELECTRIC LIGHT.

When the business of electricity supply was represented by a dozen or a score of central stations, the British public but showed its usual conservative spirit by its unwillingness to adopt electric light. It was argued—and with justice at that time—that this form of light was a luxury when a similar amount of illumination could be obtained by other means at half the cost. It was contended, with too much insistence, it is true, but yet with some reason, that electric light as supplied from a central station was unreliable; and finally the tale was hazarded in ignorance that the glare of electric lamps was bad for the eyesight, that it injured the complexion of the fairer sex temporarily if not permanently, and that it was dangerous to allow into one's house a mysterious force concerning whose very nature those who had studied the matter were ignorant. In spite of these objections by cautious householders and their wives, the "infant" fought its way onward, and soon arrived at lusty manhood. Difficulties, in the way of adverse legislation, were successfully overcome; the reaction following the failure of reckless company promotions occasioned merely a pause, after which electric light again forced its way onward; experience, improved training of electrical engineers, the energy and ability of the leading ones amongst them, and the proper study of the economic aspect of electricity supply business, soon resulted in a reduction of the cost of electrical energy; and now the demand for it grows of itself, and needs practically no encouragement except in remote parts of the country. So ardent, in fact, is this call for "more light," that the supply can hardly keep pace with the demand. Owners of generating stations are finding it impossible in many parts of the country to obtain and erect new machinery quickly enough to fulfil all that is asked of them, and cases are constantly occurring, notably in Manchester and Edinburgh last year, and in London this year, in which new consumers connected up in the summer occasioned an overload upon the station during the winter, owing to expected deliveries of machinery having failed. Thus it happens that in the very height of its prosperity another reaction of popular feeling is setting in, and the electric light is in danger of losing some of its hard-won *prestige*.

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At this juncture also the public, with the contempt bred of familiarity, finds an opportunity for exerting its well-developed faculty of criticism upon an application of science and engineering which some years ago it considered too remarkable and incomprehensible to be capable of practical application to the wants of man. Every difference of opinion between experts is duly noted by the vulgar, to be used as a weapon if necessary. Thus, a consumer will hear that a doubling of the pressure of the electric supply mains necessitates the employment of a less efficient lamp; and he will not stay to seek compensating advantages, but immediately records his grievance in the columns of the daily paper or in the smoking-room of his club. Another, whose house is connected to an alternating-current supply system, will meet a friend living in a district supplied with continuous current, and hear that this latter form of supply is the only one suitable for application to motive power. He will immediately find that he has been longing all his life for a mechanical means of driving his turning lathe or sewing machine. Possibly, much to his surprise, he will be supplied with a motor for this purpose at his desire; but then his discontent will only slumber until he, by some mischance, learns of the existence of a power factor. Having ascertained whether or not this is a desirable appendage to a motor-driven sewing machine, he will immediately clamour for the disability to be removed; and when continuous-current power mains are subsequently brought past his door, he will claim compensation for the inconvenience of having the internal arrangements of his house interfered with. A third consumer may get hold of the prospectus of a new extra-safe system of wiring, and proclaim loudly the dangers of electric light until his fire office or supply company hear him and give him a fresh grievance by compelling him to remedy the imperfections of which he is complaining.

Such grumblers are always present, and they can usually be treated with the contempt they deserve; but it happens sometimes that their cause is often favoured by a lucky—or unlucky—chance, "that oft decides the fate of mighty monarchs," and then woe to their victim. Chance has, in fact, played into the hands of those who wish to air their grievances against the manner in which electric light is furnished, and they have now a sympathetic Press and public to give ear to their murmurs. Just when a large portion of the metropolis is bearing with natural impatience the inconvenience of inadequate light through the overload difficulty already alluded to, another area in which the supply has been constant and uninterrupted for nearly a decade was suddenly plunged into darkness by one of those rare accidents likely to shake the public faith in the reliability of electric supply. While these two circumstances may appear to justify an attack made on the electric supply companies by a journal recognised as the vent for all dissatisfaction with the existing state of affairs, social, political, or economic—although it cannot justify the offensiveness of the opening onslaught: "At the present rate, it will not be long before the name of the electric light company stinks in London like that of the water company"—the electric lighting interest is receiving a severe though unmerited rebuff from another quarter. We referred in our last issue to the space devoted in *The Times* to the case from the pen of Mr. MONTAGUE CRACKANTHORPE against the safety of electric supply. This has elicited a letter from no less a personage than the President of the Institution of Electrical Engineers, who, instead of pointing to the extreme rarity of electrically-caused fires, was indiscreet enough to criticise the methods of wiring at present in vogue to a large extent—a criticism eminently suitable for the columns of a technical journal, but misplaced in the pages of the leading lay paper. The correspondence leads to a further tirade from another correspondent against the change-over from 100 to 200 volts pressures, and a reply from Mr. MONTAGUE CRACKANTHORPE quoting against Prof. THOMPSON an alarmist Paper read by Mr. F. BATHURST some time ago before the Association of Municipal and County Engineers. Mr. CRACKANTHORPE, moreover, suggests that the London County Council might take over the duty of protecting electric light consumers, and gives other kind advice to electrical engineers. It is to be hoped that Prof. THOMPSON will now retaliate by explaining to the eminent counsel the law as between supply undertaker and consumer.

These letters in *The Times* and the nasty attack in *Truth*, already alluded to, may not in themselves be taken seriously by the electrical profession; but, when considered in conjunction with the widespread and justifiable dissatisfaction in the parishes of Marylebone and Paddington, they are a clear warning that the popularity of the electric light is threatened. It behoves not only supply undertakers, whether companies or local authorities, but also manufacturers of plant and even wiring contractors, to remember that it is in their interest to fulfil precisely and to the best of their ability their duty to the consumers. It will not tend to their ultimate good merely to remark that accidents will happen, and to continue in the same way with nonchalance so long as no immediate effect on their own pockets is apparent.

REVIEWS.

(Copies of any of the undermentioned works can be had from *The Electrician* office post free, on receipt of published price.)

The Value of Electrical Treatment. By JULIUS ALTHAUS, M.D. Third edition. (London: Longmans, Green & Co. 1899.) 5s. 6d.

It appears to us that Dr. Althaus has attempted the impossible, in trying to give an adequate account of the value of electrical treatment in the modest compass of some 135 pages. For this is what it amounts to, as a part of the book is filled in with an essay on electrical treatment in gynecology from the pen of Dr. G. Apostoli, of Paris. The subject of electrical treatment is very unequally dealt with in this work. For instance, no less than 10 pages are given up to the subject of impotency and its electrical treatment, while such important subjects as infantile paralysis and the treatment of nævi by electrolysis are dismissed in a few lines. In the first part of the book is a meagre description of electrical apparatus and the definition of the electrical units. We can find no reference to the methods in use for the electrical testing of nerves and muscles except a slipshod account of the reactions of a case described on p. 86. It is a pity that Dr. Althaus still makes use of the terms galvanic and Faradic currents. The terms battery and coil current would be preferable. In the chapter on the discussion of static electricity as a remedial agent we must take exception to the definition that ozone is electrified oxygen. Next follow short sections on the subject of current from the main, and later on on the sinusoidal current. The author says: "The sinusoidal current may be obtained by means of a small dynamo, which will convert the continuous battery or the dynamo current of low tension into a sinusoidal current. . . . . It may give from 4,000 to 12,000 oscillations per minute and a difference between 32 and 64 volts." A few pages are devoted to the subject of the introduction of medicines by cataphoresis, the effects of the electrical current on bacteria, and the use of currents of high frequency. Dr. Althaus then proceeds to the discussion of the value of electrical treatment in various nervous affections in a manner which does not favourably impress us. We must congratulate Dr. Althaus on his success in the electrical treatment of cases of noises in the head, as we were under the impression that it was only a small propor-

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tion of such cases that were really benefited by electrical treatment. Dr. Althaus also recommends electrical treatment for old age!—LEWIS JONES.

A Dissected Model of a Direct-Current Dynamo. With a Description of the Various Parts. By ARNOLD PHILIP, Assoc.R.S.M., A.I.E.E., B.Sc.(Lond.). (London: George Philip & Son. 1899.) 4s. 6d. net.

This is one of Messrs. Philip's most successful "dissected models," and a marvel of ingenuity. The student is shown, by the means of hinged pieces of coloured paper, the actual position and form of the various parts of a dynamo, as seen at vertical sections parallel to the shaft, and hardly a detail is omitted. Where the sections shown are not sufficiently explanatory (viz., in the case of the field magnets and the driving spider), diagrams of cross-sections at right angles to the shaft are given in the text. Had the author chosen a bipolar machine of English design, instead of a four-polar German one (Messrs. Siemens and Halske's smaller, belt-driven, four-pole, Model A), with its magnets at an angle of 45deg. to the vertical, his task would certainly have been easier, but he acquits himself of it exceedingly well notwithstanding. The letterpress accompanying the dissected model is sufficiently accurate, and its character is elementary enough to be appreciated by the veriest tyro. Great credit is due to the printers (who, we notice, are German) for the accurate manner in which the various parts of the "model" are coloured and fitted together.

"Workmen's Compensation: Digest of Cases." By JAMES WEIR, M.A., Barrister-at-Law. (*Insurance Observer*, 37, Walbrook, London, E.C. 1899.) 5s. net.

Mr. Weir contributed, from April to September, 1899, a series of articles to the *Insurance Observer* on the subject of workmen's compensation, dealing especially with the cases decided under the new Act in England, Scotland, and Ireland. The subject of the book is one of considerable importance and interest to the principal industries of the country, and particularly to the engineering and electrical trades. There has been some difference of opinion expressed as to whether the Government was well advised in passing the Workmen's Compensation Act, but in the light of experience much of the adverse criticism levelled at the Act has proved to be unmerited. Nor is it surprising, seeing that the Act is somewhat of a new departure and raises (without, we fear, settling) a number of litigious points, that some of these have been left to the courts to decide. On the whole, however, it has worked smoothly, and, as was intimated at Leicester by Mr. Chamberlain, is likely to be extended to trades at present outside its scope. Mr. Weir's book is therefore opportune, and his treatment of the cases which have come before the courts takes a form which can be easily understood by the non-legal mind. The Workmen's Compensation Act (1897) and the schedules thereto are first set out, followed by the Factory and Workshops Act (1895). The digest of the decided cases is then given, many of these cases being accompanied by notes which help the reader to follow the findings and to appreciate the legal points raised by counsel from time to time. The book may be commended to those who take a general interest in the subject, as well as to those desirous of acquiring readily a knowledge of the legal findings up to date.

Practical Work in Physics. Part IV. Magnetism and Electricity. By W. G. WOOLCOMBE, M.A., B.Sc. (Oxford: Clarendon Press.) 2s.

This book will be found exceedingly useful for the senior students of science schools and for first year students of university colleges. The author does not, like some writers, enter into too much detail; he leaves something beyond the merely mechanical operation of taking readings to the ingenuity of the student. The experiments described cover all the essential portions of magnetism and electricity, and in the hands of a skilful teacher, who will supplement each experiment by suitable exercises, the little text-book should prove valuable.

Molesworth's Pocket Book of Engineering Formulæ. By SIR GUILFORD L. MOLESWORTH and HENRY BRIDGES MOLESWORTH. (London: E. and F. N. Spon. 1899.) 6s.

This popular pocket book is now in its twenty-fourth edition, the first edition having seen the light so far back as 1862. An electrical section, which had been discarded from the last edition, has now been resumed. It occupies only 58 pages of a total of 800, and this section cannot be described as so complete as, or equal in quality to, the other portions of the book. Useful and useless information are mixed indiscriminately, and the whole is of a "scrappy" character. We will only quote two instances of the poor editing. In a short section on testing only one method of measuring self-induction is given, and that a method which is apt to be unreliable unless certain particular conditions are fulfilled. The single page devoted to secondary batteries terminates with a comparison of the capacities of various types of cells per pound of plate in *foot pounds*. The other sections of the book maintain their high standard of excellence.

Lezioni di Elettrotecnica. GALILEO FERRARIS. (Torino: Roux, Frassati and Co.)

This first volume of the lectures delivered by Ferraris at the Museo Industriale Italiano of Turin deals with the scientific foundations of electrotechnology. As might have been expected from the discoverer of the rotating magnetic field, the principles of vector algebra form the subject of the very first lecture, and the whole system of the lectures is thoroughly modern. The electrotechnical course at Turin was Ferraris's own creation, and there were no trammels of old and worn-out traditions to interfere with the creation *de novo* of an up-to-date system of tuition. The main advantage of these lectures lies in their admirable clearness. The lecturer does not scruple to introduce the infinitesimal calculus freely wherever necessary; but it is used rather for concise representation than for the demonstration of physical laws. It is a little surprising that very little use is made of the more advanced conceptions of vector algebra, but probably the late author found that these conceptions are far less familiar in Italy than they are, for instance, in Holland. The volume before us takes the student up to the electromagnetic theory of light and the international units.

Le Magnétisme du Fer. By Dr. CH. MAURAIN. (Paris: G. Carré and C. Naud.) 2fr.

This is the second of a series of small books issued under the direction of an influential committee of French physicists, dealing with various subjects in pure physics. Maxwell's theory, cathode rays, the Zeeman effect, determination of the ohm, and other subjects are to be separately treated by different writers in a similar manner. Their object is briefly to summarise the existing state of our knowledge of these various subjects, and to indicate as far as possible the lines of further research. The book under review contains a highly satisfactory summary of most of the work which has been done on the magnetisation of iron. The subjects dealt with are: Magnetisation curves and their peculiarities, effects on shapes of curves due to shape of magnets, permanent magnetisation, magnetisation by induced currents, oscillatory discharges and rotating magnetic fields, hysteresis and its variation with temperature, law of Steinmetz. We regret to note that there are no references to the effects of temperature and time on permanent magnets, and also of Dr. Morris's most important investigations on the change of hysteresis losses with temperature. The book contains a very useful and nearly exhaustive list of references to original Papers, which alone should ensure its being in the hands of every student interested in the magnetic properties of iron.

Elektromotoren für Gleichstrom. By G. ROESSLER. (Berlin: Julius Springer. 1899.) 4 marks.

This book is based on a series of lectures delivered by the author in the summer of 1898 to mechanical engineers at the Berlin Technical College. As indicated by the title, only continuous-current motors are dealt with. Starting with an elementary chapter containing definitions, an explanation of Ohm's and Joule's laws, &c., and a second chapter on elementary principles of magnetism, the author proceeds to treat his subject clearly and more or less in the usual and orthodox manner. The final chapters on compound winding, electrical braking, sparking, armature reaction, and eddy currents and hysteresis, are short. The book would have been

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more valuable had it considered to a greater extent the question of the influence of the work of the motor on its design, the arrangements of gearing and suspension, and the special problems arising in traction work and in other important particular cases.

Analyses Electrolytiques. By AD. MINET. (Paris: Gauthier-Villars. 1899.) 2fr. 50c.

Although not professedly a text-book, this little work of 176 pages on electrolytic analyses would very well serve as such, and should be of use to many now that the Institute of Chemistry has included electro-chemistry amongst the subjects which may be taken up by candidates for admission to its membership. There are five chapters in the book, the first of which gives a brief historical summary of the application of electricity to chemical analysis, starting with the work of Gibbs on the estimation of copper. Following this is a description of the electrolytic system—*i.e.*, the apparatus which is necessary, and its mode of arrangement, including electrodes and the use of mercury as a cathode. For the very small currents used in analytical work primary batteries still find some employment, and it would be a good thing if they could be further improved, for it is not always practicable to employ accumulators which need some extraneous source of current to charge them. But if the description of some of the principal batteries is necessary, the same cannot be said of the account of the magneto-electric machine, as nowadays it is not employed in the electro-chemical laboratory.

The second chapter deals with the qualitative and quantitative analysis of metalloids, the author pointing out that very little use has been made of qualitative methods. The quantitative estimation of metals which have been separated from other metals occupies Chapter III. In the following chapter methods are given for the separation and estimation of metals from mixtures and combinations containing other metals, and the work concludes with a chapter on alloys, in which will be found a full account of M. Hollard's researches on the electrolytic analysis of commercial copper, bronze, brass, and lead in its principal alloys.

The subject matter is well arranged, the illustrations of electrolytic apparatus are clear, and there is not that redundancy of methods given which so frequently mars works of this sort and confuses the reader.

Electric Bells and Alarms. By F. E. POWELL. (London: Dawbarn and Ward.) 6d.

This little book, forming No. 3 of the "Model Engineer Series," and produced by the proprietors of the *Model Engineer and Amateur Electrician*, tells amateur bell fitters a great deal about electric bells—more than a great many "amateur electricians" probably know, but much less than would be requisite to instruct or serve as reference to a workman whose trade it is to make or install this class of apparatus. The former class of reader will probably find it well worth 6d.

THE MINIMUM CHARGING CURRENT OF A CONDENSER.

BY ALEXANDER RUSSELL, M.A.

The following is a solution of the problem of finding the form of the wave of P.D. which produces the smallest effective current in charging a condenser to a given potential in a given time. It is also the solution of the alternating-current problem of finding the form of the P.D. wave which makes the condenser current a minimum, the maximum height and the frequency of the P.D. wave being given. The solution shows that the required wave is triangular in shape. The method employed is worthy of notice, as it has been found useful in allied problems.

In Fig. 1 various E.M.F. waves (*a*), (*b*) and (*c*) are represented, each of which attains its maximum value E in the time O N. The currents (Fig. 2) charging a condenser of K farads capacity with these waves are got by the equation

$$i = K\frac{de}{dt},$$

where the symbols have their usual meanings.

The areas of all the current curves in Fig. 2 from O to N give the number of coulombs K E required to charge the condenser; they are therefore all equal. Hence the mean heights (i_m) of the current curves are all equal. Now if A be the

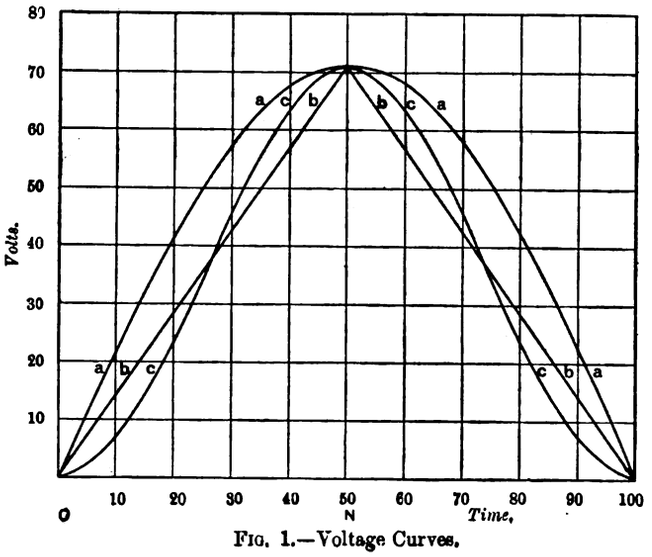

FIG. 1.—Voltage Curves.

effective value of the current and $\bar{i}$ the height of the centre of gravity of the current curve, then

$$A^2 = 2\bar{i}\, i_m.*$$

In our case i_m is a constant, and therefore A is a minimum when $\bar{i}$ is a minimum—that is, for the rectangle.

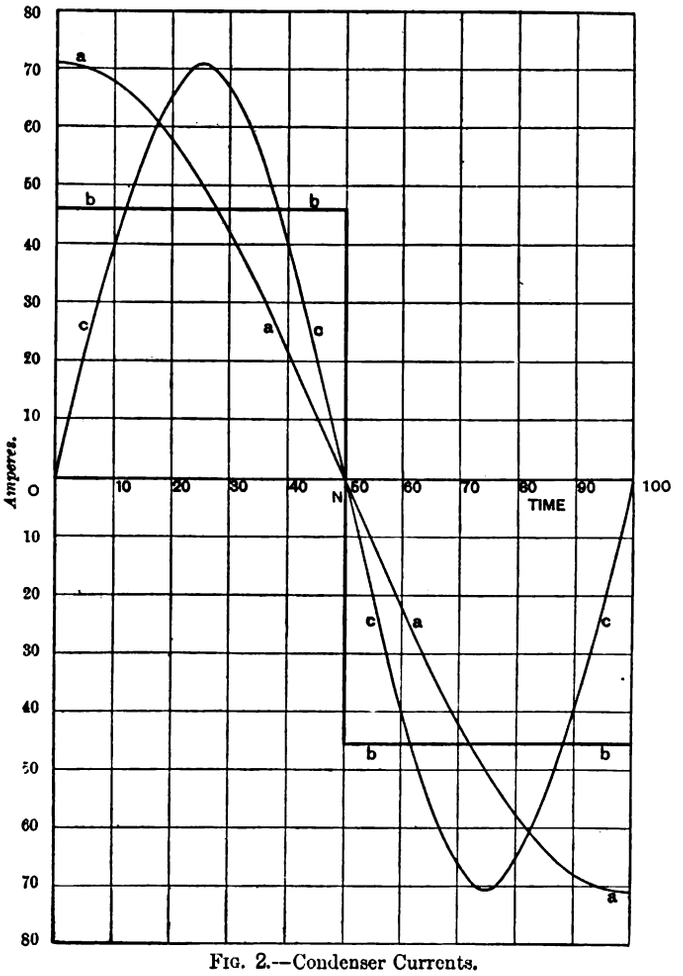

FIG. 2.—Condenser Currents.

Now the P.D. wave which makes the charging condenser current a rectangle is a triangle ((*b*) in Fig. 1). Hence, when we are given the maximum P.D., the charging current of a condenser is a minimum for the triangular wave.

* See *The Electrician*, Vol. XXXV., p. 115, "Graphical Methods of Finding Mean Square Values."

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ELECTRICAL TIME SERVICE.*

BY F. HOPE JONES.

(Concluded from page 308.)

In the system which I advocate the self-wound central or controlling clock has but one duty to perform, viz., to make and break an electrical contact every half-minute, and I prefer therefore to call it an "automatic timed-switch." Such an instrument necessarily requires the combination of the essentials of a good switch and those of a good clock. I believe I am right in saying that in the systems I have named that combination has not been effected without one or other of the essentials suffering. Either the switch is inefficient through lack of power, or the safe-going and time-keeping of the clock are in jeopardy owing to this extraneous duty being required of it. In the instrument shown in Fig 3, however, this is not the case. A is a pendulum driven by an escapement B in the usual way. The necessary turning force is applied to the scape-wheel by means of the weighted lever C, which in falling through a small arc communicates its power through a click and ratchet to wheel D gearing with the scape-wheel. E is an armature centred at F. As the weighted lever falls in its action of driving the pendulum, its lower limb meets the contract screw G in the tail of the armature, and the circuit of the electro-magnet and of a large group of dials in series with it is closed by the contact of these two parts. The weight is then thrown up, and its momentum causes a quick break as the insulated screw H comes into action and the armature is stopped by the poles of the magnet.

This instrument has therefore the two essentials of a good switch—a severe rub and thrust and a quick break. It will be noticed that

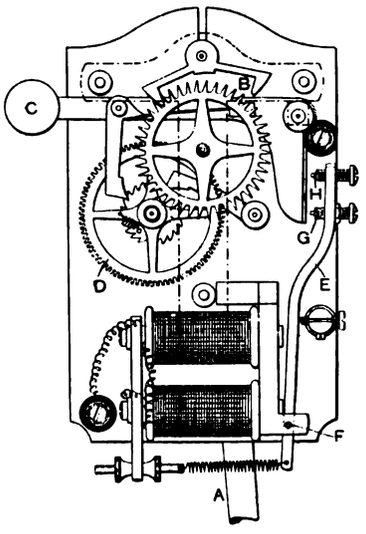

FIG. 3.*

* Figs. 3, 4 and 5 are the subject of patents granted to F. Hope-Jones and G. B. Bowell, and are reproduced by permission of the Synchronome Syndicate, Limited.

the switch consists of two moving parts—the armature which drives and the weighted lever which is driven—and that *the entire energy required to keep the pendulum swinging is mechanically transmitted through the surfaces of the contact at each operation.* Thanks to this all-important principle I have never known one of these contacts to fail, though some hundreds of them have been in use for several years under conditions in which a relay contact would have struck work in a month or two. Incidentally this automatic switching operation is used to provide a power of absolute constancy to maintain the vibrations of a pendulum by throwing up the weighted lever C every half-minute, and thus it also possesses the greatest essential of a good clock.

For operating any circuit of step-by-step movements the ordinary relay form of contact, which has invariably been used before, is to my mind quite unsuitable. Apart from the insufficiency of the rub and thrust, its duration has always been arbitrarily decided by guesswork. Obviously, if the contact is too short, the least sensitive of the dials will not respond to it. If too long, there will be a considerable waste of electrical energy, and we must not forget that the exact duration required varies in every installation according to the time-constant of the entire circuit.

Now in this automatic timed-switch it will be observed that the duration of the contact is dependent upon an electro-magnet placed in series with all the magnets it has to control; its duration is, therefore, *in exact proportion to and dependent upon* the time constant of the entire circuit. It is easy so to adjust the weight of the two moving members of the switch and the ampere-turns and self-induction of the electro-magnet which is employed to overcome their inertia, that the break cannot occur until the electric inertia of the whole circuit has been overcome and every dial in it has had exactly what it wanted. As illustrating the perfect self-adjustment of the duration of the contact under all circumstances when performed by this instrument, let me instance its operation in the numerous time-circuits where an electric light supply is used as the motive power through an incandescent lamp as a working resistance: in these circumstances the switch automatically proportions its supply to the requirements of its circuit by breaking contact at the moment when the lamp filament has become sufficiently heated to allow the necessary current to pass. The gradual rise in current secured in this way, and the sudden break at exactly the right moment, is in every way beneficial. The former is conducive to silence in the action of the dials, and the latter ensures economy. Again, in time circuits operated by a primary battery, as the internal resistance of the cells rises the duration of the contact will increase, and the dials will continue to operate in spite of a considerable drop in pressure.

Fig. 4 shows the step-by-step movement or electro-magnetic time counter operated every half-minute by the switch described. It is of such simplicity that I should feel diffident in bringing it so prominently to your notice were it not that certain points in its construction have proved themselves to be of vital importance. The main wheel carrying the minute-hand has 120 rectangular teeth, and the armature lever carries a rectangular steel propulsion click limited in its upward movement by a fixed stop. Only one other click is provided—viz., the backstop—which is also a rectangular steel block at the extremity of a pivoted arm. The wheel is propelled by a flat steel spring bearing upon the heel of the propulsion click.

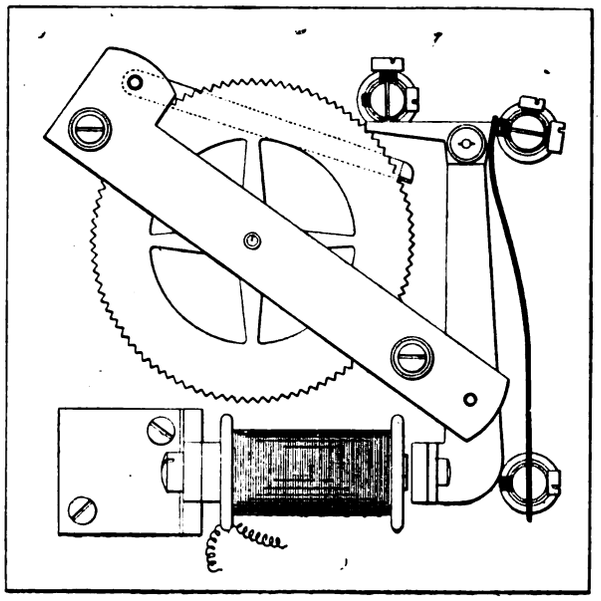

FIG. 4.

After reviewing all known forms of electro-magnetic time counters, Du Moncel lays down the rule that in addition to the impulse click and the retaining or backstop click, the wheel must be stabbed by a "cliquet d'arrêt," and, further, that the impulse click must always drive at a tangent to the wheel. We have ventured to trangress both these conclusions, and in doing so it appears that we have designed a movement which is more certain in action and more capable of wholesale manufacture than any of its predecessors. By driving at an angle of 135deg. to the radius and adopting rectangular teeth, we can with safety apply a fixed stop above the propulsion click which will effectually arrest the momentum of the hands after their forward movement, thus accomplishing the object of the third click. The position of the propulsion click and this upper stop is of the greatest importance. If we drive at a tangent the slightest eccentricity of the wheel will, by varying the dimension between the circumference and the fixed stop, allow the click either too much space, so that it locks the wheel inefficiently, or too little space, in which case it will jam. The propulsion click in this movement is carried up against the fixed stop whether the wheel is eccentric or not, and runs no risk of becoming jammed, but remains perfectly free to slide out on the dead surface of the next tooth in response to an electrical impulse of any duration, provided it is not less than 100th of a second. Another point to be noted is that when only two clicks are used, and these are placed near one another on the circumference of the wheel, there is no difficulty in adjusting them nor any necessity for accuracy of workmanship.

* Paper read before the Institution of Electrical Engineers, Dec. 14th.

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This movement is particularly suitable for operating turret clocks in which the hands are exposed to the weather. The usual turret-clock consists of an ordinary eight-day timepiece built upon a scale proportionate to the increased diameter of its dial. It is a difficult thing to build an accurate time-measurer of such a large size, and in spite of Lord Grimthorpe's invention, which prevents the wind pressure on the hands affecting the escapement, it is seldom accurate and always costly. Inasmuch as the only requirement is to revolve the hands at a given rate, it is obviously economical to accomplish this by so much brute force supplied on the spot and controlled by a time circuit or a self-wound electrical pendulum of reasonable size if no such circuit is available. It is of course necessary to provide a very large margin of power to overcome exceptional resistance, such as a gale of wind or the accumulation of snow upon the minute-hand. Consequently a much larger size of our electrical step-by-step movement is required, and as the inertia of its parts is necessarily much greater, the duration of the contact of an ordinary time-circuit would be insufficient to operate it. We therefore drive it by a separate battery in a local circuit controlled by a relay in the time-circuit. This relay is electrically interlocked with the large dial movement so that the latter can take its own time to complete its cycle of operations, the last of which is the breaking of its own local circuit. This arrangement is, I think, clearly expressed in the accompanying diagram (Fig. 5), and does not require further description. It will be noticed that the primary electromagnet of the relay is in the time-circuit, and that a contact of the shortest duration will suffice to start the secondary mechanism upon its work, which it will then perform in its own time. Even where a time-circuit is not available the great expense of the customary turret-clock movement may be saved by using an ordinary self-wound pendulum and escapement in mechanical combination with a large step-by-step dial movement; but the available space in this short Paper prevents a description of it here. I, however, exhibit a model, which will serve to show that for this particular purpose an individual and independent self-wound clock is justified by its efficiency and economy.

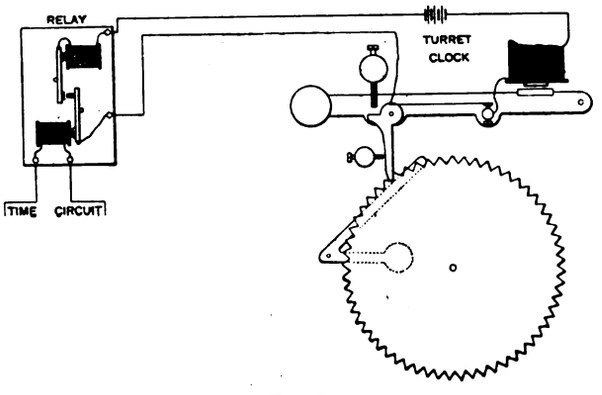

FIG. 5.

Referring again to the small edition of the step-by-step movement illustrated in Fig. 3, let us apply a rough-and-ready means of ascertaining the minimum duration of contact to which they will respond by putting a few of them in series with a vibratory interrupter. I take an ordinary electric bell for this purpose, and, removing the bell, adjust the hammer to a periodicity of about 25 per second. You will observe that the dials in circuit with it duly revolve at the rate of 12 hours per minute, and that whenever I break the circuit they stop at exactly the same half-minute, having kept perfectly in step. This test is of course unnecessarily severe, and it leads me to ask in all seriousness whether, when such step-by-step dials which have not been specially designed for rapidity will work synchronously in response to such rapid and imperfect electrical impulses, they will not serve to distribute time in a wholesale manner from house to house when controlled by a properly equipped central time station?

In such an undertaking we must, before all things, realise the enormous responsibility that public time service carries with it. With our present method there is, at any rate, some security in numbers, and knowing that no two of our ordinary household clocks ever agree, we only expect approximate time, and refer to our watches when greater accuracy is required. In an electric light service a breakdown betrays itself immediately, but in a time-service the stopping of one or more dials is an unannounced and insidious evil. Perfect synchronisation and immunity from breakdown is therefore necessary in any system of electric time distribution. There is, however, no need to starve it. A hundred pounds or so would equip a central station lavishly, and, as the earning power of the lines is great (enormous when compared with systems of synchronisation or correction), they should be laid as carefully as electric light cables.

Lest we be tempted to allow considerations of economy to outweigh those of security, let me quote Antwerp as an object lesson. For about 15 years endeavours have been made in that city to work 100 street-corner dials on overhead lines radiating in all directions from a central time station, and earthed at their extremities. It is true that their step-by-step movements and the switches to control them were partly at fault, but no circuit could be considered safe which a storm might interrupt and a falling telephone line might short-circuit. The Antwerp installation has now been abandoned.

Several suggestions have been made for utilising existing electric light networks for time service, but though interesting they are impracticable, and I must therefore deny myself the pleasure of dealing with them here. In the equipment of a central time station it would be wise to provide two automatic timed-switches (such as those described in Fig. 2) and a sentinel switch of a simple form, of which I show you a drawing, to transfer the load in the event of the one in operation stopping from any cause. They would carry all the current required in an area of several square miles, the spark being of course shunted through a non-inductive resistance. It would be convenient to use low resistance magnets, and to put any number from say 50 to 100 receivers in series. The switch operates several such circuits in parallel. I think it would be unwise to risk the safety of time mains by allowing them to circulate in any building. I would therefore confine them to street clocks and relays placed in similar positions to meters, from which sub-circuits in each building could be operated. An ordinary relay, however, would be quite unsuitable to such a purpose; instead, we should use the pattern I show you, in which the duration of the contact is dependent upon the electrical inertia of the circuit it serves, and so designed that it refuses to work at all unless the battery power in the sub-circuit is sufficient to run its dials with safety. Thus responsibility for failure in local circuits would be decentralised, and a glance at the relay would show whether the fault was insufficiency of the local battery or a break in the local line.

Once a reliable time service is established we shall recognise its utility for many other things besides turning the hands of our clocks. It will be required for operating tally clocks and watchman's watchers in factories, for ringing bells at pre-arranged times in schools, for speed-recorders in engine rooms, for automatic cut-in and cut-out switches for arc lamps, and last, but by no means least, to enable us to supply the most simple and efficient form of electricity meter imaginable.

Is it possible that such a simple method of electrical distribution of time will suffice? I maintain that it is, provided the principles upon which the dial movements are designed and the electrical impulses are produced and distributed are correct. You will tell me that key-wound clocks are reasonably serviceable, and that, thanks to the accumulated force of centuries of industry and millions of capital, independent timekeepers can now be bought for 1s. 6½d. each. You will say that the vested interests of the clock-making trade are too powerful to admit of such rivalry. But to this I reply that the best is bound to win in the long run, and that one wheel giving uniformity and accuracy without weekly winding is better than the five or six wheels, the escapement, and the pendulum of an ordinary clock which requires weekly attention.

With a capital outlay of only a few pounds, and without organisation, already several large blocks of offices in the City have this time service installed, the tenants gladly paying £1. 1s. per dial for the first year and 10s. 6d. per dial per annum afterwards; and even at these low figures the business offers tempting prospects to the financier. At such a popular price it would not be unreasonable to expect that electrically propelled dials will be required in 50 per cent. of the offices in a busy district of the City, Greenwich mean time being guaranteed, and no charge being made for erection in addition to the rental. Further, the tenants would be spared the inconvenience of the weekly visits of the clock-winder. We must not wait for the municipal authorities to establish a public time service in the streets, for they never yet in this country took the *rôle* of pioneers. It is not sufficient for them that the majority of the more important towns of the Continent have for years considered street timing as much their duty as street lighting and street cleaning, particularly as existing systems have not been uniformly successful. Private enterprise must lead the way. The commercial considerations have been carefully looked into, and the existence of a demand for such a service has been proved. I believe I have demonstrated by theory and practice that these instruments are capable of supplying it, and that it now only requires the electrical engineering profession to take it in hand to establish public time service on the same firm footing as electrical light supply.

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HOW TO GET RID OF THE "4π" ERUPTION WITHOUT CHANGING ANY OF THE LEGAL UNITS.

BY PROF. REGINALD A. FESSENDEN.

As far back as 1882 Oliver Heaviside, in one of his articles published in *The Electrician*, referred to the inconveniences arising from the fact that 4π enters into the equations for voltance and gilbertance. He proposed, later, that the matter should be remedied by changing the size of the units of current, voltage, magnetic flux, and difference of magnetic potential. This change, whilst no doubt very desirable, has not seemed to be very practical, especially since the size of some of these units has been fixed by law. How great the inconvenience is which this 4π factor introduces will be seen when I mention (what I shall show in a Paper, to be published soon) that its retention *necessitates the use of no less than 26 distinct additional electrical terms, with their corresponding symbols*, all of which would disappear, without the need of introducing any fresh ones to take their places, if only the gilbertance were defined as the curl of the current and the voltage as the curl of the time rate of magnetism. Rather than go through the years dragging this collection of mathematical junk tied to our tails, it would seem as if it would be preferable to insist on new legal definitions of the units. This would, however, doubtless meet with great opposition, and would not, with our conservative Governments take place within probably 50 years.

I have, to my great delight, found a way of getting rid of the 4π's without changing any of the legal units or creating any trouble whatever. It consists simply in taking the magnetic permeability of the ether as $(4\pi)^2$ instead of unity. (I am aware that the permeability of the air is taken as unity, but there is a mix-up here, too, as v is generally taken as the velocity of light in vacuo.) If we do this we get the following: Unit of current, no change. Unit of voltage, no change. Unit of difference of magnetic potential, 4π times as big as of old—*i.e.*, new unit equals 1 ampere-turn. This has the advantage that it is already used in practice. Unit of quantity of magnetism, $1/4\pi$ times as big as before—*i.e.*, same size as old magnetic line. This also is used in practice. Unit of magnetic permeability, $1/4\pi$ times as big as before. This does not hurt anything.

There is no change in any other way, and $1/k^2\mu^2$ is as before the velocity of light in a substance of unit permeability and specific inductive capacity.

We have now no use for magnetic flux as distinguished from quantity of magnetism, or of electrostatic flux as distinguished from quantity of electricity. Consequently, the 26 separate and distinct electric terms above referred to, with their corresponding symbols, disappear, to our great joy and the relief of the alphabet. Moreover, the 4π does not pop up in the equations for the attraction of point charges. Instead of simply driving the 4π from one important point to another, we have practically got rid of it by sticking it on to one of the constants of Nature. This may not seem a nice thing to do to Nature, but then she did not consider our own feelings when she made π what it is. It is a sort of poetic justice. So far as our own convenience is concerned, the 4π is practically gone, for we can just as easily call the permeability of iron 3,000 as 20.

To compare the new and old quotations, to see the general improvement:—

Old Equation.	New Equation.
$\frac{\mathfrak{B}^2}{8\pi\mu}$	$\frac{\mathfrak{M}^2}{2\mu}$
$\frac{\mathfrak{H}^2\mu}{8\pi}$	$\frac{\mathfrak{H}^2\mu}{2}$
$G = \mathfrak{H}\pi In$	$G = In$
$E = 4\pi\dot{N}$	$E = \dot{M}$

Where N = quantity of magnetism, G = difference of magnetism p. ct., E = voltage, and N the number of magnetic lines.

It thus seems to me that we have here an easy method of carrying out Heaviside's reform without making any disturbance with established things. The question is now one of "practical politics." No one will object to us electricians making the permeability of air $(4\pi)^2$, or of taking the ampere-turn as the unit of gilbertance. In fact, if the powers that be have realised how great the imminence of a strong demand for reform has been, they will probably give us their blessing for not disturbing them.

Another question comes up—that is, the reversal to absolute units. The practical men do not want the so-called practical units. They find them a nuisance. I would suggest, instead of calling the absolute units of quantity, voltage, &c., by new names, that we simply add the suffix ma or sta to denote that absolute magnetic or electrostatic units are meant. Thus, the absolute electromagnetic unit of difference of electric potential would be the Volma, equal to 10^{-8} volts. The absolute electrostatic unit would be the Volsta. So the Coulma would be 10 coulombs, &c.

Then I would propose a system of other affixes, to denote space, area, volume, and time differentials, also configuration constants. Thus, the Volmal would be the electric intensity or volmas per cm. The Coulmar would be the quantity of electricity per cen. sq. The Coulmav would be the volume density of electricity. The Coulmat would be the time differential of quantity, or the electric current. For multipliers use Houston and Kennelly's system.

In fact, a whole system of nomenclature is thus built up, just as was done by the chemists. In the Paper referred to I shall give the matter in detail. At present I would like to have criticism of both the matters mentioned—*i.e.*, the new way of getting rid of 4π and the nomenclature.

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THE BONN ELECTRICITY WORKS.

Some little time ago we referred briefly to an electricity supply works which had been erected in Bonn, utilising a 2 × 220 volt three-wire system, with not only an earthed middle wire but a bare middle wire. This station, which has now been running since the middle of February, 1899, was described in detail in the *Elektrotechnische Zeitschrift* of December 7th. Another somewhat new feature in the distributing system is, that although the station itself is on the borders of the district supplied, a main feeding point has been chosen in a central position of the town, which is fed directly from the station by four heavy cables each of one square inch section, and from this feeding point 13 pairs of feeders radiate out to the actual feeding points on the distributing network.

Dr. Paul Bauer, who is the writer of the article in our contemporary, states that Bonn is the first town in Germany to adopt a 2 × 220 system of any large size, although there are several smaller systems employing 220 volt two-wire systems in that country. Since the erection of the Bonn station was started, the towns of Crefeld and Basle, Switzerland, decided to employ similar systems, and these will shortly be in operation. The expectation that the weight of copper employed would be a quarter of what was necessary on a 2 × 110 volt system was not absolutely fulfilled in practice, although of course there was a great saving. There were two reasons for this. In the first place, increasing the load in this proportion would mean that the current density in the copper would be doubled, and, especially in the case of short feeders, this would result in a current density exceeding what is generally considered permissible. In the second place, some small and lightly loaded distributing mains would, according to this calculation, have sections smaller than would be advisable from practical considerations. These points apply especially to a 2 × 220 volt system with a bare middle wire, as the bare middle wire itself cannot be greatly reduced, on account of possible electrolytic or direct chemical action upon it. Moreover, the earth currents emanating from the adoption of the middle wire would, if a great fall of pressure were allowed on it, cause disturbances to the telephones (which are on the single wire earth-return system in Germany) and cause electrolytic action in other conductors under the streets. In addition, the cost of cable does not increase in proportion to the section of copper, but at a slower rate, and the cost of cable fittings is practically the same for the two pressures. So that, taking all in all, one can reckon that the cost of a 2 × 220 volt network amounts to from half to three-quarters that of a 2 × 110 volt one for the same supply.

After pointing to the advantage of a 2 × 220 volt system, that the same machines can be employed both for lighting and traction (although of course not from the same 'bus bars if the full pressure is employed for the traction with an earthed return), and the disadvantage in the necessity of having so many arc lamps in series of constant pressure mains, the writer proceeds to describe the generating station, which has some points of interest. The water in Bonn cannot be employed directly in the boilers, on account of its extreme hardness, and has first to be freed of lime and carbonates. For this purpose solutions of caustic soda and quicklime are employed to precipitate the lime and carbonates respectively. The two solutions are kept in separate wrought-iron vessels, and they are fed automatically into the water. After this mixing in a special vessel, the filtering takes place in two cylindrical vessels with funnel-shaped bottoms, in which the precipitate collects. The vessel is so constructed that this slime can be conveniently removed from time to time. Thence the water is led to two tanks, from which it flows directly to two feed-pumps beneath. This water-softening and cleaning plant can deal with 2,640 gallons of water per hour. Steam is led to the four-throw Weise and Monski feed pumps (capacity of each 3,170 gallons per hour against a pressure of 147lb. per sq. in.) through wrought-iron ring mains with copper bends. The water condensed in the various steam mains is, when clean enough, allowed to flow into the feed tank; and the feed is further heated by leading the exhaust from the feed pumps through the mixing vessel into the open air. A cooling tower is employed for the circulating water of the condenser.

The boilers are two in number, by Messrs. A. Büttner, of Uerdingen, and designed for quick steam raising. Each contains 117 inclined water tubes 3·74in. diameter, 0·14in. thickness, and 16ft. 5in. long. Each boiler is fitted with a superheater of 520 sq. ft. heating surface, consisting of a number of thin wrought-iron tubes placed in the path of the furnace gases, and through which the steam from the boiler is led to the mains. This increases the temperature of the steam by 40°C. to 60°C. Two different systems of "smoke-consuming" stokers have been put in, to enable a comparison to be made between them. One is by Kowitzke, of Berlin, and the other by Fröhlich, of Leipsic. In the former a sufficiency of strongly-heated air is automatically led through a cast-iron fire bridge of peculiar formation and provided with hollow spaces. This supply is regulated automatically by a stop valve controlled by gearing for a certain time after fresh fuel has been added, and in this way perfect combustion is attained. The Fröhlich stoker is briefly an inclined grate, which the fuel reaches through a hopper without the entrance of cold air. The fuel slides down the grate as it gradually burns, and finally falls into the ashpit through a trap at the end of the grate. Above the grate is a bridge of refractory material in which are air channels, and the glowing walls of this, in conjunction with the air entering through these passages, are said also to effect complete combustion. A convenient arrangement is provided for removing the ashes. Two similar boilers are now being erected, in addition to those already working.

Wrought-iron duplicate steam mains with copper bends lead to the engine room, where there are at present two vertical compound engines running condensing at 150 revs. per min., and with an average output of 200 H.P. and a maximum of 250 H.P. each. They are from Messrs. G. Kuhn, of Stuttgart, and their main dimensions are: H.P. cylinder 18·3in., L.P. cylinder 27in., stroke 17·7in. They have piston valves, and regulate by variation of the cut-off in the high-pressure cylinder. The condenser pump is also of Messrs. Kuhn's construction, and is worked from the cross-head. The engines are arranged to work condensing or non-condensing. According to the guarantee, the engines are to develop 200 H.P. with steam at a pressure of 132lb. per sq. in., using 17·2lb. of steam per I.H.P. per hour, and 17·6lb. of steam at the maximum load of 250 H.P. A half per cent. speed variation is allowed during one revolution. A Swiderski triple expansion engine, rated at 650 H.P., is being erected

The engines are directly connected to the dynamos, which are of the Siemens-Halske internal pole multipolar type, capable of generating 175 kw. each at a pressure of 440 to 550 volts when running at 150 revs. per min. A maximum temperature rise of 50°C. is guaranteed, and an efficiency of at least 90 per cent. For the Swiderski machine, a Siemens and Halske dynamo will also be provided

The battery consists of 290 (E 23) Tudor cells, with a capacity of 540 ampere-hours at the maximum charge or discharge rate of 180 amperes, or a capacity of 700 ampere-hours at 70 amperes discharge. Four hundred amperes may, however, be taken from the battery without injury. The cells are erected in two rooms above one another, and two similar rooms above these are provided for a similar battery which will eventually be put in as a "buffer-battery" for tramway work. Thirty-eight regulating cells are provided at each end of the battery, two to each contact of the regulating switch. A combined set of balancing transformer and boosters is employed in much the same way as is done in a number of modern stations in this country.

The switchboard is of marble mounted on an iron framework, and is placed at a distance of 5ft. from the wall on a platform 8ft. 3in. above the ground. All the fuses for the machines, battery, and feeders are fixed on the wall below the platform, and shut off from the rest of the engine room by an oaken wall with a side door at the end. Here are also meters and switches controlling the pump motors. The back of the main switchboard is also accessible through a door at the end. An innovation is the insertion of bells across the resistances bridging the contacts of the battery regulating switches, so that a bell rings if the switch is left between two contacts. The station pump-motors, and station lighting are arranged so that they can be switched on to either side of the three-wire network, and thus aid in balancing the load.

The arrangement of the feeders has already been referred to. At the central feeding point is a small iron tower, similar in form to the transformer houses so common on the Continent, and from here all the feeder circuits are branched off through fuses. Two ammeters are arranged with plugs to fit into contacts on either side of the fuses, so that an ammeter can be cut in and the current through the feeder measured without interrupting the circuit. Pilot wires run from the feeding points to this central switching point, and thence to the station, and there is also telephonic connection to the station, so that testing is greatly facilitated. The distance of the farthest point of the network to the station is about 2·4 miles, and the whole length of streets in which cable is laid is 18 miles. At all feeding points and branching or crossing points of the network, disconnection boxes are provided, but in making house connections it is unusual to disconnect, it being found that an experienced jointer can do the work while the cables are live. The network is designed for an equivalent of 8,000 16 c.p. lamps, on the basis of 2 × 50 volts drop of pressure from station to feeding points and 2 × 3 volts on the distributing network.

All the house connections are made as three-wire connections. Up to about 20 lamps the wiring is connected to one side of the three-wire network, and the service cables end in a switch fuse which enables either outer to be connected to the wiring, the free pole remaining covered by a protecting cap. Connections of over 20 lamps two separate single-pole fuses are employed, and the circuits of the house wired on two absolutely separate circuits, one on each side of the three-wire system. No fuses or switches are connected on the middle wire. Motors over 2 H.P. are connected between the outers.

When supply was started in February, there were 350 consumers, and the number now exceeds 400. This is considered a large demand for the first year's working in a town of 40,000 inhabitants. No trouble has been experienced with the new system of distribution.

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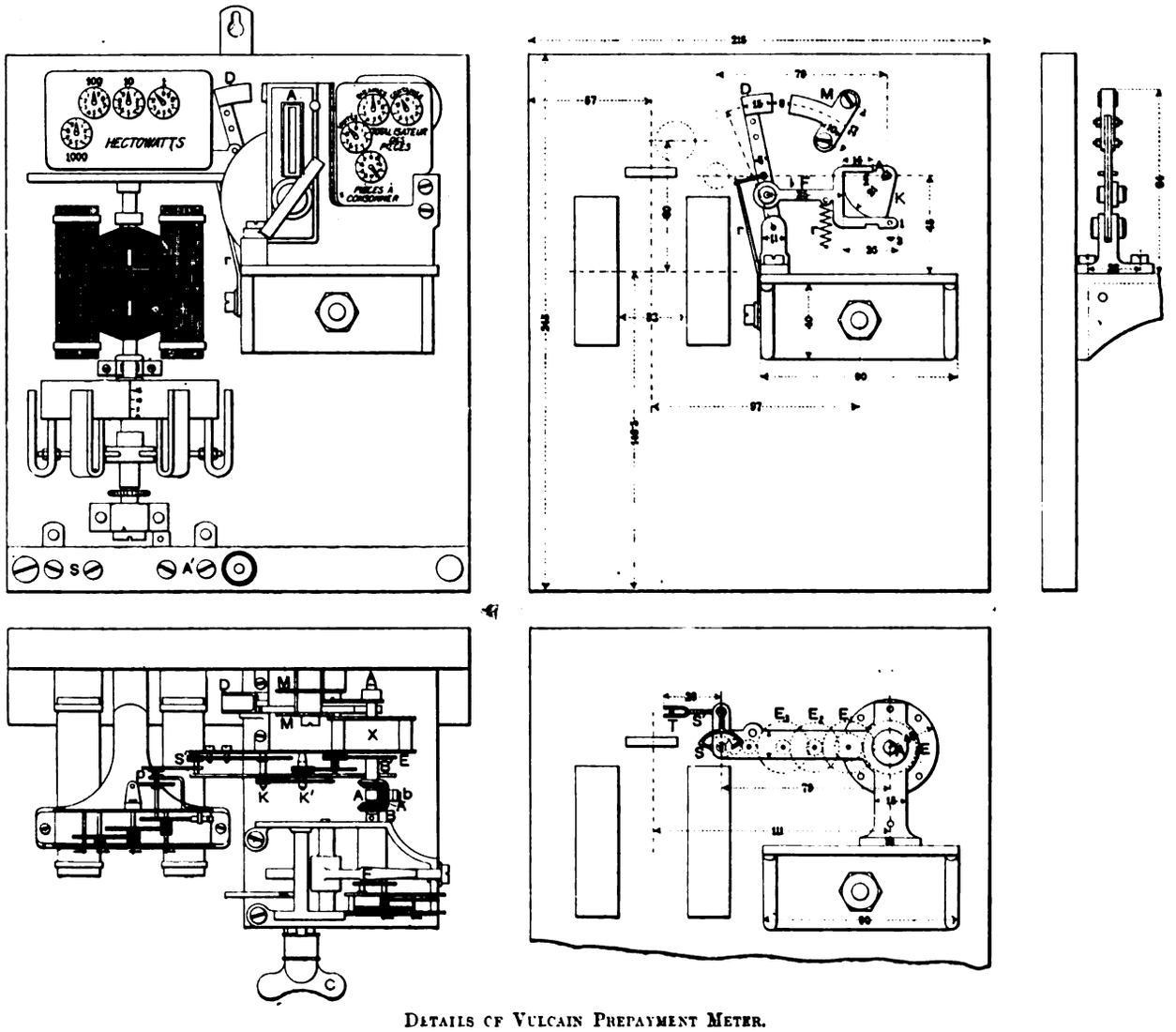
THE VULCAIN ELECTRICITY PREPAYMENT METER.

In a recent number of *L'Industrie Electrique* there is a somewhat lengthy description of a new meter which has just been put upon the French market, and of a special prepayment mechanism which can be attached to it. So far as we can see, there seems to be little that is new in the meter itself. It appears to be merely a simple modification of the ordinary Thomson meter. The additional prepayment mechanism is exceedingly ingenious, and its cost is said to be small.

Briefly we may describe the principle of the prepayment mechanism as follows: A coin dropped through the slot permits of a spring being wound up by a definite amount, and this subsequently unwinds at a rate proportional to the speed of the counter, whose only function is to move an anchor escapement—different from the case of a clock, where the escapement maintains the motion of the balance-wheel. Since the speed of the counter is proportional to the power consumed at every instant, the mechanism will automatically break the circuit when a certain definite quantity of energy, fixed by the cost per unit and also of the coin adopted, has been consumed. For example a penny is dropped through the slot A, and the handle C is turned in a clockwise direction. The coin forms a projecting tooth on a wheel, and gears with a train of wheels which finally close the switch D. By the arrangement of the spring *r* this switch makes contact until the wheels have moved backwards by the same quantity through which they were originally rotated. A number of coins may be inserted at once and the handle turned through corresponding amounts, thus requiring less attention and ensuring an unbroken supply of current. The reading on the dial marked "pièces à consommer" shows the reserve of coins still remaining in the instrument. When the reading on the dial is 0, the circuit is open; after putting in one coin and turning the handle, the reading is 1; and so on. As each pennyworth of energy is consumed, the reading is successively 2, 1, and 0, and then the switch opens and the circuit is broken. The total number of coins which have been used is registered on the dials marked "totalisateur des pièces." This is readily checked by observing on the meter itself how much energy has been consumed.

Detailed Description.—An arbor, A, has fixed at right angles to it another arbor, A', which serves for the axis of rotation of a small bevel-wheel *b*, gearing with two others, B, B', mounted on the same spindle. B is fastened to a ratchet-wheel placed behind the lever F (not seen in the figure), while B' is loose on A. This ratchet-wheel is set in motion by the coin, and moves through $\frac{1}{10}$th turn for each coin introduced. The spindle B and the wheel attached to it will therefore turn by a similar amount. On the spindle B' is fixed a toothed wheel, E, gearing into the train $E_1 E_2 E_3$, terminating by an anchor escapement, S, which is further connected to a lever, S', carrying a fork. Between the prongs of this fork passes the pin T of the flat crank *p* fixed on to the spindle governing the registering mechanism. On A is similarly fixed a cam, K, which works the mechanism of the switch for opening or closing the lamp circuit. Suppose, now, a



Details of Vulcain Prepayment Meter.

coin is introduced and the ratchet-wheel rotated through $\frac{1}{10}$th of one revolution. The pinion B will gear into the second pinion *b*, so that A' moves through an angle half that described by B and in a plane perpendicular to A. Hence, after $\frac{1}{20}$th turn, A' will gear into A—*i.e.*, for each coin introduced A turns through $\frac{1}{20}$th revolution. In the space X is arranged a spiral spring, one extremity of which is fastened permanently to the base-plate of the mechanism, whilst the other is fixed to A; so that whenever A is moved by a coin the spring will be stretched in consequence of the unwinding by $\frac{1}{20}$th turn of the extremity of the spiral. This will make the spindle A move backwards, and therefore also the spindle B' and the wheels $E_1 E_2 E_3$—*i.e.*, the motion of the spring will be transmitted to the escapement S. We see, then, that the action of the counter is transmitted to the pin T, the escapement then permits the movement of the various wheels EE_1E_2... on their axis, so that A' finally returns to the position it originally occupied before the coin was introduced.

The cam K fastened to the arbor A rests lightly on the prong 1 of the fork F, governing the bar D, which closes the circuit when it

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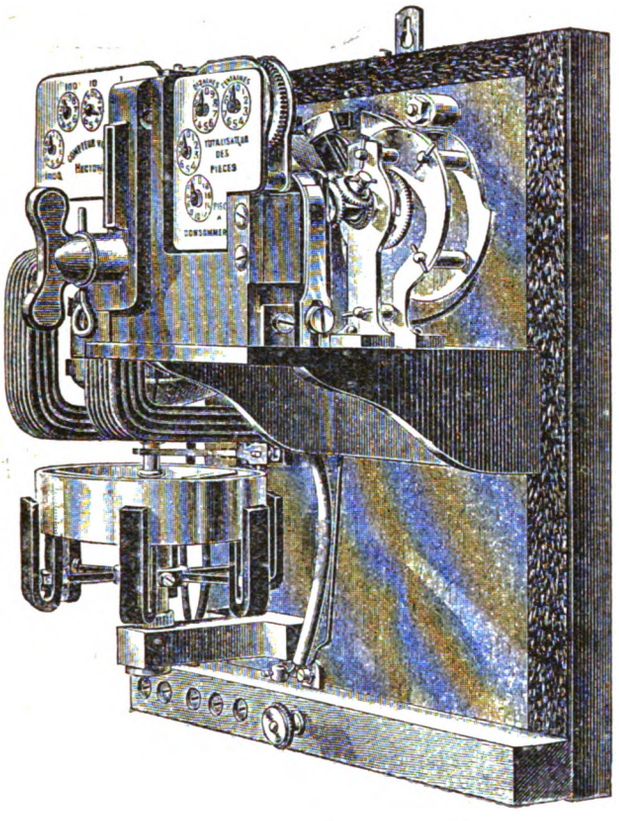
enters between the plates M. The object of the second prong 2 on C will be explained immediately. When the first coin is introduced, the first $\frac{1}{20}$th revolution impressed on A connects F through the pin 1; F will then be forced on to the knife edge 3. This is just sufficient to make the lever D enter between the plates M and close the circuit.

The circuit being closed, the counter rotates, and at each turn of the train, the escapement, the pawl of the wheels E E_1 E_2, the spindle A' and the cam K are all set in motion. The return of K to its original position brings the spring *r* into action, releases the switch bar D, and breaks the circuit.

It will be readily understood why, with this mechanism, any number of coins up to 19 may be introduced, for 19 coins will rotate A through $\frac{19}{20}$th turn only, and to disconnect from 2 and 3 A would have to move backward by the same amount. In the train of wheels E E_1 E_2... care is taken to make the wheels *k k* readily accessible. These are for the purpose of changing them with others having



VULCAIN METER, SHOWING PREPAYMENT MECHANISM.

different numbers of teeth, thus allowing a change in the quantity of energy supplied for the same coin. The dimensions marked on the figure represent millimetres.

ELECTROLYSIS OF CAST-IRON WATER MAINS.*

BY PROF. LUCIEN I. BLAKE.

The effects of electrolysis from electric railways are generally considered as limited to those points where currents are leaving underground metallic structures, for a passage through the soil and thence through other conductors to the power house. Voltage measurements have been relied upon to determine the regions within which currents are thus leaving the underground structures, and these measurements establish the so-called electrolytic danger areas. Recent observations and experiments of the writer prove, however, that effects of electrolysis upon water mains are not limited to the above determined danger areas. If the water mains were continuous metallic conductors, then indeed no electrolytic dangers would occur to them outside the above areas, and they might be allowed to form a part of the return circuit of the electric railway. Then bonding these mains to return feeders would be safe and advisable, just as now the metallic sheathings of underground telegraph and telephone cables are so bonded. But, unfortunately, the mains are not continuous conductors. Resistance at the joints in cast-iron pipes is sufficient at most joints to shunt a portion of any current allowed in these mains around the joint through the soil outside, or water inside, or through both. Thus on the positive side of joints the effects of electrolysis, both external and internal, are to be apprehended. To determine this as a fact beyond question, the writer has made, first, a series of measurements upon joint resistance in cast-iron mains, both in the laboratory and in the field; and, second, has discovered in many instances the actual electrolytic effects, both external and internal, near the joints.

Three lead-caulked joints, from a 6in. cast-iron main, taken from Kansas City water system, were measured by voltmeter-ampere-meter method, with the following results:—

—	E.M.F. (around joint).	Current.	Resistance.
Specimen I.	24 millivolts.	0·9 amp.	0·0266 ohm.
Ditto II.	45 ditto	11·4 do.	0·0321 do.
Ditto III.	37 ditto	1·4 do.	0·0264 do.
			Av. 0·0243 ohm.

The resistance measured of a 12ft. length of this pipe gave 0·000354 ohms. The average resistance of these joints, then, is 79·9 times the resistance of one length of the pipe. The current was supplied from Chloride accumulators, and Weston instruments standardised by Kelvin balances were used.

Measurements were then made upon a line of 6in. cast-iron main which has been in use now 13 years and is carrying water under about 80lb. average pressure. This main is in the city of Lawrence, Kansas, and 687ft. of it were measured. The following table gives the results:—

No. of tests.	Drop around joint. Millivolt.	Ampere.	Resistance. Ohm.
1	983·3	1·3	0·546
2	1,000·0	1·8	0·555
3	1,466 6	1 8	0·543
4	1,450·0	2·7	0·537
5	1,556·0	2·7	0·580
6	1,516·6	2·65	0·574
7	983·3	1·3	0 546
8	1,000·0	1·8	0·555
			Av. 0·556

Resistance of 58 lengths of 6in. main at 0·000354 per length of 12ft., 0·021 ohm; resistance of 58 joints, 0·535 ohm. The total resistance of the 58 joints forms therefore 96½ per cent. of the total resistance of the 687ft. Measurements of each individual joint resistance were then made upon 399ft of 20in. cast iron main which had been in use in Kansas City since 1882 under 100lb. pressure. This main crosses the Kaw river on a pipe bridge, and the housing was removed so that each joint could be measured. The readings were taken between midnight and 5 a.m., when but one "owl" car was running hourly upon the whole electric railway system, and an invariable voltage could then be supplied from storage cells.

The experiments were so arranged that voltage drop could be measured around each joint and simultaneously around one pipe length, including its particular joint. In this way resistances of joints in terms of pipe lengths were obtained. The following is the result:—

No. of joint.	Voltage drop around joint in milli-volts.	Voltage drop along pipe. Not including joint.	Joint resistance in equi-valent pipe length.	No. of joint.	Voltage drop around joint in milli-volts.	Voltage drop along pipe. Not including joint.	Joint resistance in equi-valent pipe length.
1	0·6	3·6	8·0	20	0·4	0 2	½
2	0·8	3 4	4½	21	13·0	11·0	99/10
3	1·0	8·0	8 0	22	0·2	19·8	99·0
4	0·5	18·5	37·0	23	0·2	17·8	88·0
5	0·4	19·6	49 0	24	0 4	9·6	21·0
6	0·4	17·6	44·0	25	0·4	3·6	9·0
7	0·6	17·4	29 0	26	0·4	0·4	1·0
8	0·6	6·6	11·0	27	0·4	0·2	½
9	0·6	9·8	16·3	28	0·4	0·2	½
10	0·6	16·2	27·0	29	0·4	0·4	1·0
11	0·6	10·2	17·0	30	0·4	0·4	1·0
12	0·4	11·2	28 0	31	0 4	0·2	½
13	0·4	6·4	16·0	32	0·4	0·2	½
14	0·4	8·0	20 0	33	0·3	0·1	½
15	0·1	0 2	½	34	0·4	0 2	½
16	0·4	0·6	½	35	0·4	0·2	½
17	0·4	0·2	½	36	0·4	0·2	½
18	0·4	0 2	½	37	0·4	0·2	½
19	0 2	0 2	1·0	38	0·4	0·2	½
Totals:—		29·4			221·0		543½
Total drop in pipe					29·4		
Total drop in pipes and joints					250·4		

Therefore the resistance of the joints is 88½ per cent. of the total resistance. The average of six direct measurements of the total drop of the above main gives 0·3 volts with a current of 9·2 amperes. This would give a measured resistance in 399ft. of the 20in. main to

* From the *Electrical World* of New York.

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be 0·326 ohm. The calculated resistance of this amount of 20in., exclusive of joints, is 0·0364 ohm. The joint resistance must make up the rest of the total measured resistance, or 0·2896 ohm. The joint resistances therefore form 88½ per cent. of the total resistance, which checks with the above within the limits of error.

It should be stated that for this calculated resistance of the pipe measurements were made to determine the specific resistance of the cast-iron of the pipes. A Thomson's conductivity bridge was used, made by Hartmann and Braun, and the average of several measurements on two bars cut from the 20in. main, which were respectively 500mm. long and ¼in. × ¾in. in section. The copper bar for comparison was commercial 'bus-bar ¼in. × ¾in. section, 500mm. long. The results gave an average of 56·5 times the resistance of copper of similar dimensions, and this number is used in the above calculations.

Measurements were also made on 400ft. of 36in. main which was exposed in Kansas City. The total measured resistance, including the 34 joints, was 0·0103 ohm. The calculated resistance of the pipe alone is 0·000346 ohm. The joint resistance is therefore 96 7-10 per cent. of the total resistance. The current was from a storage battery, used after the railway power was cut off after midnight. From the above direct measurements it is evident that the joints in cast-iron water mains form a large percentage of the total resistance of the mains and prevent the mains from being considered continuous conductors in the sense a metallic sheathing of a cable is. The resistance conditions for shunting a current around the joints are therefore present in general upon water mains. Furthermore, that such shunting actually occurs on cast-iron mains in use and exposed to leakage currents from electric railways has been proved by the writer by electrolytic effects discovered near joints, both inside and outside, on mains which the writer has taken up in Kansas City. A 12in. pipe line running at right angles to an electric railway, and which was negative to the rails, was found to be carrying a current of varying strength and delivering it into a 36in. main some 750ft. distant.

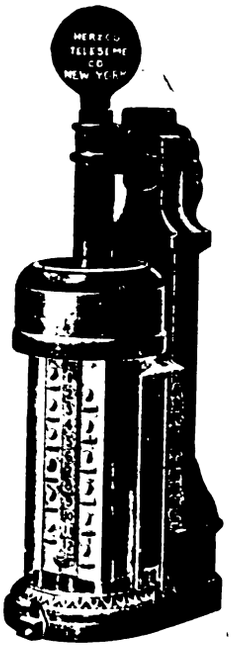
Electrolytic pittings were found on many sections near the joints, only on the positive side, where the current was shunted around the joints. Some of the pittings were ¼in. deep. The interior of the pipe could not be examined. Again, a length of 6in. cast-iron main was taken up in another part of the city, and internal electrolytic effects were apparent near the joint. A chemical analysis of the material dug from pits gave 2·2 3 per cent. graphite, 49·7 per cent. iron. A second length was removed and broken into, and a fresh fracture revealed *internal* electrolysis by the discolouration of the iron where the pitting was taking place, and which was already ¼in. deep, beginning from the inside. A number of similar cases were discovered, and are convincing proofs that cast-iron mains cannot convey currents without electrolytic damage, when these mains form part of the return circuits of electric railways.

It is not the purpose of this Paper to treat the general subject of electrolytic dangers to underground metallic structures, but to call attention to the fact that the use of grounded electric railway circuits is beginning to reveal these added dangers to cast-iron mains. The plan of occasional bonding of rails to water pipes when the pipes are negative to the rails, and then, near the power house, the further bonding of the pipes to return feeders, is sure to invite current upon the pipes, and thereby evidently intensify electrolytic effects at the joints. The insertion of insulating joints in the mains or an occasional non-conducting length, must act like joint resistance, and thus still further endanger the mains. So long as leakage currents are allowed to traverse the mains, it seems proved from the above that the mains are in danger, and corroborative evidences are accumulating in cities other than Kansas City, and which are known to the writer.

Nor does the asphaltum coating of the pipe protect it. Under the asphaltum, which remains bright and apparently intact, pittings will be found, and a fresh fracture or a careful scraping away of the coating will reveal spots of graphite structure left from electrolytic action on cast-iron. It is obvious all conduction by the pipes must be avoided to ensure immunity from electrolysis.

THE FAIRY ANNUNCIATOR.

There has just been introduced into this country from America a new type of annunciator, which from its simplicity in principle and constructional detail, its compactness and its low price, will, we believe, find much favour. The principle utilised is that of the colouring produced in a solution of potassium iodide due to the liberation of iodine when a current passes through it. In the present case, the current is completed through any one of a number of platinum studs, and the colouration is produced about that stud through which the circuit has been completed. The colouration may be made more intense, and the degree of permanence altered by changing the character of the solution in accordance with a given recipe. The colouration may thus be made to disappear in any time between 30sec. and 5min. Squeezing the indiarubber ball at the top agitates the solution and causes the colouration instantaneously to disappear. Each of the studs is connected to a separate room, and circuit is made through an ordinary bell-push, which at the same time rings a bell to call attention to the summons. Five or six Leclanché cells are needed to work the annunciator and bell, but it is claimed that these and the solution will require no attention for a very considerable period, after once being set up. On account of its small size, a 12-hole annunciator being shown one-third full size in the figure, it may be placed almost anywhere—on a bracket, shelf, or side table.



AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *December 15, 1899.*

The Pacific Cable in Congress.—A bill has been introduced in the United States Senate to authorise the construction of a cable from the United States to Hawaii and Manila by way of Guam. It authorises the Secretary of the Navy to contract for the laying of the cable, which is to be operated under the direction of the Postmaster-General, and $11,000,000 is appropriated for the purpose. On Dec. 5 a bill was introduced in the House of Representatives for the laying of a cable to the points named above. The cost of it is limited to $3,000,000, and a preliminary appropriation of $500,000 is made to begin the work. The cable is to be laid under the direction of a commission composed of the Postmaster-General, the chief signal officer of the army, and three other members to be appointed by the President. The rates are to be not more than 35 cents a word from San Francisco to Honolulu, and not more than $1 a word to Manila.

Power from the Pacific Ocean.—The Dominion Government is now considering the application of a British Columbia syndicate for foreshore privileges in Vancouver harbour.. The scheme is to establish electric power works to be driven by the water that rushes into the harbour of Vancouver, through the narrows, at nearly all stages of the tide. Prospect Point, which is one of the best known of the scenic attractions of Vancouver at the entrance of the harbour, will be the site of the principal works for the generation of electricity to supply the lower mainland. About 2,000ft. of the foreshore extending out 150ft. from the narrowest part of the harbour is asked for there, and farther down at Brockton Point about the same amount of property is included in the request. Farther up, on the opposite side of the city of Vancouver, there are extensive tide flats, opposite which are the dangerous narrows; and this location the syndicate asks to be granted to them for a distance of one mile long and a half mile in width, with about half as much land also on the opposite side of the narrows.

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This is the spot where it is proposed to erect the main electrical buildings. The three points are far enough apart that the tide changes come at different times, and there is always a run of five or six miles at one of them. If all else should fail, there is a large stream running through the tide lands from the mountains, and this in itself would be sufficient to supply all demands. If the Government grants the concession, a strong local company will be formed to exploit the scheme.

"The Motorman as an Element of Street Railway Economy."—This was the title of a brief Paper recently read by Mr. Charles Hewitt, engineer of the Union Traction Co., of Philadelphia, before the Engineers' Club in that city. The Paper gives some interesting results of observations made to determine the extent the motorman enters as a factor in the power consumption by the cars. Tests were made by placing a wattmeter on a car without the knowledge of the motorman, and then having that car run on various routes by a number of different motormen. All the necessary records, such as the number of passengers, the time, &c., were kept, and the results were given in two tables, one showing the watt-hours per car mile by trips irrespective of motorman, and the other showing the watt-hours per car mile per motorman irrespective of trips. The results showed that the number of passengers carried had an almost inappreciable effect on the watt-hours per car mile, and that the variations in the amount of energy consumed depended almost entirely on the motorman. The watt-hours per car mile varied very greatly for different motormen, but were nearly constant for the same motorman. They indicated that the usual test of a motor made in this way is really a test of the motorman. Omitting extremes, which may have been due to abnormal causes, the saving if all the motormen were as good as the best amounted to 43 per cent. The results showed what an important factor the motorman really is in the amount of power consumed by the cars, and how important it is to properly instruct the motorman in the most economical use of the controller. He also mentioned some tests in which the motormen were instructed to use only the series connections; and it was found that they could make the trip in the same time, with considerably less energy than the usual amount: the maximum speed of the car was not so high, but the average was the same and the amount of energy consumed was considerably less. This, however, was accomplished only with certain motors which had been installed on some of the cars, and would not apply to the usual motors.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers, or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London:—

NOW READY.

"The Electrician" Electrical Trades' Directory and Handbook for 1899.—The *Second Edition* of the "Big Blue Book" for 1899 is now ready. The volume contains the large Sheet Tables of Electricity Supply Stations and Electric Railways and Tramways. The price of the Directory and Handbook is now reduced to 5s. post free 5s. 9d.; abroad, post free, 6s. 6d. (United States 7s. 6d.).

"Submarine Cable-Laying and Repairing."—By H. D. Wilkinson, M.I.E.E., &c., fully illustrated; price 12s. 6d. This work gives a detailed technical summary of modern practice in manufacturing, laying, testing, and repairing submarine telegraph cables.

"Practical Notes for Electrical Students."—By Messrs. A. E. Kennelly and H. D. Wilkinson. Price 6s. 6d., post free. The authors give in a clear and concise manner a good summary of the general principles of electrical science.

"Magnetic Induction in Iron and other Metals."—By Prof. J. A. Ewing. Price 10s. 6d., post free. *New Edition nearly ready.*

"The Incandescent Lamp and its Manufacture."—By Gilbert S. Ram. Price 7s. 6d., post free. The principles underlying the manufacture of the incandescent lamp are carefully and fully dealt with in this volume.

"The Steam Engine Indicator and Indicator Diagrams."—Edited and enlarged by W. Worby Beaumont. Price 3s. 6d., post free. This work is a concise guide to the objects, construction, and use of the steam engine indicator and to the interpretation of indicator diagrams.

"The Art of Electrolytic Separation of Metals."—A second issue of Dr. Gore's book is now ready, price 10s. 6d., post free. The author treats fully both the theoretical principles of the art of electrolytic separation of metals and the practical rules and details of technical application on a commercial scale. The work is adapted to the use of the manufacturer as well as the student.

"The Manufacture of Electric Light Carbons."—A Practical Guide to the establishment of a Carbon Manufactory. Fully illustrated, price 3s. 6d.; post free, 1s. 9d. In this work the author gives useful hints as to the manufacture of electric light carbons, including the preparation of material, firing, saturating, and coring, together with a description and estimate of cost of the plant required.

"The Centenary of the Electric Current, 1799-1899."—By Dr. J. A. Fleming. Price, paper covers, 1s. net, post free 1s. 3d.; strong cloth, 2s. 6d., post free.

"Localisation of Faults in Electric Light Mains."—By F. C. Raphael. Price 5s., post free. The book deals with the important subject of localising faults in electric light and power cables; and the various methods of insulation testing are here collected and discussed.

"Motive Power and Gearing for Electrical Machinery."—By E. Tremlett Carter, C.E., M.I.E.E. Price 12s. 6d., post free. In this comprehensive work an account is given of the scientific principles and modern practice in the use of engines for dynamo driving, not only for isolated power plants, but also for public electric lighting and power stations. The various forms of gearing in the power station and for electric motors are also dealt with; and the book contains, in addition, numerous tables giving exact data of the equipment and working of electric power stations.

"The Manufacture of Carbons for all Electrical Purposes."—by Francis Jehl. 10s. 6d., post free. This is a practical handbook, giving a complete description of the art of making carbons for electric lighting, electrodes, &c., with particulars of the various gas generators and furnaces used in carbonising. The work also contains particulars of the cost, &c. of erecting and working carbon works, and plans of a model factory.

"Drum Armatures and Commutators," by Mr. F. Marten Weymouth. also ready. Price 7s. 6d., post free. Prospectus on application. This is a complete treatise on the theory and construction of drum winding, and of commutators for closed coil-armatures, together with a *résumé* of the principal points involved in their design, and an exposition of armature reactions and sparking.

"Wireless Telegraphy: Signalling across Space without Wires by Electric Waves." A Review of the Work of Hertz and his Successors.—By Dr. O. J. Lodge, with a large number of illustrations. *New and Enlarged Edition ready Jan. 5.*

"Electromagnetic Theory."—By Oliver Heaviside. *Vol. I.*, 12s. 6d. *Vol. II.*, 12s. 6d.

IN THE PRESS.

"The Electric Arc."—By Mrs. Ayrton.

"Secondary Batteries, their Design and Manufacture."—By E. J. Wade.

"Primary Batteries: Their Construction and Use."—By W. R. Cooper. *Nearly ready.*

"Practical Telephony."—By Dane Sinclair and F. C. Raphael.

"'The Electrician' Wireman's Pocket-book."—Edited by F. C. Raphael. *Nearly ready.*

TENDERS INVITED.

The *Newcastle-upon-Tyne* Corporation invite tenders for the construction of about 11 miles of double-track tramway—rails, fastenings and poles being supplied by the Corporation. An advertisement gives further particulars, and specifications, &c., may be inspected at the offices of the city engineer after Jan 3. Tenders (addressed New Tramways committee) must be in by noon of Jan. 24.

The *Barking* District Council invite tenders for the supply of two continuous-current transformers and switchgear, underground cables and roadwork, for their Creeksmouth extension. An advertisement contains further particulars, and copies of specification, &c, can be obtained at the offices of the clerk to the Council (Mr. Edwin H. Lister). Plans can also be inspected, but not obtained, at the offices of the consulting engineer (Mr. W. C. C. Hawtayne), 9, Queen-street-place, London, E.C., after Jan. 7. Tenders (addressed chairman of Council) must be in before noon of Jan. 23.

The *Tynemouth* Corporation invite tenders for wiring premises in connection with their electricity supply scheme. Applications to the borough electrical engineer (Mr. C. Turnbull). See advertisement.

The Corporation of the city of Melbourne require tenders for the supply and delivery of plant and the superintendence of its erection, and the carrying out of the work in connection with the electric lighting of the city. The specifications include (1) boilers; (2) steam engines, dynamos, equaliser, booster, and switchboard; (3) feeders, mains, and arc light leads; (4) accumulators. The specifications, &c., can be obtained from the Agent-General for Victoria, 15, Victoria-street, London, S.W., on and after 28th inst. The specifications and drawings can also be seen at but not obtained from the office of Dr. A. B. W. Kennedy, 17, Victoria-street, S.W. Further information as to local conditions, &c., can be obtained up to Jan. 3 from Mr. A. J. Arnot (city electrical engineer of Melbourne), First Avenue Hotel, London, W.C.

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The *Salford* School Board invite tenders for electric lighting of their new schools in Grecian-street North, Lower Broughton. Tenders (addressed chairman of the Board) to the clerk (Mr. Ogilvie Duthie) by noon of Jan. 8.

The *Tunbridge Wells* Corporation invite tenders for surface condensing plant for their electricity supply station. Tenders to Mr. W. C. Cripps, Town Hall, Tunbridge Wells, by Jan. 15.

The *St. Pancras* (London) Vestry invite tenders for condensing plant. Tenders to the Vestry clerk (Mr. C. H. F. Barrett), Town Hall, St. Pancras, N.W., by noon of Jan. 9.

The *Bedford* Electric Light committee invite tenders for the supply of a 420 b.h.p. inverted compound double-acting engine and a 250 kw. alternator. Tenders to Mr. T. S. Porter, by Jan. 5.

The District Council of *Burgess Hill*, Sussex, invite proposals for the establishment of electricity supply works. Further particulars can be obtained of the clerk to the Council.

The *Dublin United Tramways Co.* invite tenders for the supply of general stores. Tenders (addressed to chairman) must be lodged with the secretary (Mr. R. S. Tresilian) by Jan. 1.

The *Bermondsey* (London) Vestry invite tenders for the construction, supply, and erection of a dust destructor, with furnaces, flues, water-tube boilers, economiser, fans, and forced draught appliances. Tenders to Mr. F. Ryall, Town Hall, Bermondsey, before noon of Jan. 13.

The Urban District Council of *Barnes* are prepared to receive tenders for the supply and erection of: (*a*) Boilers; (*b*) steam dynamos and switchboards; (*c*) storage batteries; (*d*) cables, &c. Tenders to Mr. J. Eustace Anderson, High-street, Mortlake, London, S.W., by noon of Jan. 9.

Accrington Corporation invite tenders for switchboards, wiring, &c., for the electric lighting of the Town Hall. Tenders Jan. 10.

Glasgow Corporation require a cast-iron cable tunnel, water storage tanks, travelling cranes for outside coal storage, mechanical stokers, coal and ash conveyors, and steel flues. Tenders to Sir J. D. Marwick by 1 p.m. Jan. 6.

Hackney (London) Vestry invite tenders for accumulators. Tenders to Mr. George Grocott, Town Hall, Hackney, by 4 p.m. of Jan. 2.

Birkenhead Corporation require tenders for new electric tramway generating station. Tenders by Jan. 16.

TENDERS RECEIVED AND ACCEPTED.

The following tenders have been received by the Londonderry Corporation for the supply of carbons during the ensuing year: —

		Per 1,000ft.
G. Braulik, 13mm. carbons (positive cored, negative solid) (*accepted*)		£2 4 10
Johnson and Phillips (ditto)		2 8 0
Brush Co. (positive)		2 11 3
Brush Co. (negative)		2 7 2
English Electric Carbon Co.		2 10 0
Bergtheil and Young	"G" quality (positive)	2 10 0
	Ditto (negative)	2 6 6
	"W" quality (positive)	3 19 6
	Ditto (negative)	3 12 6

The Leeds Lighting committee reiterate their recommendation to accept the tender of Messrs. J. Schofield, Sons and Co. for the construction of various transformer chambers at £2,298. The matter was referred back at the last Council meeting, as it was alleged that the firm did not pay the trade union rate of wages.

APPOINTMENTS VACANT AND FILLED.

The British Electric Traction Co. invite applications for the position of district superintendent for South Wales. Applications to the secretary (Mr. Geo. Stevens), Donington House, Norfolk-street, London, W.C. See advertisement.

A foreman cable jointer and a cable jointer are required for the Bolton Corporation electricity department. An advertisement contains further particulars, and applications must be sent in to the general manager (Mr. Arthur Ellis) by Jan. 4.

The Brighouse Corporation invite applications for the position of consulting electrical engineer to the borough. Applications to Mr. James Parkinson, Municipal Offices, before Jan. 10.

The Bradford Corporation invite applications for the position of electrical engineer to take charge of their electricity department. Salary £500 per annum. Applications to the town clerk (Mr. Frederick Stevens) by Jan. 4.

The Gloucester Electricity Supply committee requires a chief assistant electrical engineer and a cable jointer. Applications to the town clerk (Mr. Geo. Sheffield Blakeway) by 10 a.m., Jan. 3.

A demonstrator in physics is required for the University of Sydney, N.S.W. Salary £350 per annum. Applications to Sir Julian Salomons, 9, Victoria-street, London, S.W., by Jan. 1.

The Manchester Corporation require an accountant and a chief clerk for their tramways department. Applications by Jan. 6.

Mr. H. N. Thomas, of Douglas, has been appointed resident tramway engineer and clerk of works at Huddersfield.

BUSINESS NOTICES.

The Eclipse Brass and Copper Co. (Ltd) notify that their works are about to be removed from Halifax to new buildings at York. The address of the company from Jan. 1 will be c/o the Engineer, Cycle Works (Ltd.), Hull-road, York.

The City address of the Western Electric Co has been removed from 79, Coleman-street, to Bridge-chambers, 171, Queen Victoria-street, London, E.C.

BANKRUPTCIES, LIQUIDATIONS, &c.

W. Rowbotham, electrical engineer, Loamvale, Stanley-road, Teddington, has been adjudicated bankrupt. Mr. H. C. Howard, 17, Coleman-street, London, E.C., is trustee. The following are the principal creditors: T. O. S. Leak, £371; J. E. Headley, £200; Royce Ltd., £110; J. E. Rowbotham, £100; F. J. Mudford, £73; F. T. Handford, £29; H. Headley, £25; H. Levetus, £25; F. Coote, £11; W. Evans, £10; Herring and Son, £10; C. Fitzgerald, £10.

In the bankruptcy of Wm. Dalzell (trading as Wm. Dalzell and Co.), electrical engineer, 73, Forsyth-road, West Jesmond, late of Newcastle-on-Tyne, the first meeting of creditors will take place on 29th inst, at 30, Mosley-street, and the public examination on Jan. 11, at the Court-house, Newcastle-on-Tyne.

Alfred John Hartill, described as "plumber, gas-fitter and electrical engineer," 4, Worcester-street, Townwell Fold, and Penycoed, Penn Fields, Wolverhampton, has executed a deed of inspectorship and assignment upon trust to secure the payment of creditors in full by eight equal quarterly instalments. Mr. G. Aiken, Midland-chambers, Princess-street, Wolverhampton, is trustee. Liabilities are returned at £894. 8s. 8d., assets £1,131. 13s. 6d. Secured creditors represent £3,122. 2s. 6d.

The creditors of Henry Lionel Howard, electrical and mechanical engineer (trading as Thompson, Howard and Co.), Wyvestow, Dragon-parade, Harrogate, and at York and Hull, include: G. Thompson, £339; John Gray and Sons, £89; Johnson and Phillips, £55; W. T. Henley's Co., £29; C. Walker, £19; Electrical Co., £18; Penistone Electrical Co., £17; Raworth and Allen, £16; Miller and Co., £16; G. Braulik, £15; Veritys Ltd, £15; Bunce Bros. and Co., £12; International Electric Co., £10. The liabilities are returned at £1,993. 10s. 5d., and the assets at £690. 19s. 1d.

Claims against Round's Accumulator Co. (Ltd.) are to be sent to the liquidator, Mr. A. Pigram, 70 and 71, Bishopsgate-street Within, London, E.C., by Jan. 26.

Claims against the Power Accumulator Syndicate (Ltd.) are to be sent by Jan. 26 to Mr. A. Pigram, 70 and 71, Bishopsgate-street Within, London, E.C.

Calendars.—Messrs. Witting Bros., 49, Cannon street, London, E.C., issue a neat illustrated hanging calendar for 1900.

The usual neat pocket calendar for 1900 is to hand from the Brush Co.

Personal.—Mr. C. P. Sparks, chief engineer to the County of London and Brush Provincial Electric Lighting Co., has been appointed consulting engineer to the Bournemouth and Poole Electricity Supply Co.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Dec. 20 to Dec. 22, with the ports of destination:—

Africa—Chinde, £64; Port Elizabeth, £439 (including £371 telegraph cable). *Argentina*—Buenos Ayres, £1,784 (including £634 telegraph wire). *Australasia*—Albany, £15; Brisbane, £57 (telegraph material); Launceston, £120; Melbourne, £1,287 (including £1,037 telegraph material); Perth, £44; Sydney, £787; Wellington, £657. *Belgium*—Brussels, £124. *Canada*—Montreal, £86. *Ceylon*—Colombo, £278 (telegraph material). *China*—Shanghai, £578. *Denmark*—Copenhagen, £95 (telegraph wire). *Egypt*—Alexandria, £23. *France*—Boulogne, £30; Marseilles, £694 (telegraph cable). *Germany*—Bremen, £63. *Holland*—Amsterdam, £15. *Hong Kong*, £88. *India*—Bombay, £80 (telegraph wire); Calcutta, £503. *Norway*—Christiania, £236 (telegraph wire). *Straits Settlements*—Singapore, £47. *Sweden*—Stockholm, £557. Total, £8,767 (for three days), against £11,322 (for eight days) last year (Dec. 21 to Dec. 28).

MUNICIPAL, FOREIGN, AND GENERAL NOTES.

Aberdeen.—At the request of the Gas and Electric Lighting committee, the city electrical engineer (Mr. J. A. Bell) has prepared a report upon the extensions of the plant and buildings necessary to meet the increased demand for electric current. After pointing out that during 1899 the number of lamps connected to the mains had

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risen to 48,156, or 14,065 over 1898, and that the horse-power of motors (153) is 83 more, Mr. Bell recommends, with a view to meeting next year's load, that an additional 700 H.P. steam dynamo be erected at the existing station, at an estimated cost of £6,325. In view of the rate at which the demand for current is increasing, and also of the electrical equipment of the tramway routes, it is considered inadvisable to purchase the land available on the east side of Cotton-street, as only plant sufficient for the next five years could be there put down. Mr. Bell therefore recommends the committee to acquire a suitable site for a new station, which from an electrical point of view should not be much east of a line running between Holburn-street and Mount-street, and should be capable of accommodating plant of at least 10,000 H.P. The engines at the new station should work condensing. After examining three sites, Mr. Bell considers the Dee Village site to be the most desirable. As to combining a refuse destructor with the electricity works, the benefits to be be derived were not, in Mr. Bell's view, very great, as the horse-power available varied very largely with the kind of refuse burned, and additional space would be required for the works.

Barking.—The Local Government Board have sanctioned the borrowing of £15,080, out of the £15,780 recently applied for, for electric lighting extensions. The Board have asked for further particulars in regard to the £700. The consulting engineer (Mr. W. C. C. Hawtayne) reported that if the Council decided not to proceed with the construction of light railways, the plant for which they had accepted tenders could be utilised for electric lighting purposes, as the load on the present station was rapidly increasing and would shortly necessitate the provision of extra plant. The clerk (Mr. Edwin H. Lister) said they were authorised to raise the money under the light railways order. If at a future date the Council decided to lease the railways, application should then be made to the Local Government Board for sanction to transfer the loan to the electric lighting account. It was therefore resolved—

That the necessary loan required to execute the work under sections A, B, C, and D of the electrical engineer's specification be raised under the light railways order for the time being and if, when tenders for the construction of the bridge, &c., are received, it be found too costly to proceed with the whole of the work, application be made to the Local Government Board for sanction to transfer such amount to the electric light undertaking.

Bendigo (Victoria).—Negotiations have been completed for the purchase of the undertaking of the Bendigo (Victoria) Electric Co. by the British Insulated Wire Co.

Camberwell.—The clerk reported at a special meeting of the Vestry last week that the County of London Co. had refused to name the figure at which they would be willing to sell that portion of their undertaking which lies within the district. After discussion it was decided to adjourn the question until June 27, 1900, and in the meantime the Vestry clerk has been instructed to obtain the assistance of the Board of Trade in obtaining the information.

Certificates of Origin.—The British Chamber of Commerce in Paris has been notified by the French Ministry for Foreign Affairs that an arrangement has been concluded between the English and French Governments under which from Jan. 1 the charge previously made for the consular visa to certificates of origin will be abolished. The benefit to be derived by British firms under this new arrangement is large, as a fee of 6fr. had to be paid for every certificate of origin taken out for France.

Chester.—In presenting the minutes of the Electric Lighting committee at the Corporation meeting last week, the chairman of the committee (Mr. B. C. Roberts) said it was necessary that the committee should be authorised to purchase an additional engine and dynamo, at a cost not exceeding £3,165. The development of electric lighting made it necessary that they should have the new engine by next winter. The cost was about £200 more than the last engine, because the machine would be adapted for supplying current for the working of the tramways. The recommendation was adopted.

Dover.—Mr. S. Sellon has been asked by the Council to report upon the Cinque Ports light (electric) railway scheme.

Dublin.—Yesterday the Corporation discussed the report of the Electric Lighting Committee in favour of an extensive scheme for the more general lighting of the city by electricity. The plans for these extensions have been prepared by Mr. Robert Hammond, and include the erection of a new generating station at Pigeon House Fort, the increase in the number of public arcs from 80 to 500, and provision for a further 5,500 private consumers. Mr Hammond's estimate for the whole of this work is £254,500. The Corporation, after full discussion, adopted the scheme in its entirety.

Fatal Accident at Bolton.—An unfortunate accident occurred at the Newport-street transformer chamber, Bolton, on Friday last, by which two employés of the Corporation electricity department, named William Hazelton and Frederick J. Walker, lost their lives. An inquest was held by the borough coroner (Mr. R. Taylor), at the Town Hall, on Tuesday. Walker was a mains superintendent, aged 41, and Hazelton a jointer, aged 26. Both were married.

Mr. Arthur Ellis, borough electrical engineer of Bolton, stated that on Thursday evening some of the electric apparatus in the underground transformer chamber in Bradshawgate broke down, with the result that the whole of the lights of the town were extinguished for a quarter of an hour. He was at the Town Hall at the time, and proceeded to the works, where he afterwards saw Walker, who informed him of the breakdown near the Balmoral Hotel. They had no spare transformers of the same size in stock, and Walker suggested that he might take one from the Town Hall, where there were three, and replace it with two small ones. This was agreed to. The next day Walker reported that he had not done the work, as he could not get permission from the Town Hall to take the transformer away, and the night's work was thus lost. He expressed surprise that Walker had not been allowed to carry out his instructions. Permission being subsequently granted, Walker took the transformer from the Town Hall and put it in the Bradshawgate chamber. It was then found that another transformer in the same chamber was wrong, and on his own authority Walker went to the Newport-street chamber to get a transformer. Witness would not have sanctioned this, as they had already had trouble there, and it was fully loaded. They were short of transformers because they intended changing their system of supply to continuous current and doing away with transformers altogether. This should have been done in the summer, but the plant they contracted for last year had not yet been erected, and they had had to run overloaded. They had been unable to add fresh customers for some time past. They had been extremely fortunate in the matter of breakdowns. The committee were spending £30,000 to do away with the substations, which were a source of great danger. Mr. Ellis then explained at length the interior and working of the chamber and transformers. In the Newport-street chamber four transformers were at work, two of them being coupled. It was one of these which the men intended to take away. Before doing this they switched off supply. After they had isolated the transformer which they intended to remove, they proceeded to do what they believed would put the current on again to the transformer which had not been disconnected. Instead they put on the wrong switch, with the result that the cables which had been disconnected, and also left lying loose and touching the transformer case, were made "alive," as was also the metal case of the transformer, getting the full pressure of current. The men had hold of the transformer in order to get it out of the substation, and they received the full pressure of current through their bodies. Two mistakes were made: leaving the cables lying loose, and turning the wrong switch on, this being the fatal mistake. He believed the mistakes were made through hurry and anxiety on the part of the men to get the supply right again. They were perfectly competent men, especially Walker. Had the work been done at night they would not have met with the accident, as current would have been off at the station. The staff at the works were not aware that any work was going on at the Newport-street chamber. The switches were not touched at the works. He could not account for Walker's mistake. He was always anxious to keep the supply right, and that was no doubt the reason why he had of his own accord undertaken the work in the daytime.

J. W. Symonds, a cable jointer, who was working with deceased, said Walker cut off the current, and after they had prepared for removing the transformer Walker turned on the wrong switch, and, being nearest, got the shock first. He reeled against Hazelton, who received the shock, and Hazelton fell against witness, who was powerless to move a muscle. When Hazelton fell down he got out and ran to the station to get the current off. Being anxious to get the current on as soon as possible, they were doing two jobs at once: hence the mistake.

Mr. A. E. Sides, scavenging inspector, spoke to going to the rescue of the men. He volunteered to go into the chamber. A rope was fastened round his body, and he told Mr. Lloyd, who was helping at the top, to pull him up if he felt a jerk at the rope. The chamber was filled with smoke, but soon he got his sight and found Walker, whom he handed up. Hazelton was lying on his side, and he also handed him up; and he was himself also medically treated.

Dr. Adam said Walker was first got out, and animation was restored, but efforts failed in the case of Hazelton. He examined Hazelton after death, and found that he was burned about the feet and hands, the boots being very much charred. Death was due to electric shock, and the smoke was caused by the burning.

Mr. Ellis said it was a very risky thing to order anyone down into the chamber. No one should do it without having ascertained that it was absolutely safe. They might have lost a third life. If the current had been on it would have been certain death.

Dr. Liddell testified to Walker having died from nervous paralysis, the result of an electric shock.

The Coroner said the jury would doubtless be satisfied as to the cause of death. It was clearly an accident. He could not say anyone was to blame; the men themselves had control of the current.

The jury returned a verdict of accidental death.

Dr. Panton, speaking on behalf of the Electricity committee, said they much deplored the regrettable occurrence. Deceased were both capable men, and they tendered their sympathy to the widows and families. The unfortunate accident had been brought on, it seemed, by the hurry of the men and the mischance of doing the wrong thing instead of the right one.

Glasgow.—At their meeting on Wednesday afternoon the Tramways committee recommended the acceptance of the tender of the National Conduit and Cable Co. for the supply of feeder cables required for those extensions of the electric tramways which have yet to be constructed in the city. The amount of the National Conduit and Cable Co.'s tender is £151,000, which is £10,000 below that of the next lowest tender by an English firm. Three tenders were sent in. The committee's recommendation will come up for consideration at a meeting of the Corporation to be held next week.

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Halifax.—The dispute between the Halifax Corporation and the Elland Council on the question of the proposed electric tramway to Brighouse *viâ* Elland has not yet been settled. The chief point of difference is the question of the supply of current for working the line. The Elland Council, who are applying for a provisional order, insist that they should be allowed to supply current, but according to the Halifax Corporation this would entail divided control of their tramway system, to which they have a strong objection. They, however, offer to erect a sub-station near Elland, for supplying current for tramway and lighting purposes. The Halifax Corporation now state that unless the Elland Council accept their terms they will alter the route of the proposed tramway and construct it through Hipperholme.

Hastings.—On the recommendation of the borough electrical engineer (Mr. Leonard Andrews) it has been decided to reduce the price of electric current from 8d. to 6d. per unit, plus 5s. per quarter for meter rent. Long-hour customers are to be treated on special terms. The chairman of the Electric Light committee (Councillor Dr. Allfrey) said the undertaking was in a sound condition, and they anticipated that by the end of next year they would be able to carry over a credit balance. On Oct. 1 they were supplying current to the equivalent of 16,150 8 c.p. lamps.

Inverness.—Mr. E. G. Craven has presented his report on the electric lighting question. The low-tension continuous current system is recommended, and the total estimated cost is put at £28,000. The report will be considered at the next meeting of the Council.

Ilford (Essex).—An inquiry was held here on Friday into the application of the Council to borrow £68,500 for electric lighting and tramway purposes. Mr. McMorran, Q.C., and Mr. Bartley Dennis appeared for the Council, and opposing ratepayers were also legally represented. Mr. McMorran pointed out that Ilford was an important and growing residential suburb, and it was necessary to have electricity supply available in the district. In 1899 the Council obtained a provisional order enabling them to construct tramways, which it was proposed to work electrically. They had obtained sanction to a loan for a station site. The only questions were the advisability of constructing the proposed works and the sum to be borrowed. On both points the Council had been advised by Mr. W. C. C. Hawtayne. There was a demand for electric current for lighting and for the tramways. At present the public lighting was in the hands of the local gas company, who had the lighting of 530 lamps at £1,937. 5s. 1d. per annum. The number of lamps and the cost would be increased this year, and as new estates were being developed there would be need for still more lamps. The Council's consulting engineer (Mr. Hawtayne) gave technical details. The sum to be allocated to electric lighting, he said, was £66,319, but, after allowing for probable deductions, this figure was reduced to £61,520. Repayment of loan and interest would amount to £3,230 per annum, and a net profit of £1,007 was anticipated. It was proposed to charge 4d. per unit for current. The high-road would be lighted electrically, and the overhead system of electric traction had been decided upon, because it was the most workable and the least expensive system. Mr. Soper (for the opposition) stated that the price of gas would be reduced to 3s. 6d. next year, but Councillor Lusby interjected that it would have been 4s. 6d. but for the electric lighting scheme coming forward. The Council (resumed Mr. Hawtayne) were now paying £3. 15s. per lamp for gas lighting, but electricity would only cost them £3 per lamp. A petition in favour of electric lighting, signed by 650 persons, was presented by the clerk to the Council (Mr. J. W. Benton), who was cross-examined as to the liabilities of the Council and the rateable value of the district. Mr. H. Stevenson (a consulting engineer) was called in opposition to the scheme. He said that to his knowledge in only 23 cases out of 49 where municipal boroughs had electric lighting was it remunerative, and electric lighting was more likely to pay in municipal boroughs than in a place like Ilford. The inquiry lasted over six hours.

Labour Disputes in 1898.—The report of the chief labour correspondent to the Board of Trade on strikes and lock-outs in 1898 shows that the number of disputes in that year was 711. The number of workpeople affected numbered 253,907 and the number of working days thus lost was 15,289,478. The results of the various disputes resulted to a very large extent in the defeat of the men, chiefly owing to the failure of the strike in the Welsh coal trade.

Leeds.—The opening of the Headingley-Chapeltown electric tramway route has been fixed for Thursday next.

Light Railways.—The Finance committee of the Middlesex County Council estimate the cost of constructing the light railways projected by the Council at £3,000,000. Negotiations are still proceeding between the joint promoters, the Middlesex Council and the North Metropolitan Tramways Co., as to the terms of constructing and leasing lines, &c.

The Light Railway Commissioners will hold an enquiry on Jan. 8 into the application of the Bath Corporation to construct light (electric) railways in the district.

The Light Railway Commissioners have issued their order for the construction of the Colne and district light (electric) railway. The promoters are Messrs. Greenwood and Batley. The clause enabling the Colne Corporation to borrow money for supplying electrical energy in or outside the district with the consent of the Local Government Board has been expunged.

Limehouse (London).—The District Board of Works have decided to proceed with their application for a provisional order. The sum proposed to be spent on electricity works has been fixed at £55,000.

Limerick.—Mr. J. Enright has been appointed consulting electrical engineer to the Council. At the Council meeting last week the town clerk said that, as directed, he had communicated with the four electrical engineers recommended by Prof. Kennedy—namely, Messrs. R. Hammond, Burstall and Monkhouse, W. M. Mordey, and Prof. D. S. Capper, and in addition he had received applications from Mr. H. M. Leech and Mr. F. J. Warden-Stevens, Mr. A. H. Gibbings, Mr. R. Quin, and Mr. J. Enright. The terms were these to have been received by Prof. Kennedy—namely, 5 per cent. on the expenditure.

Manchester.—The *Manchester Courier* of 22nd inst. contains a *resumé* of the progress made by the electricity supply department of the Corporation during the year. At present there are 3,014 customers of the electricity department, representing the equivalent of 289,043 8 c.p. lamps connected, against 2,376 customers and 224,033 lamps in 1898. There are also 180 customers (representing 39,653 8 c.p. lamps) awaiting connection. The department has, it is stated, been put to considerable inconvenience owing to the delay in the delivery of machinery. The second 2,500 H.P. generator, which should have been completed and erected at the Dickinson-street station in Oct., 1898, is even yet not ready for running. The disaster which occurred at the works on Sept. 19 last did considerable damage to the plant, and further increased the difficulties of the department. Three of the 400 H.P. engines and dynamos were disabled by this accident, and although one of these engines has since been repaired and is now at work, the other two machines were so badly damaged as to render them entirely useless for the present winter. Considerable additions to the electric mains have been laid in the city and in the districts of Moss Side, Withington and Levenshulme. Current has been available in part of Moss Side since the middle of last month, and preparations are being made to supply current in the other districts at an early date. Parliamentary powers have been obtained to authorise the supply of electricity (by agreement) in districts adjacent to the city, and formal agreements have been entered into with the Councils of Droylsden, Denton and Heaton Norris. The Electricity committee have decided to establish a second generating station at Bloom-street, adjoining the present station, and the work of building a canal wall and preparing foundations for the engines and boilers is already in progress. Contracts have been placed for four 2,500 H.P. generators and the necessary boilers and fittings. The committee are also making preliminary preparations for the equipment of a third station in Stuart-street, Bradford (Manchester), where it is proposed to erect large generators producing three-phase current at a pressure of 6,500 volts, to be transmitted to sub-stations in the area of supply and be thence distributed on a three-wire network, with 200 volts pressure on the lamps and 400 for motors, while for traction purposes current will be distributed at a pressure of 500 volts.

Manchester-Liverpool Electric Express Railway.—The bill promoted by the Manchester and Liverpool Electric Express Railway Co. has been deposited at the Private Bill Office, in accordance with Parliamentary standing orders. The company seek powers to construct a railway about 34½ miles in length, commencing on the west side of Deansgate, Manchester, passing through Salford, Pendleton, Eccles, Widnes, Halewood, Garston, and Toxteth Park to Liverpool. The capital required for the construction of the line is £2,000,000, divided into 200,000 shares of £10 each, with power to raise £660,000 in debentures. The first directors will be the Hon. R. J. Strutt, Mr. J. S. Bergheim, Mr. E. T. Broadhurst, Mr. J. H. Macmillan, Mr. William Mather, and two other persons to be nominated by them. The line will be worked by electric power from a generating station erected in Great Sankey, the line being constructed on the mono-rail system. The time required for construction is five years, and during this period £150,000 interest may be paid out of capital. The maximum passenger fares proposed to be charged are 2d. per mile first class and 1d. second class, with a minimum charge "as for three miles." For merchandise traffic it is intended to apply the schedule contained in the Manchester, Sheffield, and Lincolnshire Railway, &c., Order, 1892.

Marylebone (London).—A meeting of ratepayers was held at the Portland Hotel, last week, to discuss the complaints of repeated failures of the electric light, when it was decided to take common action, "with a view to obtaining a better supply in future and compensation for any losses sustained." The Guardians have unanimously decided to apply for a summons against the Metropolitan Co. for "making default in the supply of electric current on several occasions."

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Mile End (London).—The deputation recently appointed by the Vestry to inspect combined refuse destructor and electric lighting works in the kingdom, and to report upon the advisability of erecting similar works in this district, have presented their report, and recommend that, as the Whitechapel District Board are already erecting electric lighting plant in conjunction with a refuse destructor, and as these will in November, 1900, be the property of the new borough, that the Board do not undertake electricity supply.

Opposition to Electric Lighting Orders.—The Middlesex County Council is opposing the applications for electric lighting orders for Teddington, Twickenham, Staines, Egham, Chertsey, Uxbridge, Edmonton, Hendon, Enfield, Harrow, Heston and Isleworth, on the ground that the main roads and bridges controlled by the Council are affected by these orders.

Paddington (London).—The Paddington Vestry are much exercised over the complaints of failure of electricity supply in the district, but have left the matter in the hands of their Electric Lighting committee.

Poplar (London).—The bill of the Charing Cross and Strand Electricity Supply Corporation will be opposed by the District Board of Works, as the Board is afraid that the company "has an eye to supplying current throughout the district."

Provisional Order Transfer.—The Audenshaw District Council give notice of intention to transfer their electric lighting provisional order to the Manchester Corporation. The Council reserve the right to repurchase at the end of 21 years or any subsequent period of five years.

Russian Customs Duties.—Duties on goods imported into Russia have been increased by 50 per cent., all customs dues being now collected on the basis of the new currency rouble, 15 of which (equal 66⅔ copecks gold each) are equal to one imperial. In effect, however, no alteration has taken place in the amount of duty payable, the English equivalent of the rouble being now $\frac{3s.\ 2d. \times 66\frac{2}{3}}{100} = 2s.\ 1\frac{1}{3}d.$

Sydney (New South Wales).—According to the *Australian Mining Standard*, the New South Wales Railway Commissioners are having 150 tramcars built in anticipation of the conversion of the western and suburban lines to electric traction, and the order for the motors has been given to the General Electric Co. of America.

Veracruz.—The tramway lines of the Empresa del Ferro-Carril Urbano de Veracruz have recently been acquired by an English syndicate with a capital of £50,000. The lines, which are at present operated by mule power, are to be reconstructed into a well-equipped modern electric service.

Whitechapel (London).—The same charge is to be made for current for public and private lighting in this district.

PATENT RECORD.

The following list of Applications for Patents and Specifications published has been compiled for this journal by Messrs. J. C. Chapman and Co., *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs, and Trade Marks may be obtained.*

APPLICATIONS FOR PATENTS.

Note.—*The undermentioned Applications are not open to public inspection until after the acceptance of the complete Specification. The names within parentheses are those of communicators of inventions. When complete specification accompanies application, an asterisk is affixed.*

November 15, 1899.

22,830. S. Robinson. London. Improvements in primary batteries. (S. R. V. Robinson, United States.)

22,832. C. A. Sahlstrom. London. Improvements in batteries for the generation of ozone and for like purposes.

November 16, 1899.

22,853. J. Jones. Dundee. Improvements in electromagnetic coils and magnets.

22,857. L. Cunow. Birmingham. A medicinal light-curative apparatus for the production of complete or partial baths of chemical and electrical rays of light.*

22,889. W. R. Ormandy and J. Unsworth. Liverpool. Improvements in or relating to trolleys for electric tramways and the like.

November 17, 1899.

22,919. S. W. Johnson. Sheffield. Improvements in insulators for electrical purposes and method of making same.

22,954. L. E. Granichstaedten. London. Improvements in kinematographs.

22,960. H. H. Lake. London. Improvements in electric insulating devices. (L. McCarthy, United States.)*

22,964. P. Hébert and E. Cannevel. London. A new or improved electric automotor carriage.

22,967. W. R. Ridings and Verity's (Limited). Birmingham. An improved automatic "cut-out" and "cut-in" for use with electric arc lamps.

November 18, 1899.

22,989. F. Hewer. London. Improvements in electric tramways or railways.

23,009. J. H. Hollyer. Droitwich. Improvements in automatic electric warning signals for railways and the like.

23,021. H. Sefton-Jones, of the firm of W. P. Thomson and Co. London. Improvements in or relating to electric motor vehicles. (Kölner Accumulatoren-Werke Gottfried Hagen, Germany.)*

23,029. H. Lane. Birmingham. Improvements in or relating to electrical traction particularly applicable for tramways and railways.

23,033. W. Schlothauer. London. Improvements in secondary batteries.

23,040. A. J. Boult. London. Improvements in or relating to apparatus for the electrolysis of alkali chloride solutions. (F. Störmer, Germany.)*

23,054. Siemens Bros. and Co. (Limited). London. Improvements in coupling appliances for the electrical conductors of electrical railway and tramway vehicles. (Siemens and Halske Aktien Gesellschaft, Germany.)

23,055. Siemens Bros. and Co. (Limited). London. Improvements in current collecting apparatus for the underground conductors of electric railways and tramways. (Siemens and Halske Aktien Gesellschaft, Germany.)*

November 20, 1899.

23,077. H. Chapman. Sheffield. Electrical sewing machinery.

23,096. J. A. L. Dearlove. London. Improvements in recording apparatus for use on telegraph cables and other lines.

23,100. H. Long. London. Improvements in electric lamp supports.*

23,102. G. Weissmann and A. Wydts. London. Improvements in contact breakers, especially applicable to induction coils. (Date applied for under Patents, &c., Act, 1888, Sec. 103, 25th April, 1899, being date of application in France.)

23,119. P Jean and A. Bouchon. London. Improvements in and relating to electric illuminating devices.

November 21, 1899.

23,138. W. P. Miles. Grove Park. For determining the flow of liquids, including gases and electricity, within given times.

23,141. J. Goddard. Ashton-under-Lyne. Automatic controlling arrangements for switches for direct-driven cage hoists and general electric and motor work.

23,153. H. Hirst and F. O. Hunt. London. Improvements in switches for use with rheostats for starting and controlling electric motors for lifts or the like.

23,154. A. Eckstein and H. J. Coates. Manchester. An improved electrical indicator.

23,219. A. J. Boult. London. Improvements in or relating to electric signal alarm and safety devices for railways. (F. Cumont, Belgium.)*

23,235. H. Leitner. London. An improvement in secondary voltaic batteries.

November 22, 1899.

23,241. R. Alexander. London. Improvements in holders for electric lamps. (A. B. Vanes, Cape Colony.)

23,267. G. J. Ball. Dublin. An improved trolley and connections for overhead electric traction or similar uses.

23,283. The British Thomson-Houston Co. (Limited). London. Improvements in systems of electrical distribution. (E. Thomson, United States.)*

23,284. The British Thomson-Houston Co. (Limited). London. Improvements in electric circuit breakers. (E. Thomson, United States.)*

23,285. The British Thomson-Houston Co. (Limited). London. Improvements in electric arc lamps. (E. W. Rice, jun., United States.)*

23,287. The British Thomson-Houston Co. (Limited). London. Improvements in producing high vacua. (J. W. Howell, United States.)*

23,288. The British Thomson-Houston Co. (Limited). London. Improvements in enclosed electric arc lamps. (O. N. Wiswell, United States.)*

23,289. The British Thomson-Houston Co. (Limited). London. Improvements in controlling devices for electric motors. (W. B. Potter, United States.)*

23,290. The British Thomson-Houston Co. (Limited). London. Improvements in regulating rotary electric converters. (E. J. Berg, United States.)*

23,291. The British Thomson-Houston Co. (Limited). London. Improvements in systems of electrical distribution. (C. P. Steinmetz, United States.)*

23,292. The British Thomson-Houston Co. (Limited). London. Improvements in electric locomotives or motor cars for adhesion and rack railways. (The Union Elektricitäts-Gesellschaft, Germany.)*

23,293. The British Thomson-Houston Co. (Limited) and F. Samuelson. London. Improvements in trolley stands for electric railways.

23,294. H. J. Banks. Birmingham. Improvements in and connected with electrical, gas and other fittings.

23,315. A. Wright and The Mutual Electric Trust (Limited). London. Improvements in and connected with electrolytic meters.

23,316. A. Wright and The Mutual Electric Trust (Limited). London. Improvements in and connected with electrolytic meters.

23,318. R. Houghton. London. Improvements in electrodes for medical applications of electricity.*

23,319. L. B. Atkinson. London. Improvements in electrical measuring instruments.

23,327. R. A. Hadfield and W. F. Barrett. London. Improvements in electrical and magnetic apparatus such as transformers, dynamos, and other appliances and alloys for use therein.

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November 23, 1899.

23,371. R. A. Sloan and J. E. L. Barnes. Liverpool. Improvements relating to switches specially applicable to switches for electromotors and the like.
23,400. A. F. Harris. Birmingham. Improvements in electrical anodes.
23,403. H. H. Lake. London. Improvements in and relating to electric igniting apparatus useful for lighting cigars or for similar purposes. (S. Abbott, United States.)*
23,413. M. H. Robinson and M. H. P. R. Sankey. London. Improvements in the construction of dynamo electric machines.

November 24, 1899.

23,435. J. W. Milligan and F. Oldfield. Birmingham. Improvements in or relating to electrical contact makers and breakers.
23,440. H. G. Mason. London. An improvement relating to electric lamps.
23,443. P. C. McFarlane (of the firm of J. White). Glasgow. Improved automatic make and break for electric circuits.
23,447. J. S. Prentice. Glasgow. Improvements in gramophones.
23,497. F. von Madaler. London. Improvements in phonographs.*
23,504. J. C. Baviera. London. Improvements in receiving apparatus for Hertzian radiations or electromagnetic waves.*

November 25, 1899.

23,522. E. C. St. John. London. An improved automatic electric cut-out.
23,540. W. Hart. London. Improvements in graphophone reproducers.*
23,541. H. J. Lawson. London. Improvements in or relating to electric ignition apparatus for explosion engines.
23,575. E. W. Tangye. Birmingham. Improvements in or relating to pulley blocks or lifting and lowering mechanism operated by electricity.

November 27, 1899.

23,621. E. Bolbruiker. Berlin. Improvements in apparatus for adjusting electromagnetic ignition in gas or oil engines.*
23,627. A. Rosenberg. London. Improvements in or relating to holders for record cylinders of phonographs, graphophones, and the like.*
23,663. J. Burke. London. Armature for alternating-current motors.*

November 28, 1899.

23,696. A. G. Brookes. London. Improvements in and relating to electric alarm systems for the protection of buildings or for like use. (E. T. Woodman and H. A. Fiske, United States.)*
23,713. H. Tripp, G. E. Stephenson and W. C. C. Larty. London. Improvements in or relating to electrically-illuminated advertisements or signs.*
23,728. M. Wuillot. London. Improved manufacture of lead plates for secondary batteries.*
23,734. J. Bouillet. London. Improvements in or relating to electric lighting or heating apparatus.
23,737. The British Thomson-Houston Co. (Limited). London. Improvements in pneumatically-operated contact shoes for third-rail electric railway systems. (S. H. Libby, United States.)*
23,738. The British Thomson-Houston Co. (Limited). London. Improvements in compounding electric alternators. (C. P. Steinmetz, United States.)*
23,739. The British Thomson-Houston Co. (Limited). London. Improvements in electric railway systems and cars. (W. B. Potter, United States.)*
23,740. The British Thomson-Houston Co. (Limited). London. Improvements in controlling alternating electric current motors. (C. P. Steinmetz, United States.)*
23,753. E. C. Rimington. London. Improvements in maximum electrical current indicators.
23,755. J. D. Darling and C. L. Harrison. London. Improvements in electrolytic apparatus.*

November 29, 1899.

23,781. L. B. Powderly. Dublin. Improvements in and in relation to trolley heads for electric tramcars.
23,813. Siemens Bros. and Co. (Limited). Improvements in galvanic batteries. (Siemens and Halske, Aktien Gesellschaft, Germany.)*
23,829. G. Koppelmann. London. An improved system for the generation of electric current at constant potential.*
23,830. E. Pohl. London. Improvements in the process of manufacturing carbons for electrical and electro-chemical and other purposes.
23,834. A. C. Crehore and G. O. Squier. London. Improvements in or relating to telegraphic apparatus.

November 30, 1899.

23,869. R. B. Ransford. London. Improvements in incandescent electric lamps. (A. W. W. Miller, United States.)
23,870. S. G. Brown. London. Improvements in apparatus for electric telegraphy.
23,877. H. de Thiersant and H. J. Norballe. London. Improvements in or relating to electric gas lighters.
23,879. F. M. F. Cazin. London. Improvements in and connected with electric incandescent lamps.
23,905. F. M. Lewis. London. A new or improved alternating-current electro-motor.
23,918. L. de Somzée. London. Improvements in the manufacture of electrically conductive incandescent filaments and the like.
23,919. J. Stockert. London. Improvements in or relating to type printing telegraphs.*

December 1, 1899.

23,925. J. M. Hewitt and W. G. Rhodes. Manchester. Improvements in starting, regulating and reversing switches for electric motors.
23,960. E. Cros. London. An improved electric switch or governor.

SPECIFICATIONS PUBLISHED.

Note.—All Specifications can now be obtained at the uniform price of 8d. each.

1893.

5,339. Lardeur. Apparatus for the conversion of light waves into electrical waves for the transmission of such electrical waves to a distance, and for the reconversion of such electrical waves into light waves; also for recording such waves upon suitably prepared surfaces. (Post dated October 27, 1898.)
22,261. Ries. Methods of and means for manufacturing metal tubing and utilising the heating effect of electrical energy in connection therewith.
24,104. Wilson and Cater. Apparatus connected with the charge and discharge of storage cells in systems of electrical distribution.
24,133. Hirst and Bevis. Open or enclosed arc electric lamp.
24,593. Rhodes and Miners' Lamp Electric Lighting Co. (Limited). Lighting of miners' and other lamps by means of an electric current.
24,626. Hardy and Picard. Microphones.
24,812. Crompton. Electrical meters.
25,260. Nunns. Electricity meters.
25,752. Addenbrooke. Electrometers and keys for operating the same.
26,033. Miller, Turvey, and Weston. Connectors for electrical cables or wires.
26,154. Tschernoff. Means for heating by electricity.
26,214. Phillips and Bray. Electrical furnace.
26,703. Harrison. Primary batteries.
27,586. Egger. Direct-coupled driving arrangement for electric automotors.

1899.

2,350. Bell and Byng. Method of connecting telephonic apparatus as a system.
5,849. Endruweit. Brushes for dynamos.
7,624. Edwards (Ludwig and Pfefferkorn). Phonographs, gramophones, and the like.
10,183. Cutting and Cutting. Removable combination magnet and coil for electric generators and motors.
11,646. Ravené. Devices for securing incandescent electric lamps in their sockets.
11,258. Boult (Trillet). Galvanic batteries.
15,370. De Michalowsky. Secondary or storage battery.
16,140. Feeny (Allgemeine Elektricitäts Gesellschaft). Electrical resistances and heating bodies composed of metallic oxides.
16,879. Siemens Bros. and Co. (Limited) (Siemens and Halske Aktien Gesellschaft). Method for dividing an alternating current into two currents whose phases are shifted relatively to each other through a determined angle.
16,898. Short. Pneumatic controlling mechanism for electric railway cars.
17,130. Rausch. Automatic electric alarms.
17,263. Siemens Bros. and Co. (Limited) (Siemens and Halske Aktien Gesellschaft). Electrical measuring instruments employed in combination with current and potential transformers for measuring electrical energy.
17,341. Stendebach. Contact apparatus for electric railways with underground current feed and mechanical partial conductor service.
17,379. Hellström. Electric arc lamps.
17,336. Guett. Snap electric switches.
17,454. Anderson and Anderson. Support for overhead electric conductors on electric railways, tramways, and the like.
17,510. Johnson and Murday. Electricity meters.
17,522. Adamson. Apparatus for photographing by means of gas and electric light.
17,858. Späth. Phonographs.
17,938. Marius. Electro-medical appliances.
18,173. Byng and Bell. Telephonic systems, and in apparatus therefor.
18,254. Polzin. Construction of electric accumulator plates.
18,489. Siemens Bros. and Co. (Limited) (Siemens and Halske Aktien Gesellschaft). Process for forming a conducting connection between electrical incandescence bodies of second class conductors with conductors of the first class.
18,502. Von Kramer. Safety devices for electrically-operated hoisting apparatus.
19,285. McTighe. Rail bonds for electric railways.
19,619. Burke. Laminated armatures for dynamo-electric machines.
19,863. Gray. Telephonic apparatus.
20,412. Lundell. Electric railways working on the surface-contact system.

NEW COMPANIES, STATUTORY RETURNS, &c.

ELECTRIC LIGHTING BOARDS (LTD.)—This company was registered on Dec. 18, with a capital of £7,500 in £1 shares, to acquire from E. O. Sachs the benefit of certain inventions, to manufacture and deal in electric lighting boards, particularly with regard to luminous advertisements, and to carry on the business of electrical and mechanical engineers, &c. The first directors are Sir H. Nicholson, K.C.B., E. S. Enoch, and E. O. Sachs.

SOUTHERN ELECTRIC FREE WIRING CO. (LTD.)—This company was registered on Dec. 19, with a capital of £5,000 in £1 shares, to carry on the business of electricians, mechanical, electrical and general engineers, suppliers of electricity, contractors, metal workers, &c. The first directors are H. J. Weston (chairman), G. W. Capper, J. H. Laidman, T. Mitchell, and H. J. Richards.

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CITY NOTES.

MEMORANDA.—Bank rate 6 per cent. (since Nov. 30, 1899). Price of silver 27 1/16d. per oz. (Dec. 28). Consols (2¾ per cent.) £8 3/8—99 for money, 99 1/16—98 1/8 for account; 2½ per cent. 96—97 (Dec. 28). Stock Exchange Settling Days: Consols, Jan. 4; Stocks and Shares Continuation Day, Jan. 10; Ticket Day, Jan. 11; Pay Days, Dec. 29 and Jan. 12; Mining Share Carry-over Days, Jan. 9 and 23.

ALDERLEY AND WILMSLOW ELECTRIC SUPPLY (LTD.)—The annual meeting of this company was held on Thursday last, at Manchester, the chairman (Mr. F. E. Gripper) presiding. The report of the resident engineer stated that the works were giving every satisfaction, and the number of applicants for the supply of electric current was increasing. It was understood that application had been made for the supply to be extended to the district of Mobberley, but the directors had decided to obtain further particulars in regard thereto. The secretary (Mr. W. E. Rowcliffe) reported that the company had entered into an agreement with the National Electric Wiring Co. for the "free" wiring of premises in the district. The directors are in communication with the Wilmslow District Council, with a view to making an arrangement for the supply of current to that district, in respect of which a provisional order had been obtained by the company.

BLACKPOOL, ST. ANNES, AND LYTHAM TRAMWAYS] CO. (LTD.)—In their annual report the directors state that the working of the line during the past season has been to a great extent of an experimental but of a promising character. The company has been unable to cope with the traffic offered, but arrangements have been made enabling the directors to adopt any mode of traction that may be found advisable to bring the line up to a higher state of efficiency, when at least twice the number of cars will be placed on the road. Steps have also been taken for the application to Parliament for doubling the company's line.

KAMM'S ZEROGRAPH SYNDICATE (LTD.)—A meeting of this syndicate was held at Winchester House yesterday (Thursday).

LYON'S PATENT ELECTRIC REFRIGERATOR SYNDICATE (LTD.)—The second annual general meeting of the shareholders of this company was held on Wednesday, at Glasgow, Mr. J. Macintyre, chairman of the company, presiding. He claimed that the company had now established the fact that their patent system of refrigeration was the cheapest in the market. They had passed from the experimental to the commercial stage of operations, and had at the present time a perfected machine on exhibition. They had orders on hand from tradesmen who would use their electric refrigerators, and he foreshadowed handsome profits to the shareholders of this company, which had secured patents in Great Britain, France, Belgium, Spain, U.S.A., New South Wales, and Cape Colony, as well as having put in applications for a number of other countries.

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee have appointed Jan. 4 as a special settling day in the further issue of 15,000 Ordinary fully-paid £10 shares (Nos. 60,001 to 75,000) of the *British Electric Traction Co. (Ltd.)* and 300,000 Five per Cent. Cumulative Preference £1 shares (Nos. 1 to 300,000) and £200,000 Four per Cent. Irredeemable First Mortgage Debentures (Nos. 1 to 300,000) of the *Thames Iron Works, Shipbuilding and Engineering Co. (Ltd.)* These securities have also been ordered to be quoted in the Official List together with a further issue of 6,000 Four-and-a-Half per Cent. Cumulative (£5 fully-paid) Preference shares (Nos. 6,001 to 12,000) of *W. T. Henley's Telegraph Works Co. (Ltd.)* The committee has also been asked to appoint a special settling day in 14,320 £3 shares (£2 paid) (Nos. 32,099 to 46,418) of *Crompton and Co. (Ltd.)*, and to appoint a special settling day in and to grant a quotation to 10,000 Five per Cent. Cumulative fully-paid Preference £10 shares, and a further issue of £48,100 Four-and-a-Half Redeemable stock of the *Barcelona Tramways Co. (Ltd.)*

WESTERN AND BRAZILIAN TELEGRAPH CO. (LTD.)—The liquidator (Mr. W. H. Axworthy) is prepared to pay the holders of share warrants an amount equalling £12. 10s. per share, together with the dividends due thereon. Share warrants to bearer must be deposited at 209, Winchester House, London, E.C.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	1899	£	£		£	£
*Birmingham Tramways.	Dec. 23	4,273	+ 130	25	103,773	+ 10,286
Blackpool Corporation...	„ 21	115	− 5	38	20,536	+ 4,353
Blackpool and Fleetwood	„ 23	122	− 10	25	20,083	+ 5,824
Bradford Corporation ...	„ 24	372	+ 95	71	23,643	...
Brisbane Trams	Nov. 8	8,690	+ 2,584	6	16,505	+ 5,222
*Bristol Trams & Carriage	Dec. 22	2,764	+ 34	25	77,186	+ 8,365
*Buenos Ayres & Belgrano	Nov. 26	2,332	+ 738	47	101,785	+ 45,266
City & South London Ry.	Dec. 24	1,194	+ 60	26	25,995	+ 29
Dover Corporation	Dec. 23	151	+ 5	38	8,040	+ 1,036
Dublin United	Dec. 22	3,228	+ 438	...	...	...
Dublin Southern Dist....	„ 22	647	− 6	...	...	...
*Glasgow Corporation ...	„ 23	8,505	+ 157	...	...	...
*Liverpool Corporation...	„ 16	6,043	− 7	50	343,941	+ 40,933
Liverpool Overhead Rly.	„ 24	1,442	+ 3	25	41,812	+ 1,994
*Sheffield Tramways	„ 24	1,858	+ 546	52	74,781	...
*South Staffs. Trams.....	„ 22	624	− 12	51	33,802	+ 1,613

* Partly electrical.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Dec. 20.	Price Wednesday, Dec. 27.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Dec. 27. Highest	Lowest
			TELEGRAPHS.			£ s. d.			
£110,900	100	4%	*African Direct Telegraph 4% Mort. Deb. (red.)	100 104	100 104	3 16 11	January and July.....	...	...
25,000	10	...	Amazon Telegraph.....	3 4	3 4	...	June and December ...	...	...
£125,000	100	5%	Do. 5 per Cent. Debentures	85 90	85 90	5 11 1	...	...	...
£875,520	Stock	15/0	Anglo-American	63 66	62 65	5 8 0	Feb., May, Aug., Nov.	65	...
£3,062,240	Stock	30/0	Do. Preferred	113 115	111 113	5 8 4	„ „	113⅞	111¼
£3,062,240	Stock	18/0	Do. Deferred.....	15⅛ 16	15⅜ 16⅛	5 10 9	...	15⅞	15⅛
207,930	10	3/0	Western Telegraph (late Brazilian Submarine)	14¼ 14⅜	14 14⅛	4 16 7	Mar., June, Oct., Dec.	14⅜	14¼
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1900)	107 111	107 111	4 11 6	June and December ...	...	...
$10,000,000	$100	$1¼	Commercial Cable Capital Stock	198 202	198 202	3 19 9	Jan., Apr., July, Oct.	...	...
£1,332,823	Stock	4%	* Do. 4 per Cent. Debenture Stock.....	103 105	100 103	3 18 5	„ „	103½	102
16,000	10	8/0	Cuba Submarine Ordinary	8½ 9½	8½ 9½	8 8 5	February and August	9 1/16	...
6,000	10	10,0	Do. Preference 10 per Cent.	19 20	19 20	5 0 0	„ „	...	...
12,931	5	2/0	Direct Spanish Ordinary.....	4 5	4 5	4 0 0	April and October.....	...	...
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference	9 10	9 10	5 0 0	„ „	...	...
£30,000	50	4½%	Do. 4½ per Cent. Debentures	103% 107%	103% 107%	4 4 1	January and July.....	...	...
60,710	20	3 0	Direct United States Cable	11¾ 12¼	11⅞ 12	5 16 8	Jan., Apr., July, Oct.	12	11⅞
£120,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red.)...	101 104	101 104	4 7 10	June and December ...	...	...
£4,000,000	Stock	5%	Eastern Ordinary	145 150	143 148	4 15 7	Jan., Apr., July, Oct.	154	146
£1,795,000	Stock	3½%	Do. 3½ per Cent. Preference Stock	98 101	97 100	3 10 6	„ „	100	99¾
£1,432,268	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.).....	115 120	115 120	3 6 11	May and November ...	116¼	115½
250,000	10	2/6	Eastern Extension	14⅞ 15¼	14¼ 14⅝	4 14 11	Jan., Apr., July, Oct.	14	10½
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	116 121	116 121	3 6 7	February and August	121	116
£16,200	100	5%	* Do. 5% (Austln. Gov. Sub.) Deb., 1900 (reg.)...	99 103	99 103	4 17 4	January and July.....	...	...
£64,400	100	5%	Do. (Bearer)	100 103	100 103	4 17 1	„ „	...	...
£17,400	100	5%	*Eastern and S. African 5% Mort. Deb., 1900 (reg.)...	99 103	99 103	4 17 1	„ „	...	...
£24,500	100	5%	Do. (Bearer)	100 103	100 103	4 17 1	„ „	...	...
£300,000	100	4%	* Do. 4 per Cent. Mortgage Debentures, 1909 ...	101 104	101 104	3 16 11	February and August	101	...
£200,000	25	4%	Do. 4 per Cent. Mauritius Sub. Debs. (red.) ...	101% 104%	101% 104%	3 16 10	May and November ..	...	...
180,227	10	1/9	Globe Telegraph and Trust	10⅜ 11⅛	10⅜ 11⅛	4 13 4	Jan., Apr., July, Oct.	11⅜	10⅞
180,042	10	3/0	Do. 6 per Cent. Preference	14¾ 15¼	14¾ 15¼	3 18 8	„ „	15⅝	15
150,000	10	5/0	Great Northern of Copenhagen	31 33	31 33	3 15 9	January and July.....	31¾	...
£86,300	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb. (red.)...	100 103	100 103	4 7 5	...	...	...
17,000	25	12/6	Indo-European.....	48 52	48 52	4 16 2	May and November ...	...	...
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904 ...	106 109	106 109	5 10 1	March and September	...	...
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.)	102 105	102 105	3 17 6	June and December...	...	...
11,839	8	4/0	Reuter's.....	7 8	7 8	5 0 0	April and October.....	...	...
3,381	£100 Cert.	6%	Submarine Cables Trust	125 130	125 130	4 13 0	„ „	...	...
15,609	10	...	West African Telegraph	2½ 3½	2½ 3½	4 9 3	December and July ...	...	...
£200,000	100	5%	* Do. 5 per Cent. Debentures (red.)	99 102	99 102	4 18 0	March and September	98	...
30,008	2½	...	West Coast of America	½ 1	½ 1	...	...	...	...
£150,000	100	4%	* Do. 4 per Cent. Debentures	102 105	102 105	3 16 8	January and July.....	...	...
88,321	10	6d.	West India and Panama	⅞ 1⅛	⅞ 1⅛	...	May and November ...	1	...
34,563	10	6/0	Do. 6 per Cent. 1st Preference	9½ 9⅞	9½ 9⅞	6 3 1	„ „	...	...
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	7½ 8½	7½ 8½	7 1 2	„ „	...	...
£80,000	100	5%	* Do. 5 per Cent. Debentures	106 109	106 109	4 13 7	January and July.....	...	...
£389,731	Stock	4%	Western & Brazilian 4 per Cent. Debenture Stock ...	104 107	104 107	3 15 0	June and December ...	...	...
£158,100	100	6%	*Western Union 6 per Cent. Sterling Bonds (red.) ...	98 103	98 103	5 16 6	March and September	...	...

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Dec. 20.	Price Wednesday, Dec. 27.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Dec. 27. Highest	Lowest
			TELEPHONES.			£ s. d.			
44,000	£5	3/0	Chili Telephone (fully paid)	2 3	2 3	6 13 4	August	...	...
224,850	10s.	0/1½	Consolidated Telephone Const. & Manufacturing	½ ¾	½ ¾	4 15 3	July	...	...
72,680	1	0/6	Monte Video Telephone Ordinary	½ ¾	½ ¾	5 0 0	October	...	...
86,492	1	1 0	Do. 5 per Cent. Preference	¾ 1	¾ 1	5 0 0	...	...	...
490,000	5	3/0	National	5 5½	4⅞ 4¾	6 3 1	February and August	4¾	4⅞
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Preference	14 15	14 15	4 0 0	,, ,,	14½	14
15,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference	14 15	14 15	4 0 0	,, ,,	...	...
250,000	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref.	5⅛ 5⅜	5⅛ 5⅜	4 13 0	,, ,,	5¼	5⅛
1,329,471	Stock	3½%	* Do. Debenture Stock 3½ per Cent. (red.)	100 102	100 102	3 8 8	June and December	101	99½
171,504	1	0/4	Oriental	¾ 1	¾ 1	5 0 0	April and October	...	...
58,000	5	6/0	United River Plate	4⅜ 5⅛	4⅜ 5⅛	5 14 3	July	...	...
16,639	5	...	Do. 5% Cumulative Preference (£3. 10s. paid)	3½ 3¾	3½ 3¾	...	...	...	...
£179,947	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	105 108	105 108	4 13 9	June and December	105½	...
			ELECTRICITY SUPPLY COMPANIES.						
85,000	1	...	British Electric Works Co. Ordinary	...	14 6 15/6	...	...	...	...
50,000	1	...	Do. 5 per Cent. Cumulative Preference	...	17/0 18/0	...	...	...	...
100,000	1	...	Bl'ckh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.)	¾ 1	¾ 1	...	...	...	...
6,000	10	7/9⅜	Bournemouth and Poole Elec. Supply Ord.	12 13	12 13	3 0 0	...	...	...
6,000	10	4/6	Do. 4½ per Cent. Cumulative Pref.	10 11	10 11	4 1 10	...	...	...
19,661	5	2/6	Brompton & Kensington Electricity Supply Ord.	7⅛ 8⅛	7⅛ 8⅛	3 15 0	...	...	...
12,000	5	3/6	Do. 7 per Cent. Preference	9 10	9 10	3 10 0	March and September	...	...
20,000	5	...	Calcutta Elec. Supply Ordinary (£4 paid)	6½ 7	6⅝ 7	...	...	...	...
30,000	5	4/0	Charing Cross & Strand Electricity Supply Corp.	9⅝ 10⅛	9⅝ 10⅛	4 5 9	February and August	10	9⅞
20,000	5	...	Do. (Nos. 3,001 to 50,000)	9⅛ 10⅛	9⅛ 10⅛	...	...	...	...
20,000	5	2/3	Do. 4½ per Cent. Preference	5⅝ 6⅛	5⅝ 6	3 15 0	,, ,,	...	...
31,000	5	2/6	Chelsea Electricity Supply Ordinary	7⅛ 8⅛	7⅛ 8⅛	3 10 7	March	...	...
£100,000	Stock	4½%	* Do. 4½ per Cent. Debenture Stock (red.) ...xd	109 111	109 111	4 1 1	June and December	...	...
$1,200,000	$1,000	5%	Chicago Edison 1st Mort. 5% 30 year Gold Bonds (red.)	100 110	100 110	4 10 11	April and October	...	...
60,000	10	7/0	City of London Electric Lighting Ordinary	10 11	10 11	5 9 1	February and August	11⅛	...
40,000	10	6%	Do. 6 per Cent. Cumulative Preference	13 14	13 14	4 5 9	January and July	10⅝	...
£400,000	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	125 130	125 130	3 17 5	June and December	129⅛	...
40,000	10	...	County of London and Brush Prov. Ordinary	10 11	10 11	...	...	...	...
20,000	10	6/0	Do. 6 per Cent. Cumulative Preference	13 14	13 14	4 5 9	March and September	...	...
£200,000	Stock	7/8	Do. 4½% Deb. Stock Certs. (all pd.) (red.)	110 113	110 113	...	...	...	...
15,000	5	10%	Kensington and Knightsbridge Ordinary	12⅛ 13⅛	12 13	4 1 6	...	...	...
10,000	5	6%	Do. 6 per Cent. 1st Preference	7⅛ 7⅞	7⅛ 7⅞	3 17 5	January and July	...	...
110,000	3	...	London Electric Supply Ordinary	2⅛ 2⅝	2⅛ 2⅝	...	...	2⅝	...
48,050	5	3/0	Do. 6 per Cent. Preference	5⅛ 6	5⅛ 6	5 0 0	...	...	...
£100,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures...xd	102 104	102 104	3 16 11	Mar., June, Sept., Dec.	103	...
62,500	10	5/0	Metropolitan Elec. Supply Ord. (Nos. 1 to 62,500)	13 14	13 14	3 11 5	April and October	14⅛	12¹⁵⁄₁₆
22,500	10	3/7½	Do. (Nos. 62,501 to 85,000)	13 14	13 14	3 10 0	...	...	...
£220,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage	117 119	117 119	3 15 7	June and December	...	...
£125,000	Stock	...	Do. 3½ per Cent. Mort. Deb. Stock (red)	97 99	97 99	...	...	...	...
6,452	10	6/0	Notting Hill Electric Ordinary	15½ 16½	15½ 16½	3 15 0	March	...	...
10,000	5	5/0	Oxford Electric Ordinary	6¾ 7¼	6¾ 7¼	3 9 0	,,	7⅜	...
300,000	1	8%	Rand Electric	⅝ ¾	⅝ ¾	10 13 4	...	...	...
£130,070	Stock	5%	River Plate El. Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb.	80 90	80 90	5 11 1	...	...	...
150,000	$100	$2	Royal Electric Company of Montreal Shares	160 180	160 180	4 8 11	...	...	...
£123,200	100	4½%	* Do. 4½ per Cent. 1st Mortgage Debentures	104 106	104 106	4 5 6	April and October	...	...
31,980	5	5/0	St. James's and Pall Mall Electric Ordinary	15 16	15 16	4 10 8	February and August	15⅜	...
20,000	5	3/6	Do. 7 per Cent. Preference	9 9½	9 9½	3 13 8	,, ,,	...	...
65,000	5	...	South London Electric Supply Ordinary (fully paid)	4½ 4¾	4½ 4¾	...	...	...	...
79,900	5	5/0	Westminster Electric Supply Ordinary	13½ 14½	13½ 14½	4 2 9	March and September	14⅛	11½
			ELECTRIC MANUFACTURING, &c., COMPANIES.						
125,000	1	7½d.	Aron Electricity Meter 6 per Cent. Cum. Pref.	⅞ 1	⅞ 1	6 17 2	...	...	...
40,000	5	5/0	British Insulated Wire Ordinary	11½ 12⅛	11½ 12⅛	4 0 0	...	...	...
27,500	5	3/0	Do. Preference	6¼ 6¾	6¼ 6¾	4 8 11	...	...	...
90,000	2	2/0	Brush Electrical Engineering	1⅞ 2	1⅞ 2⅛	4 14 1	September	...	...
90,000	2	1/2⅞	Do. 6 per Cent. Pref. Non-Cumulative	2⅛ 2⅜	2⅛ 2⅜	5 1 1	,,	...	...
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Deb. Stock	110 115	110 115	3 18 5	February and August	...	...
£50,000	Stock	4½%	* Do. 2nd Debenture Stock (red.)	104 107	104 107	4 4 11	June and December	...	...
20,000	5	5/0	Callender's Cable Construction Ordinary	1 1⅛ 13⅛	12½ 13⅝	5 11 1	,, ,,	...	...
20,000	5	...	Do. 5 per Cent. Cumulative Preference	5½ 6	5½ 6	...	...	...	...
£90,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb. (red.)	113 116	113 116	3 18 7	November and May	...	...
300,000	1	0/9⅜	Castner-Kellner Alkali Co. (fully paid)	1⅛ 1⅜	1⅛ 1⅜	5 16 5	...	...	...
60,000	1	0/7½	Chadburn's Ship Telegraph Ordinary	⅝ 1½	⅝ 1½	5 6 8	...	...	...
60,000	1	0/7½	Do. 6 per Cent. Cumulative Preference	⅝ 1½	⅝ 1½	5 6 8	...	...	...
32,098	3	2/11½	Crompton and Co. (Nos. 1 to 32,098)	3½ 4	3½ 4	4 10 9	January and July	...	...
£100,000	100	5%	* Do. 5 per Cent. First Mortgage Deb. (red.)	100 103	100 103	4 17 10	,, ,,	...	...
60,000	1	0/3	Davis and Timmins 6 per Cent. Cum. Pref.	¾ 1	¾ 1	...	...	...	...
99,261	5	1/9⅛	Edison and Swan United ("A" Shares) (£3 paid)	2 2⅛	2 2⅛	7 4 0	February and August	...	...
17,139	5	2/9⅜	Do. (£5 paid)	3½ 4⅛	3½ 4⅛	6 13 4	,, ,,	...	...
£314,023	Stock	4%	Do. 4 per Cent. Mortgage Deb. Stock (red.)	95 97	95 97	4 2 6	June and December	...	...
26,100	5	5/11⅛	Edmundson's Electric Corporation Ord. (fully pd.)	4⅜ 5⅛	4⅜ 5⅛	5 14 3	Half-yearly	...	...
112,100	2	1/2⅜	Electric Construction Co. (Limited)	2 2⅛	2 2⅛	5 2 3	January and July	...	...
25,000	2	2/9⅛	Do. 7 per Cent. Cumulative Preference	2⅜ 3⅛	2⅜ 3⅛	4 6 2	July	...	...
182,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	104 107	104 107	3 15 8	January and July	...	...
91,195	1	...	Elmore's Patent Copper Depositing	⅜ ⅝	⅜ ⅝	...	...	...	...
30,000	5	...	Henley's Telegraph Works Ordinary	12 13	12 13	...	February and August	...	...
15,000	£5	...	Do. 4½ per Cent. Preference	5 5½	5 5½	4 1 10	,, ,,	...	...
£50,000	Stock	4½%	Do. 4½ per Cent. Mortgage Deb. Stock (red.)	111 113	111 114	4 0 0	,, ,,	...	...
50,000	10	5/0	India Rubber, Gutta Percha, &c., Works	21 22	21 22	4 8 11	,, ,,	...	...
£300,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	100 104	100 104	3 16 11	March and September	...	...
37,350	12	12/0	Telegraph Construction and Maintenance	36 40	33 37	4 17 3	March and July	...	...
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909	103 106	103 106	3 15 6	...	...	...
20,000	5	3/0	Do. Manufacturing Ordinary	9 10	9 10	3 10 0	...	9⅜	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5½ 6	5½ 6	4 3 4	...	...	...
30,000	5	5/0	Willans and Robinson Ordinary	10½ 11	10 11	4 1 10	April and October	...	...
30,000	5	3/0	Do. 6 per Cent. Cumulative Preference	7 7½	7 7½	4 0 0	,, ,,	...	...
£100,000	Stock	4¼%	Do. 4¼ per Cent. 1st Mortgage Debentures xd	104 105	104 105	4 0 2	May and November	...	...
			ELECTRIC RAILWAYS, TRAMWAYS, &c.						
12,000	10	6/0	Blackpool and Fleetwood Tramways	17 19	17 19	3 13 8	...	...	...
£167,900	100	5%	Brisbane Tramway 5 per Cent. Debentures	104 106	104 106	4 14 4	...	...	...
50,000	10	7%	Bristol Tramways and Carriage Ordinary	23 24	23 24	2 17 2	February and August	...	...
25,000	10	...	Do. Cumulative Preference (£4 paid)	4⅜ 4⅝	4⅜ 4⅝	...	...	...	...
£100,000	Stock	4%	Do. 4 per Cent. Debentures	118 119	118 119	3 7 3	...	...	...
30,000	10	9/0	British Electric Traction Ordinary	15 16	15 16	1 11 3	...	1⅝	1⅜
30,000	10	6/0	Do. 6% Cum. Pref. (Nos. 30,001 to 60,000)	12¾ 13¼	12¾ 13¼	4 8 11	...	13⅜	13
£200,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures	125 128	125 128	3 18 6	...	127	12⅞
40,000	5	1/9	Buenos Ayres & Belgrano 6% "A" Cum. Pref.	5⅛ 5⅜	5 5⅛	5 14 3	...	5⅛	5 5/16
27,500	5	...	Do. "B"	4¼ 5¼	4⅜ 5⅛	...	...	...	...
265,585	Stock	5%	Do. 5 per Cent. Debentures	108 111	108 111	4 10 1	...	...	...
35,250	10	3/0	Central London Ordinary	9¾ 10¼	9⅞ 10	3 0 0	June and December	10	9 1/16
178,303	10	2/4 1/16	Do.	...	...	...	,, ,,	...	...
£855,000	Stock	2½%	City and South London Railway Con. Ordinary	59 62	59 62	3 8 6	January and July	62	61
37,500	10	...	Do. (Nos. 22,501 to 60,000) (£4. 10s. paid)	3½ 4½	3½ 4½	...	...	...	...
£150,000	Stock	5%	Do. 5 per Cent. Perpetual Preference (1891)	143 148	143 148	3 8 0	January and July	...	...
£200,000	Stock	5%	Do. (1896)	135 140	135 140	3 11 11	...	...	...
£87,701	Stock	4%	Do. 4 per Cent. Perpetual Debenture	127 133	127 133	3 3 0	May and November	...	...
20,000	10	7½%	Imperial Tramways Ordinary ...x new	23 24	23 24	...	March and September	...	...
10,000	10	6%	† Do. 6 per Cent. Preference ...x new	15½ 15⅝	15½ 15⅝	3 13 10	,, ,,	...	...
£200,000	Stock	4½%	† Do. 4½ per Cent. Debenture ...x new	115½ 116½	115½ 116⅜	3 17 6	January and July	...	...
30,000	10	1/3	Kidd'rm'nst'r & Dist. E.L. & Tr'ct'n 5% Pref. (£6 pd.)	6 6½	6 6½	4 10 11	May and November	...	...
37,500	10	2½%	Liverpool Overhead Railway Ordinary	8⅝ 8⅞	8⅝ 8⅞	3 15 4	February and August	...	...
10,000	10	5%	Do. 5 per Cent. Preference	13 13½	13 13¼	3 15 6	,, ,,	...	...
125,000	Stock	4%	Do. 4 per Cent. Debenture	106 108	104 106	3 16 3	January and July	...	...
24,000	5	...	New General Traction Ordinary	3½ 4	3½ 4	...	...	...	...
30,000	5	6/0	Do. 6 per Cent. Cumulative Preference	5 5½	5 5½	5 9 1	May	...	...
4,000	10	...	Oldham, Ashton and Hyde Elec. Tramway Ord.	18 19	19 19½	4 11 11	February and August	...	...
4,000	10	5/0	Do. per Cent. Preference	10½ 10¾	10¾ 10¾	...	,, ,,	...	...
13,334	10	...	Potteries Electric Traction Ordinary	11½ 12½	11½ 12½	...	...	...	...
20,000	10	5/10	Do. 5 per Cent. Cumulative Preference	10 11	10 11	4 12 11	...	...	...

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THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861: Second Series (Weekly), 1878.

No. 1,129. [No. 11. Vol. XLiv.] FRIDAY, JANUARY 5, 1900. PRICE SIXPENCE (by post, 6½d.). Abroad, 8d., or 15 cents. or 80fr., or 70pf.

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NOTES.

WE wish all our readers a happy New Year, and trust that the last year of the nineteenth century, upon which we have now entered, will abound in prosperity and be prolific in progress for electrical science and its patrons. Although a sombre war-cloud hangs menacingly over our great Empire at the commencement of the new year, it is to be hoped that the record of the year's electrical progress, when it comes to be written, will form a fitting conclusion to a century that has witnessed the creation of practically the whole of modern physical science and mechanical engineering. In this creative work the empire of Great Britain has taken the foremost place, and every indication points to its continuance in that exalted position. Undue pride in all such national achievements is without doubt to be deprecated; but there is a due and legitimate pride in them, which serves as a stimulus to further efforts and as a reminder of our high national responsibilities.

APROPOS of the *locus* of the present year in the greater divisions of time, it is remarkable that the question as to whether the year ends the nineteenth or inaugurates the twentieth century has been allowed so much ventilation. It is the last farthing of the 100th pound that completes £100, and it is the last second of the 100th year that must end a century. Not even Sir COURTENAY BOYLE's ingenious plea in *The Times*—that we should regard January 1, 1900, as commencing the twentieth century, in order that essayists and public speakers might not be disappointed—can induce us to inflict on our readers before another year has elapsed a review of the departing century.

THE new year's honours bestowed by Her Majesty partake this year of a distinctly Imperial character, the Colonies and Crown possessions coming in for more than usually abundant recognition. Everyone will recognise the especial fitness of this at the present time, when the heart of the mother country is being cheered by the spontaneous patriotic zeal of all her children. Science, however, upon which depend as much the arts of war as of peace, is not unrecognised. The peerage bestowed on Sir JOHN LUBBOCK raises to the Upper House a man whose striking versatility embraces much useful work in the domain of science; while the titles of K.C.B. and C.B., granted respectively to Capt. W. DE W. ABNEY and Major-General FESTING, are well-deserved rewards for many years of service to the Science and Art Department at South Kensington. Sir W. DE W. ABNEY is well known to our readers, not only in connection with his numerous researches in physics, but also as a past-President of the Physical Society; and we tender to him and to his colleague our hearty congratulations on their recent honours.

FROM the annual report of the New Zealand Post and Telegraph Department, just to hand, for the year 1898-9, we learn that the prosperity of the telegraph service, which suffered rather serious disturbance by the reduction of tariffs three years ago, is now fairly established. The revenue, which in 1895-6, when the 1s. tariff prevailed, was £92,289, has now reached £101,104 under the 6d. rate; and the additional cost for staff is only slightly in excess of the augmented receipts. Contrary to common experience the average value of each telegram appears to be rising, the actual figures in this case for the past year being 8·85d., against 8·47d. for the year preceding. Should this increase be maintained for a while longer, the additional outlay on plant and wire to carry the heavier traffic will be soon covered. The same cannot be said, unfortunately, as regards intercolonial Press messages, which here, as elsewhere, are worked unremuneratively. For insufficient reasons, as it turns out, the Press rates were reduced in 1893 from 3d. to 1d. per word, with the result that the total number of messages forwarded and received has increased by only 25 per cent. in the five years. Telephone business is rapidly progressing, the exchange connections within the colony already numbering over 6,000 and the receipts amounting to nearly £40,000.

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Dublin has long lagged behind its northern sister city and other Irish towns in the matter of electric lighting. At the present time the number of lamp connections in Dublin is only about 23,000, while that of Belfast is 38,000. As we announced in our issue last week, however, the Corporation of the Irish capital have decided upon spending £254,500 for the erection of a truly magnificent electric supply works. This sum is to be expended in accordance with a careful and eminently satisfactory report drawn up by Mr. Robert Hammond, the consulting engineer to the Corporation, given in full on another page of this issue. The effect of creating these new works will be to add 420 new arcs to the street lighting, and to provide for 5,500 new consumers; or, in other words, to provide a new power station with a capacity of 100,000 lamps, to use the existing station as a distributing centre, and to lay down some 30 miles of additional mains. Three-phase generation at, and transmission from, the power station are to be adopted, at a line pressure of 5,000 volts and a frequency of about 50 cycles per second. At the existing station power will be transformed down to 2,400 volts single-phase. It is not yet decided, however, whether to generate the power at 5,000 volts, or to use stationary transformers and raise the pressure from 500 volts to the line voltage. We are glad to note the indications that the Dublin Corporation, awakened at last to a sense of their duties in this respect, are determined to push on with this important scheme without delay.

Although "nothing succeeds like success," it is possible for very rapid success to become embarrassing where it comes so swiftly that provision cannot adequately be made to meet it. The obscure author who "awakes to find himself famous" may reasonably be troubled lest his genius suffice not to maintain the unexpected reputation; and, similarly, the electric supply concern with a suddenly and largely augmented patronage may be placed in an awkward predicament through the inability of its boilers and engines to meet the overgrown demand for current. This is the condition of questionable happiness enjoyed by the Metropolitan Electric Supply Company at the present time—a state of affairs which has brought it into collision with one of its most powerful customers, the Marylebone Vestry.

In another column we report the action of this Vestry against the above-named company, for having made default in supplying electric energy to the Vestry's premises and the workhouse. The action was heard by Mr. Plowden, who, after careful consideration of the special circumstances of the case, decided to adjourn the summons for three months. Several causes appear to have contributed to place the company in its present fix. In the first place, large machinery, which it expected to have ready for running in 1898, has been delayed by the contractors, and is not even yet ready to take any share in the work of supply. Besides this, the company appears to have had difficulty in obtaining suitable fuel, the naval operations having made large draughts from the Welsh coal market. Such trying circumstances call for forbearance on the part of every consumer, and should elicit the sympathy of all electrical engineers. At the same time, strict business considerations should induce the company to make strenuous efforts to surmount these difficulties with all possible speed.

It was only to be expected that the temporary misfortunes of the Metropolitan Electric Supply Co., to which we have alluded in the foregoing note, should elicit from the gas journals a diatribe against electric light. Our usually fair contemporary, the *Journal of Gas Lighting*, exclaims: "What is a saving of fuel appearing in the second place of decimals in the analysis of working costs per unit—what is anything else—to a man who cannot get a light when and where he wants it?" As if, forsooth, economy necessarily implied risk of breakdown. Our contemporary has invented an amazing *non sequitur*. Electrical engineers are usually not slow to place reliability in the forefront when designing their works, and they recognise the supreme importance of this factor; but it will be news indeed to them that economy implies any sacrifice of this essential. Facts are to the contrary, for the best made plant is not only the most economical, but also the least likely to get out of order. We can well understand, however, the growing alarm of our gas friends at the close attention electrical engineers are paying to high economy, and at the excellent results this careful attention is producing.

Quite a large number of electrical and allied patents, granted in 1886, have been kept up during the entire period allowable, and will expire, in the ordinary course, during the current year. A glance at the list, however, which we print on another page this week, will show that the expiry of none of these is likely to produce any serious consequence to electrical industry in general. No epoch-making invention appears to have matured in the fertile brain of any electrical inventor in 1886. We may note, nevertheless, several in the list which are not devoid of interest. Nikola Tesla's patent, No. 2,975, relates to an ingenious arrangement of a third-brush and even additional brushes to a dynamo, for the purpose of efficient regulation. But the era of third-brush dodges departed before the expiry of the patents it evoked.

Prof. Elihu Thomson's patent, No. 10,241, has a claim for electric welding by "pressing against each other the pieces or parts to be united and passing an electric current through the same." It would appear, therefore, to cover the master process in the Thomson system of electric welding. The expiry of this would be a matter of more general importance were electric welding more generally practised in this country; but the limited work of this description is so well executed by the few existing firms, that these need be in no fear of competition through the disappearance of the patent. Among the patents of historical interest are No. 10,765, for the Lowrie-Hall transformer, and No. 9,708, for Messrs. Holmes and Vaudrey's automatic cut-out for use in charging storage cells. Electric light engineers may also be interested in the expiry of the Welsbach patent, No. 3,592, covering the use of oxides of certain rare metals for incandescent gas mantles.

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THE first telephone licence under the new Act has been granted, not to a municipality but to a company, the Mutual Telephone Co. of Manchester. The licence granted to the company is for the districts comprised by the borough of Salford and the urban districts of Moss Side, Wilmslow, Stretford, Audenshaw, Gorton, Altrincham, Sale, Swinton and Pendlebury, and not for any other part of the Manchester area. It expires in 1911, and, moreover, the POSTMASTER-GENERAL reserves to himself the right of revoking it at any time. From the report in another column it would appear that the Manchester Corporation, in spite of its deputation some time ago to the Treasury authorities, has not quite made up its mind to whom it shall give its support in matters telephonic.

THE Glasgow Corporation has not been so successful as the Mutual Telephone Co. At the Council meeting yesterday a letter from the Postmaster-General was to have been considered setting out the conditions under which a 14 years licence would be granted for Glasgow. Its discussion, however, was postponed. These conditions specify certain minimum sections of conductors and other restrictions as to technical matters which Mr. BENNETT, the consulting telephone engineer to the Corporation, considers unnecessary. It looks as if the new Act may not work so smoothly after all.

IT has been rumoured that difficulties are being experienced in sending wireless telegraph messages between certain of our camps in South Africa, and the theory has been advanced that the trouble is due to the presence of ironstone hills. We understand, however, that Mr. MARCONI discredits this ingenious hypothesis, even presupposing the truth of the rather doubtful rumour. The seat of war may indeed be rich in ironstone hills, and even in gold reef mountains; but Mr. MARCONI, who has signalled through the solid hulls of no less than 30 ironclad battleships, is quite confident that the waves from his telegraph transmitter would make no trouble about going through the South African kopjes. If trouble there has been, it is due, he thinks, to the imperfect earth afforded by the dry soil and substrata. By the way, we are glad to be able to assure our readers that the wireless telegraph instruments sent out to the enemy were neither manufactured in this country nor supplied by any British firm.

THE sheet table of Electricity Supply Works in the United Kingdom, which we publish as a supplement to-day, is larger than last year. Several new columns of useful information have been added, notably one containing particulars of condensing plant and others setting forth the class of fuel employed and its price. The "Remarks" column also contains more matter than in previous years. We cordially thank engineers of the various stations in operation, and the consulting engineers of stations projected and in course of construction, for their assistance in the preparation of the table.

Legacy to Glasgow University.—Under the will of Mr. James Brown Thomson, of Kinning Park, Glasgow, the University of Glasgow will receive £10,000 and the Glasgow Technical College £2,000.

Opening of Bolton Electric Tramways.—Seven of the ten sections of the electric tramways of Bolton were opened for traffic on the trolley system on Tuesday last. The lines comprise 31 miles of track, and extend over 28 miles of route.

Cable Interruptions.	Date of Interruption.
Latakia—Cyprus	June 21, 1899
Cayenne—Pinhieros	Oct. 11, 1899
Zanzibar—Mombassa	Oct. 27, 1899
Mozambique—Lourenco-Marquez	Dec. 17, 1899
Gibraltar—Tangier	Dec. 31, 1899

The Glasgow Cable Tenders.—The Glasgow Corporation yesterday unanimously adopted the recommendation of the sub-committee to accept the tender of the National Conduit and Cable Co. of New York. Further particulars will be found in our "Tenders Accepted" column.

Obituary.—We regret to announce the death of the Belgian chemist, Dr. Dieudonné Rigole, which took place last week at Brussels. Dr. Rigole was well known in the Far East, especially in Singapore, Java, and North Borneo, in connection with his attempts to extract gutta-percha from the leaves of the *gutta* plant. In this and other electrical work he was associated with Mr. Wells, of Brussels.

Finsbury Technical College.—The evening lectures at this college will commence on Monday, 8th inst. The Wednesday evening course till Easter will be taken by Prof. Silvanus P. Thompson, whose topic will be the design of electromagnets. The Monday evening course will be upon continuous-current machines and arc lamps. In the months of February and March there will be a special course of six lectures on petroleum by Dr. Dorkowitz.

Fatal Tramcar Accident at Glasgow.—A lamentable collision took place on Monday last between two of the electric cars on the Glasgow tramways, resulting in the instantaneous death of a girl of seven years and serious injuries to three men. The collision was caused by a single-deck car running into the rear of a double-deck car standing on the track, the colliding platforms being severely telescoped and causing injuries to the driver of the moving car and the conductor of the standing car, as well as to a man who was alighting with the little girl. The circumstances of the accident call for minute official inquiry.

A Motor-Driven Dredging Plant.—The Bed Rock Dredging Co. of Philadelphia, and its associated companies, says the *Engineering and Mining Journal*, have for two seasons carried on operations about 30 miles distant from Boise City. Current is generated 15 miles from the scene of the dredging by a Westinghouse two-phase generator, directly connected to a Pelton wheel. The generator is rated at 400 kw., and generates current at 500 volts and 30 ∿ per second at 360 revs. per min. Two 200 kw. transformers, of the self-cooling oil-insulated type, raise the voltage from 500 volts two-phase to 10,000 volts three-phase for the transmission circuit. From the power house, a three-wire three-phase circuit of No. 4 B. & S. gauge bare copper is supported on wooden poles and Locke porcelain insulators, with porcelain pin protectors to prevent leakage to pin. About 600ft. distant from each of the three dredges now in operation a small building has been erected, in which are placed the step-down transformers, reducing the pressure to 400 volts two-phase. A full equipment of Wurts non-arcing lightning arresters and choke coils is provided for the 10,000 volt circuits. The dredges are known as the ladder or elevator bucket type, with a capacity of 3,000 cubic yds. a day, each of them having the following electrical equipment of 400 volt two-phase Westinghouse type C motors. One 75 H.P. motor operates a string of heavy buckets upon the ladder of the dredge, each having a capacity of $3\frac{1}{4}$ cubic ft., which discharge upon the delivery plate at the rate of 13 buckets per minute. The working of this motor is controlled by a reversing switch and auto-starter. Two other 75 H.P. motors are directly connected to centrifugal pumps for furnishing water to hold the screened dirt in solution and to force it along the sluice box for the washing process.

MEETINGS OF SCIENTIFIC AND ENGINEERING SOCIETIES, &c.

THURSDAY, January 11th.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Report of the Institution's Visit to Switzerland. The report will be taken as read, and the discussion will be opened by Mr Crompton with a comparison between British and Continental practice in electrical engineering.

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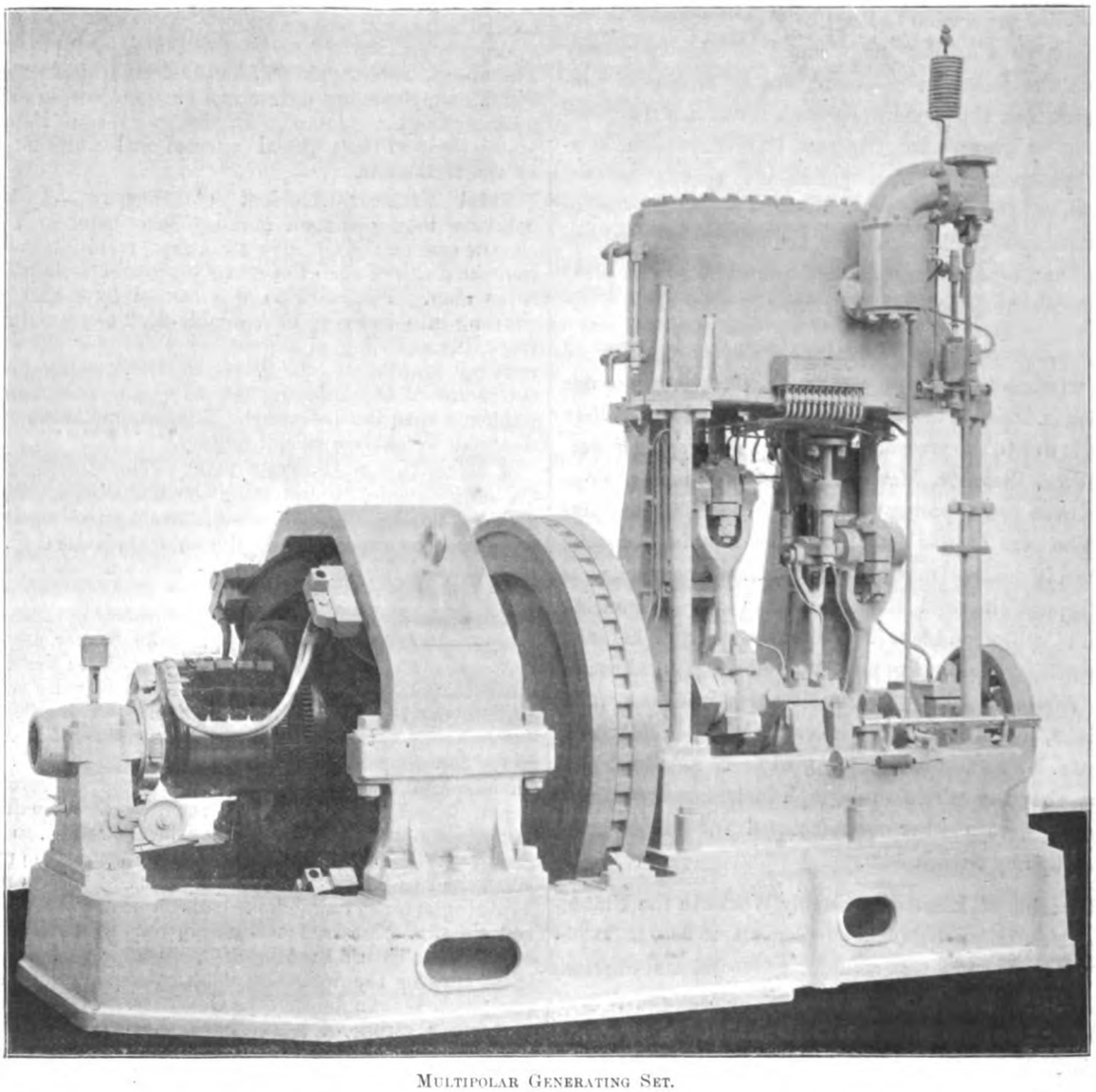
THE SS. "OCEANIC."

The ss. "Oceanic" is at present the largest steamship afloat, having a total length of 704ft. and a displacement of over 30,000 tons. She has been built and luxuriously fitted for the White Star Co. by Messrs. Harland and Wolff, of Belfast, and runs between New York and Liverpool. As may be gathered from the following particulars, the electrical installation of this ocean greyhound is very complete, and has been installed throughout by Messrs. W. H. Allen, Son and Co., of Bedford. The generating units are four in number: the engines, which are of the compound twin type, have cylinders 11in. and 18in. diameter by 11in. stroke, driving direct dynamos with an output of 100 volts 600 amperes at a speed of 240 revs. per min.



Multipolar Generating Set.

The dynamos are compound wound, of the four-pole type, with two sets of brushes. Absolute steadiness of light has been ensured by exceptionally heavy flywheels. Each dynamo has a capacity for 1,000 16 c.p. incandescent lamps, the aggregate of 4,000 lamps being as large as that of many small central stations on shore. Two engines and dynamos are on the starboard and two on the port side, being separated by a central bulkhead. By closing a watertight door in this bulkhead the two compartments can be isolated, so that in an emergency the two pairs can be worked quite independently of each other, thus minimising the risk of a failure of the entire installation. There are two switchboards, one in each dynamo room, constructed so that one or more of the dynamos can be run in parallel or, if necessary, entirely separate. The power and lighting circuits are connected to separate 'bus bars, rendering it possible to connect one or more dynamos to the power and heating circuits whilst the others run the lamps; or, on the other hand, the power and lighting circuits may be paralleled. In practice it is usual to run the whole day-load in parallel on one or two machines, whilst at night two machines are run in parallel on the lighting and another independently on the power circuits.

All the switches on the boards are of the quick-break type, and the main dynamo switches are provided with auxiliary equalising contacts to prevent a reversal of polarity. Each board has a voltmeter of the illuminated dial type with volt divisions between 80 and 120 volts, and can be connected by a four-way switch to either light or power 'bus bars, or to either of two dynamos. There are also four ammeters of Evershed's circular marine pattern reading to 700 amperes, one for each dynamo. The ammeters are in circuit with the return cables, which are connected to the ship's hull through massive gun-metal castings bolted to a steel bulkhead. This arrangement has been found advantageous with compound-wound dynamos running in parallel. The main dynamo fuses are of $1 \times 0{\cdot}013$ tinned copper, and are covered by hinged plate glass shields. The circuit fuses are of stranded No. 33 tinned copper wire, and their sizes and descriptions of circuits are engraved on corresponding brass name-plates.

The wiring of the ship has been carefully planned to ensure that the lamps in the saloons, libraries, smoke-rooms, emigrants' spaces, and in fact all the principal accommodation,

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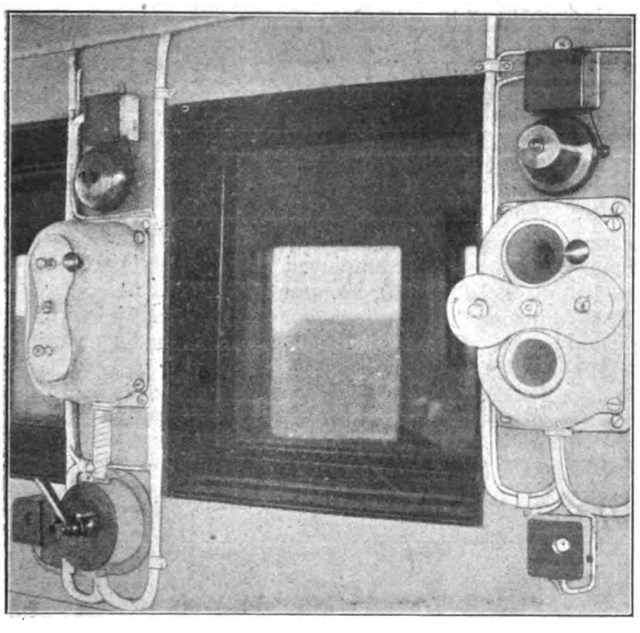
receive current from at least three independent circuits. This arrangement is to guard against total extinction of light should one circuit be put out of action through a main fuse blowing or from any similar cause. One of these circuits runs on the port side, the other on the starboard, and the third feeds police lights, which in small groups remain burning all night when the other lights are switched off. There are in all 28 circuits:—

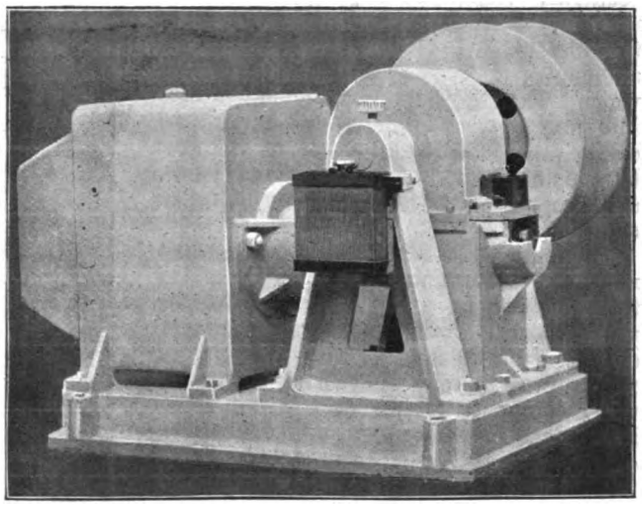
No. 1. First class saloon. Starboard.
No. 2. Ditto. Port.
No. 3. Officers, crew, captain, signals, stewards, firemen, and personnel generally. Starboard.
No. 4. Ditto ditto. Port.
No. 5. Daylight throughout the ship. Starboard.
No. 6. Ditto ditto. Port.
No. 7. First class state rooms. Starboard.
No. 8. Ditto ditto. Port.
No. 9. Second class saloon. Starboard.
No. 10. Ditto. Port.
No. 11. Emigrants forward. Starboard.
No. 12. Ditto. Port.
No. 13. Emigrants aft. Starboard.
No. 14. Ditto. Port.
No. 15. Cargo.
No. 16. Projector.
No. 17. Electric fans forward.
No. 18. Spare.
No. 19. to No. 22. Heaters.
No. 23. Starboard engine room.
No. 24. Port engine room.
No. 25. Aft and forward boiler rooms. Starboard.
No. 26. Ditto. ditto. Port.
No. 27. Electric fan aft and motors.
No. 28. Cooking apparatus.



TWO TELEPHONES ON THE BRIDGE; ONE SHOWN OPEN, THE OTHER CLOSED.

The wiring is carried out on the distribution fuse box system, there being on the different circuits over 100 distribution boxes, some single pole, others double pole: those for the engine rooms are of cast iron, and in the boiler spaces of cast brass, whilst on the decks they are of teak. The boxes for the saloons and engine room contain, in addition to fuses, switches for controlling groups of lights. The fuses themselves are mounted on detachable porcelain bridges, which can be quickly replaced. There are no isolated fuses. The wiring is on the single wire system and the fittings make "earth" to the skin of the ship through concentric blocks. In the vicinity of the compasses, however, and in the elaborately decorated saloons, where direct attachment to the steel hull is not advisable on account of its inaccessibility, the return cables are taken to double-pole distribution boxes and the 'bus bars connected to the beams by ⅜in. Whitworth brass terminal screws. Three types of cables have been employed, those in the engine room of vulcanised rubber, lead-covered and armoured, having a minimum insulation resistance of 2,500 megohms per mile, and these are clipped to the bulkheads. On exposed decks the cables are lead-covered and braided, whilst elsewhere ordinary vulcanised and braided cables are run in teak casing. The fittings and electroliers generally are of brass, gold-plated, silver-plated and bronzed, except in the emigrants' quarters, where they are of cast iron, with massive hinged covers, which are closed when cargo is carried.

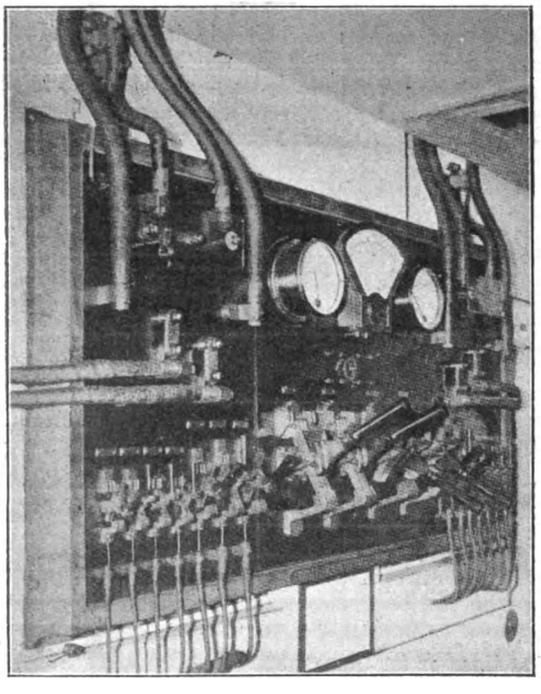
The total number of lamps installed is 1,975, of which some 350 are fixed in the engine and boiler rooms, whilst the



MOTOR-DRIVEN WINCH.

motors, heaters, and other apparatus demand current approximately equal to that taken by the lamps. The illumination of the stained glass domes in the libraries and smoke-rooms is effected by inverted 32 c.p. incandescent lamps on the principle sometimes adopted with arc lighting.

A large proportion of the first class state-rooms on the upper and promenade decks are electrically heated. The



THE SWITCHBOARD.

radiators absorb from 7½ to 10 amperes each at 100 volts, and the switches controlling them have four positions of contact, —viz., one-third, two-thirds, full-heat and off—so that the temperature of any room can be regulated to a nicety by its occupant.

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The fan motors, also of Messrs. Allen's manufacture, are of enclosed water-tight design, direct coupled to centrifugal fans, and move each 11,000 cubic ft. of air per minute at a water pressure of ½in. Their output and speed can be varied by means of multiple contact rheostats in series in the armatures.

The stores hoist motor, on the other hand, is of the semi-enclosed type, and is operated by a controller of the construction usually associated with traction work. The motor gears by worms and wheel to a drum, and is reversible in direction of rotation, whilst a magnetic switch cuts off the current automatically when the rope has reached two predetermined positions. Simultaneously it closes a low-resistance circuit across the armature terminals as a brake. The signal lamps are protected by an automatic indicator which, when a lamp burns out, brings into play a second one, at the same time calling the officer's attention to the fact by ringing a bell, lighting a red lamp, and dropping the corresponding indicator shutter.

The fog whistles are actuated by a magnet relay and time mechanism, which causes them to blow for a few seconds at regular intervals, thus avoiding continual personal operation during a fog. These last-named novelties, as are also the cooking apparatus, which comprises griddle cake plates, coffee heaters and hot-water urns, are of American origin. The bell installation includes 1,130 pushes and 15 separate indicators, each so fitted with a single-stroke and trembling bell that either can be switched into action. The single-stroke bell is used at night, and the trembling one during the day. Multiple change-over switches are also employed for transferring groups of rooms from one indicator to another.

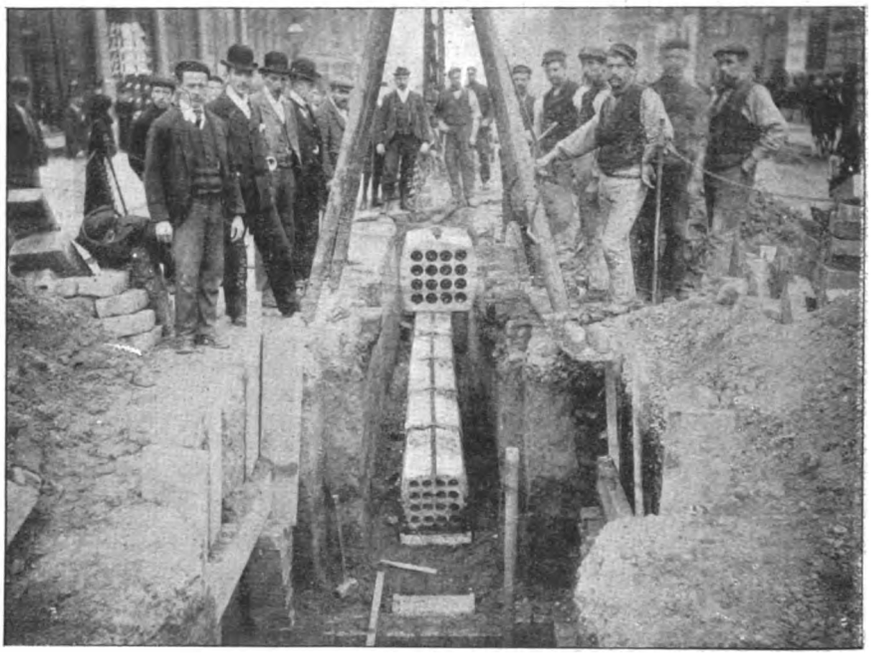

FIG. 1.—LAYING CEMENT CONDUITS.

CEMENT CONDUITS.

Many of our readers will already have noticed the large cement conduits being laid by the National Telephone Co. for their underground inter-exchange cables in London. These conduits, instead of iron pipes, are now being used by the company on all new underground work, whether for junction lines or for those parts of subscribers' lines between exchanges and distributing points, and in the Provinces as well as in London. In Sweden similar ducts have been employed in connection with the telephone service, and there they have been found to come up to all the expectations of the engineers who recommended them. The National Telephone Co., finding that a large quantity of this material would be required for its own work, has now undertaken the manufacture itself, and is therefore also in a position to deliver similar ducts for electric light and power cables to undertakers of electrical supply. The general appearance of the ducts may be gathered from Figs. 1, 2 and 3; Fig. 1 showing an open trench with the conduits being laid, Fig. 2 a three-way duct, and Fig. 3 a nine-way duct. The company claim that the tubes, having been designed and constructed for the purpose they are to fulfil, are uniform in bore, that the interior surface of the ways is absolutely smooth so that there can be no abrasion of the cable during drawing-in, and that the blocks are interchangeable. Experience up to the present has shown no deterioration of the blocks with age, nor has any action on the lead of the cables been observable. The company has already employed on various parts of its system 3, 6, 9, 12, 16, 20, 24, and 30-way ducts.

The following instructions for laying and jointing are issued by the company. They will be made clearer by reference to Fig. 4:—

The line of conduits should be kept as straight as possible from manhole to manhole, and no more ground than necessary disturbed.

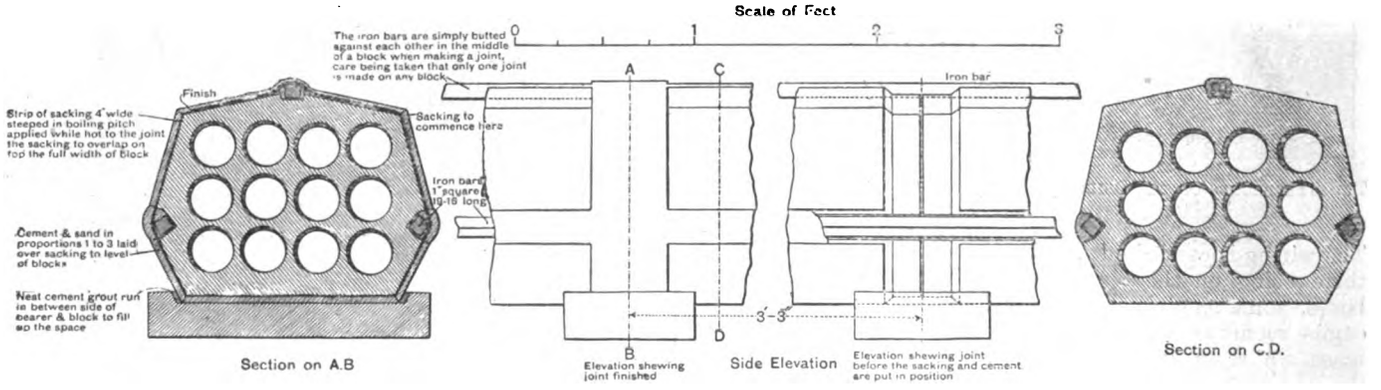
Scale of Feet
0
1
2
3
The iron bars are simply butted against each other in the middle of a block when making a joint, care being taken that only one joint is made on any block
Finish
Strip of sacking 4" wide steeped in boiling pitch applied while hot to the joint the sacking to overlap on top the full width of block
Sacking to commence here
Iron bars 1" square 19-16 long
Cement & sand in proportions 1 to 3 laid over sacking to level of blocks
Neat cement grout run in between side of bearer & block to fill up the space
A
C
Iron bar
3'-3"
B
D
Section on A.B
Elevation shewing joint finished
Side Elevation
Elevation shewing joint before the sacking and cement are put in position
Section on C.D.

FIG. 4.—METHOD OF JOINTING CEMENT BLOCKS.

The top of the cement blocks should be not less than 2ft. from the surface of the carriage-way, or 1ft. 6in. from the surface of the footway, as the case may be.

The bearers carrying the ends of the conduit blocks should be laid at right angles to the line of the trench, and level as regards the cross-section thereof. The earth between the bearers should be well rammed and levelled, so that the blocks take a solid bearing throughout their entire length. No bearers are employed with three-way blocks.

The conduit blocks must be carefully laid in position with the abutting ends resting for an equal distance on the bearers, a space of ⅛in. being left between such ends, and care being taken that the inside of the conduits

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is free from all obstruction, and that all the holes in each block exactly correspond with those in the block on which it abuts. This must be proved by passing a mandril 2⅞in. diameter through the one block into the other.

Wrought-iron bars of the proper sizes are laid in the longitudinal grooves of the blocks, and so arranged that not more than two bars meet on the same block.

A strip of canvas of suitable width and length, coated with melted asphalte of an approved quality, is passed completely round the joint,

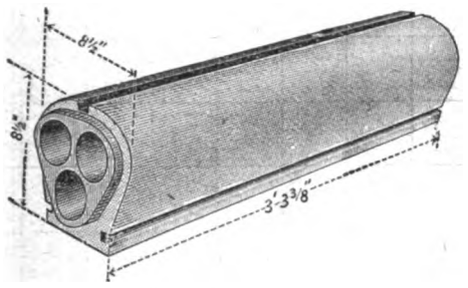

FIG. 2.—THREE-WAY CEMENT DUCT.

overlapping the ends of the two blocks, and passing between them and the bearer and over the iron jointing bars. The space between the blocks and the bearer is to be filled up with a cement grout run in, and the recessed portion and grooves of the blocks filled with neat cement carefully trowelled in. In the case of the three-way block, which is made with spigot and socket ends, the canvas is dispensed with, the joint being made good with

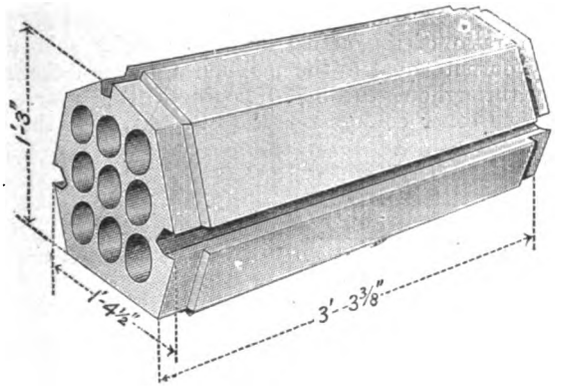

FIG. 3.—NINE-WAY CEMENT DUCT.

cement trowelled in. The work should be so conducted that the blocks shall not be disturbed while the cement joints are setting. The free ends of the conduits must be firmly stopped with wooden plugs when the work is left at night or other time.

The whole of the conduits on completion should be tested by having a piece of lead pipe, or a mandril covered with lead, 4ft. long and 2⅜in.

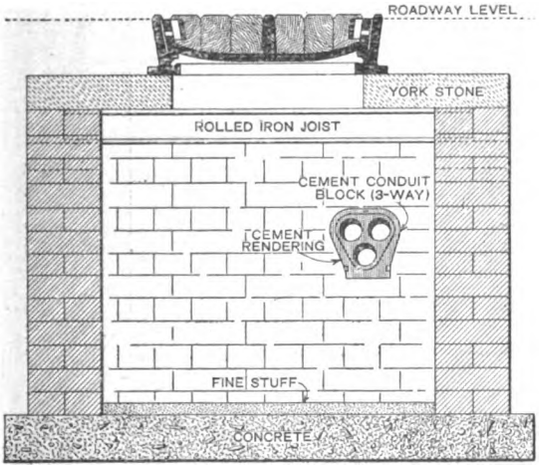

FIG. 5.—SECTION OF MANHOLE FOR CARRIAGE WAY. Scale ½in. = 1ft.

external diameter, drawn through to ensure a perfect way for the reception of the cables; such lead pipe or mandril to pass easily through without being cut or distorted in any way.

Fig. 5 is a type of manhole commonly employed by the National Telephone Co.

PATENTS EXPIRING IN 1900.

The following is a list of the patents of interest to electrical engineers which (unless specially extended by recommendation of the Judicial Committee of the Privy Council) will expire during the present year. The list includes only those patents of 1886 which have been kept in operation up to date by the payment of the necessary renewal fees:—

Date (1886).	No.	Name of patentee.	Subject of patent.
Jan. 5	186	H. E. Newton	Direct-acting steam engines.
Jan. 13	566	R. Hadfield	Chrome steel.
Jan. 15	658	F. H. W. Higgins	Telegraphic printing receiving instruments.
Jan. 19	807	W. Chadburn and G. Smith	Speed indicator.
Feb. 1	1,439	J. Atkinson	Air pumps.
Feb. 9	1,877	N. Tesla	Arc Lamps.
Feb. 18	2,403	E. H. & A. H. Cowles	Electric furnaces.
Feb. 23	2,608	C. Cuttriss	Syphon recorders.
Feb. 25	2,769	L. de Naeyer	Steam boilers.
Mar. 2	2,975	N. Tesla	Dynamos, &c.
Mar. 13	3,592	C. Welsbach	Illuminant appliances for gas burners.
Apr. 12	5,063	W. Chadburn	Telegraphic apparatus for engines
Apr. 14	5,168	R. E. B. Crompton & J. Swinburne	Electric lighting of trains.
Apr. 17	5,377	C. C. Worthington	Vertical direct-acting engines.
Apr. 19	5,436	J. P. Serve	Ribbed boiler tubes, &c.
Apr. 20	5,451	S. and J. Dawson	Governors.
May 4	6,027	Volta Graphoph'ne Co	Sound-recording apparatus.
May 4	6,042	Volta Graphoph'ne Co	Sound-reproducing apparatus.
May 4	6,047	Volta Graphoph'ne Co	Sound-reproducing apparatus.
May 4	6,062	Volta Graphoph'ne Co	Sound-reproducing apparatus.
May 11	6,358	Sir D. Salomons	Suspended lamp.
May 11	6,368	C. C. Worthington	Steam engines, &c.
May 20	6,792	F. Hilton	Open-hearth furnaces.
May 24	6,960	C. A. Knight	Sectional steam engines.
June 1	7,311	J. J. C. and M. Smith	Conductors and cables.
June 11	7,825	R. Richardson and S. Alley	Steam engines.
June 19	8,157	F. Siemens	Regenerative gas retort furnaces.
June 29	8,531	E. C. Kleiner-Fiertz	Separation of aluminium.
July 10	9,016	Sir W. Thomson	Efficiency-testing apparatus.
July 15	9,201	S. Haley	Belt-splicing apparatus.
July 15	9,214	F. Elmore	Electro-plating, &c.
July 27	9,708	A. B. Holmes and J. C. Vaudrey	Automatic cut-out.
July 29	9,806	C. A. von Welsbach	Incandescent mantles, &c.
Aug. 10	10,241	Elihu Thomson	Electric welding.
Aug. 23	10,765	W. Lowrie & C. J. Hall	Secondary generators, &c.
Sept. 10	11,512	H. Barcroft	Brushes for electric locomotion.
Sept. 17	11,853	R. A. Scott	Searchlights.
Sept. 21	11,977	W. Stanley	Transformers.
Sept. 21	11,978	W. Stanley	Transformers.
Sept. 21	11,979	W. Stanley	Transformers.
Sept. 22	12,059	A. Muirhead	Standards of E.M.F.
Sept. 23	12,097	W. Chadburn	Telegraphs for ships, &c.
Sept. 23	12,108	C. A. Knight	Sectional steam generators.
Sept. 24	12,136	M. F. Roberts	Wire drawing machinery.
Sept. 29	12,346	H. Robinson	Hot-air engines.
Oct. 9	12,880	R. E. B. Crompton	Armatures, &c.
Oct. 19	13,340	E. D. McCracken	Conduits, &c.
Oct. 19	13,341	E. D. McCracken	Covering wires, &c.
Nov. 5	14,249	G. Smith	Electrical fuses.
Nov. 9	14,431	R. Wilby	Governors, &c.
Nov. 9	14,471	T. Main	Steam boilers.
Nov. 12	14,646	J. E. Carroll	Heating feed water.
Nov. 12	14,673	E. Hermite, E. J. Paterson and C. F. Cooper	Electrolytic preparation of bleaching solutions.
Nov. 13	14,757	E. Lahmeyer	Dynamo-machine.
Nov. 16	14,853	J. H. Hopwood	Vertical boilers, &c.
Dec. 3	15,831	F. E. Elmore	Electro-deposition of metals from salts, &c.
Dec. 4	15,858	A. F. Scott	Steam engines.
Dec. 8	16,047	G. and E. Ashworth	Tempering steel wire, &c.
Dec. 31	17,123	G. Dürr & H. Conrad	Tubular boilers.

Statistics of Artificial Light.—Among the mass of statistics which it is customary to publish at the commencement of each year, it may be useful to record the amounts of revenue respectively derived from various sources of artificial light. The annual revenue from the sale of gas is now about £20,500,000; that from the sale of petroleum about £4,500,000; while that accruing from electric supply during the past year may be expected to attain nearly £2,000,000.

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ELECTRICITY SUPPLY WORKS COSTS IN 1897 AND 1898.

Following in some respects the course we took last year, we have collected together in tables and averaged in curves the more interesting values arrived at in our weekly analyses of electricity supply works accounts. As before, the figures relative to municipal concerns have been kept rigidly distinct from those pertaining to company undertakings, being for many reasons incomparable therewith; while only the accounts for periods of twelve months of working have been made use of.

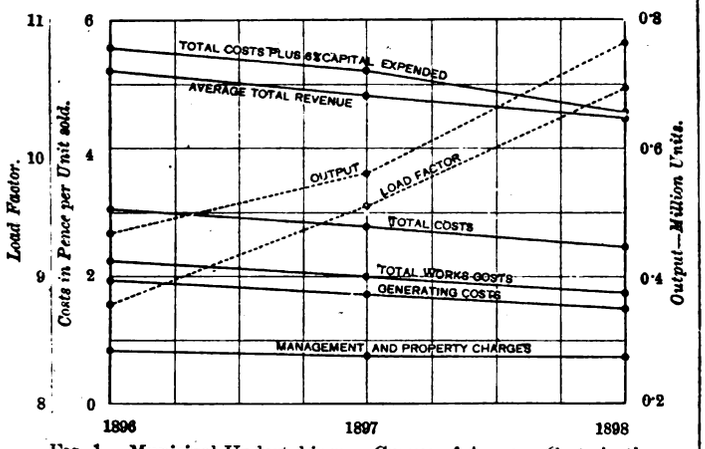

FIG. 1.—Municipal Undertakings. Curves of Average Costs in the years 1896, 1897 and 1898.

inserted, which possibly require further explanation—they are headed "Load factor" and "Total costs plus 6 per cent. of the mean capital expended." The first quantity is a measure of the uniformity of the load on the station, and is the percentage ratio of the actual output in units sold to an imaginary output equal to the maximum demand occurring uniformly throughout the 8,760 hours of the year. The values in the other column represent in each case the total

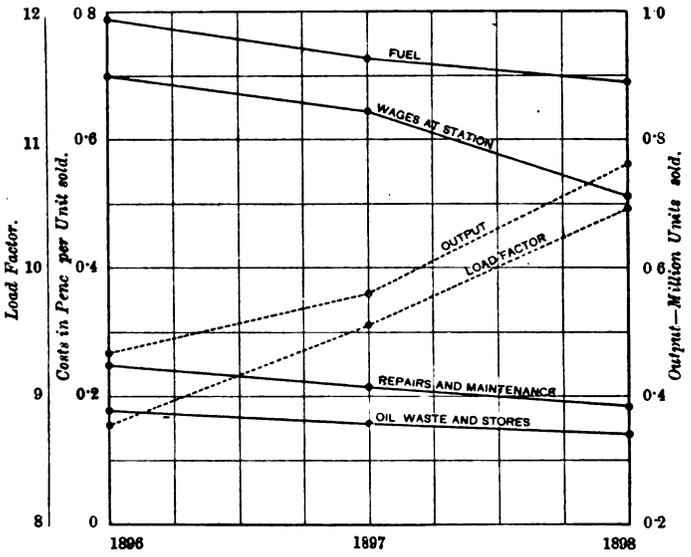

FIG. 2.—Municipal Undertakings. Curves of Average Costs in the years 1896, 1897 and 1898.

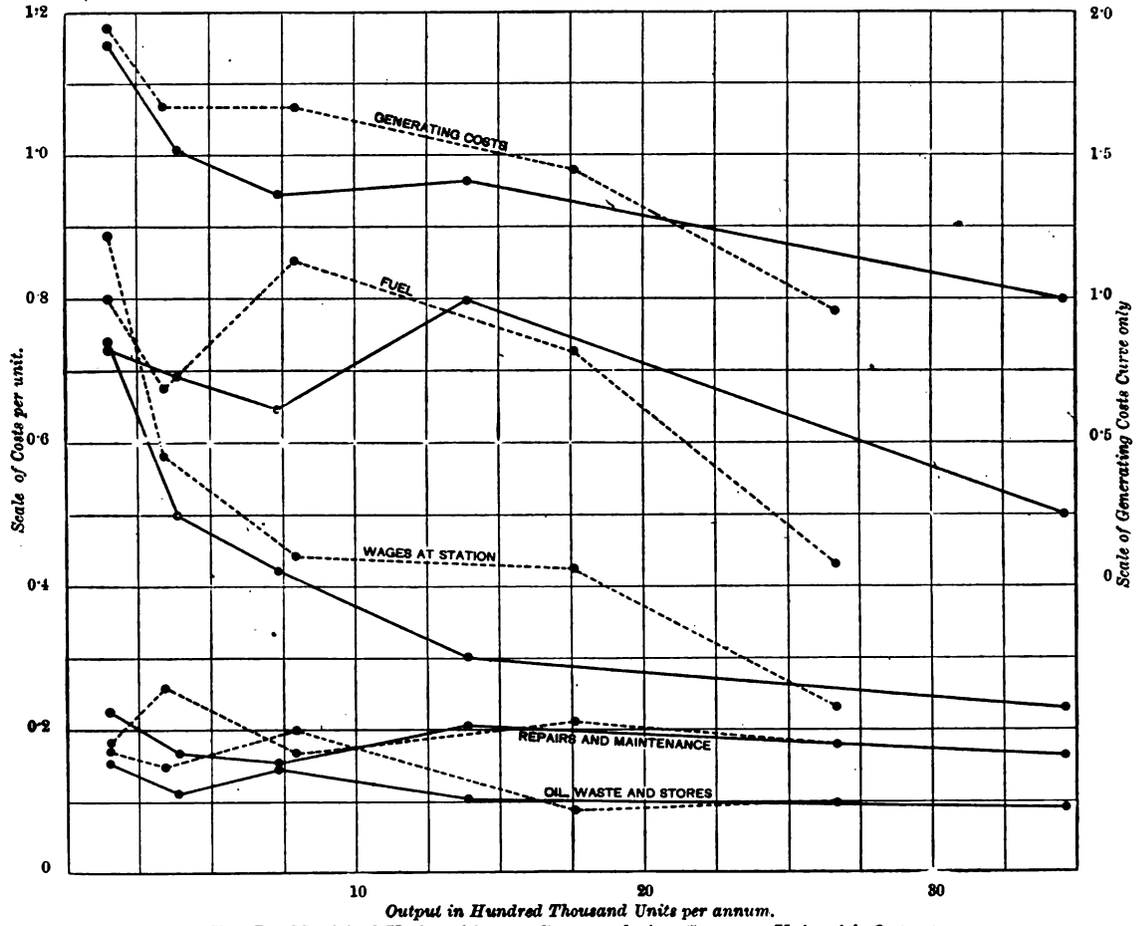

FIG. 3.—Municipal Undertakings. Curves relating Costs per Unit with Output.
Dotted lines 1897, full lines 1898.

Municipal Electric Supply Works.—Table I. gives the chief particulars and results of working of 54 municipal stations during 1897 and 1898. In addition to some of the quantities usually given in our weekly analyses, two columns have been costs plus an amount estimated to represent the capital charges on the concern—in the case of municipal undertakings 6 per cent. of the mean expended capital. The record values in the list are picked out in heavy type.

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TABLE I.

Place.	Output 1,000 units sold.		Units sold per 8 c.p. lamp capacity.		Load factor, $\frac{\text{units sold} \times 100}{\text{max. dem.} \times 8760}$		Revenue per unit sold.		Fuel costs per unit sold.		Oil, waste, water and stores per unit sold.		Wages at generating station per unit sold.		Repairs and maintenance at station per unit sold.		Generating costs per unit sold.		Works costs per unit. sold.		Manag'm'nt and property charge per unit sold.		Total costs per unit sold.		Working profit % to mean capital expended.		Ratio of total costs to revenue (per cent.).		Total costs plus 6% of mean capital exp'nd'd per unit sold.	
	1897	1898	1897	1898	1897	1898	1897	1898	1897	1898	1897	1898	1897	1898	1897	1898	1897	1898	1897	1898	1897	1898	1897	1898	1897	1898	1897	1898	1897	1898
Aberdeen	287	412	15·0	13·2	8·9	9·2	4·77	4·44	0·377	0·448	0·122	0·106	0·463	0·379	0·293	0·207	1·26	1·14	1·39	1·26	0·784	0·706	2·17	1·97	7·3	7·4	46	44	3·75	3·97
Ayr	161	297	8·3	15·3	12·6	16·1	3·64	3·15	0·679	0·684	0·091	0·048	1·030	0·580	0·106	0·125	1·91	1·44	2·21	1·65	0·723	0·468	2·93	2·11	1·5	3·2	80	67	5·88	4·05
Bath	315	357	...	11·4	11·4	12·3	5·34	4·78	1·426	1·418	0·294	0·291	0·466	0·454	0·255	0·185	2·45	2·39	3·10	2·76	0·956	1·026	4·06	3·79	5·1	3·5	76	79	5·57	5·49
Bedford	256	328	18·3	15·7	10·8	11·0	4·42	4·30	1·240	1·067	0·127	0·167	0·602	0·546	0·169	0·157	2·14	1·94	2·39	2·12	0·539	0·583	2·93	2·70	3·8	4·2	66	63	5·32	4·99
Belfast	202	357	12·9	12·7	6·4	5·7	6·26	5·54	1·302	1·016	0·150	0·143	0·781	0·662	0·185	0·144	2·42	2·01	2·63	2·18	0·902	0·740	3·54	2·92	5·3	5·2	57	53	6·65	5·91
Blackburn	...	368	...	15·1	...	7·5	...	4·64	...	0·698	...	0·219	...	0·498	...	0·215	...	1·63	...	2·05	...	0·670	..	2·72	...	4·5	...	59	...	5·30
Blackpool	708	870	21·6	20·6	8·5	10·5	4·83	4·29	0·876	0·555	0·267	0·217	0·507	0·445	0·221	0·169	1·87	1·41	2·35	1·74	0·394	0·498	2·74	2·24	8·1	8·0	57	52	4·29	3·78
Bolton	342	417	14·6	13·3	10·3	9·9	4·69	4·57	0·485	0·483	0·232	0·201	0·698	0·626	0·050	0·068	1·47	1·38	1·48	1·42	0·571	0·537	2·05	1·95	7·3	7·3	44	43	4·24	4·10
Bradford	994	1419	11·0	16·4	10·1	10·2	4·69	3·75	0·375	0·327	0·103	0·078	0·302	0·264	0·158	0·125	0·94	0·79	1·38	1·01	0·603	0·601	1·98	1·61	9·0	8·1	42	43	3·79	3·19
Brighton	1993	2649	30·5	26·5	12·9	12·7	3·47	3·43	0·619	0·644	0·079	0·086	0·355	0·310	0·159	0·158	1·21	1·20	1·34	1·32	0·439	0·357	1·77	1·68	7·2	8·6	51	49	3·18	2·80
Bristol	911	1363	18·7	16·3	10·3	9·1	5·42	4·60	0·878	0·864	0·073	0·064	0·430	0·336	0·135	0·154	1·52	1·42	1·77	1·73	0·733	0·649	2·50	2·37	8·5	7·5	46	52	4·55	4·16
Burnley	198	272	20·8	28·6	10·5	10·8	4·60	4·05	0·363	0·301	0·098	0·114	0·495	0·405	...	0·054	1·62	0·87	1·69	1·01	0·740	0·733	2·43	1·74	6·5	7·5	53	43	4·44	3·58
Burton	79	108	9·7	14·4	6·7	7·3	6·27	5·74	0·530	0·408	0·170	0·166	2·690	2·038	0·160	0·264	...	...	3·60	3·09	0·540	0·608	4·14	3·70	2·4	3·0	66	65	9·49	7·85
Bury	64	116	6·8	12·2	8·0	9·2	4·91	4·52	0·492	0·466	0·179	0·081	0·745	0·479	0·086	0·085	1·50	1·11	1·60	1·17	1·304	1·126	2·90	2·30	2·4	3·7	59	51	6·99	5·94
Cardiff	357	405	26·0	12·5	10·9	11·0	4·72	4·18	0·586	0·652	0·335	0·285	0·981	0·831	0·160	0·191	2·06	2·01	2·41	2·32	0·571	0·693	2·97	3·01	4·7	3·0	63	72	5·23	5·38
Cheltenham	249	376	19·1	15·0	10·6	11·9	3·88	3·84	0·680	0·844	0·179	0·153	0·801	0·622	0·096	0·055	1·76	1·69	2·23	2·13	0·428	0·337	2·65	2·46	2·7	3·3	69	64	5·31	4·96
Chester	...	474	...	25·5	...	15·5	...	3·86	...	0·303	...	0·083	...	0·310	...	0·158	...	0·86	...	1·02	...	0·507	...	1·52	...	8·9	...	40	...	3·10
Derby	341	491	17·4	14·6	5·6	10·9	5·54	4·91	0·982	0·729	0·160	0·139	0·569	0·343	0·377	0·320	2·09	1·54	2·49	1·96	0·786	0·771	3·28	2·73	5·2	6·3	59	56	5·91	4·82
Dewsbury	145	161	16·9	18·4	11·0	9·7	4·65	4·87	0·548	0·632	0·208	0·237	0·597	0·526	0·216	0·598	1·57	1·99	1·65	2·14	1·456	1·232	3·11	3·37	3·8	3·9	67	69	5·57	5·69
Dundee	323	452	18·5	24·2	8·2	8·3	4·47	3·86	0·624	0·564	0·153	0·116	0·395	0·288	0·254	0·226	1·43	1·19	1·53	1·31	0·864	0·717	2·40	2·02	7·2	8·1	54	52	4·12	3·38
Edinburgh	2894	4175	28·1	28·4	**13·8**	15·3	**3·16**	**2·77**	0·347	0·424	0·056	0·050	**0·172**	**0·146**	0·135	0·116	**0·71**	**0·73**	**1·08**	1·09	**0·364**	**0·316**	**1·44**	1·41	8·0	7·0	46	51	**2·73**	**2·59**
Glasgow	2114	2824	32·3	**42·0**	5·0	5·3	4·13	3·75	0·448	0·544	0·058	0·060	0·288	0·288	0·267	0·226	1·06	1·12	1·56	1·45	0·588	0·587	2·15	2·04	10·6	7·6	52	54	3·27	3·38
Halifax	240	629	9·0	14·4	9·3	**18·8**	4·85	3·42	0·795	0·553	0·306	0·194	0·772	0·345	0·102	0·077	1·98	1·17	2·05	1·21	0·827	0·445	2·87	1·65	3·8	7·1	59	48	6·01	3·14
Hammersmith	...	518	...	23·7	...	11·8	...	4·28	...	1·024	...	0·200	...	0·445	...	0·064	...	1·63	...	1·97	...	0·574	...	2·54	...	6·7	...	60	...	4·10
Hampstead	656	1002	21·4	23·9	12·2	12·5	5·63	5·69	1·220	1·228	0·148	0·137	0·365	0·314	**0·101**	0·346	1·83	2·03	1·98	2·13	0·692	0·442	2·67	2·57	8·8	**11·5**	47	45	4·69	4·19
Hanley	352	474	17·6	23·7	10·7	11·8	4·45	3·90	0·685	0·707	0·154	0·168	0·476	0·393	0·414	0·404	1·73	1·67	2·12	2·08	0·610	0·598	2·73	2·68	5·3	4·3	61	69	4·69	4·39
Huddersfield	439	593	11·6	16·7	7·9	8·8	4·96	4·80	0·493	0·473	0·057	0·065	0·478	0·412	0·277	0·202	1·30	1·15	1·52	1·41	0·718	0·586	2·24	1·99	7·8	8·5	45	42	4·33	3·97
Hull	467	750	17·0	17·2	7·8	8·0	5·37	5·29	0·563	0·652	0·087	0·086	0·419	0·444	0·712	0·301	1·78	1·49	1·86	1·79	0·940	0·771	2·80	2·57	9·2	10·9	52	49	4·48	4·06
Islington	504	912	20·1	19·4	9·8	13·0	5·82	5·59	1·140	1·215	0·373	0·215	0·823	0·610	0·232	0·224	2·57	2·29	2·72	2·61	0·976	0·619	3·70	3·23	3·6	5·4	64	58	7·22	5·85
Kingston	194	232	21·6	14·9	10·9	10·8	4·85	4·85	1·620	1·806	0·192	0·181	0·772	0·524	0·137	0·289	2·72	2·80	3·04	3·04	0·745	0·555	3·78	3·59	2·9	3·1	78	74	5·44	6·00
Lancaster	147	205	19·6	15·6	8·8	9·4	4·76	4·84	0·700	0·633	0·163	0·179	0·605	0·494	0·085	0·106	1·55	1·41	1·74	1·58	0·474	0·527	2·21	2·01	6·6	9·1	46	42	4·52	3·87
Leicester	262	386	12·4	7·7	5·8	6·6	5·53	5·52	0·529	0·489	0·176	0·151	0·959	0·665	0·390	0·303	2·05	1·61	2·34	1·95	0·669	0·487	3·01	2·43	6·6	7·8	54	44	5·32	4·81
Leyton	124	249	28·3	30·0	11·2	11·6	3·49	3·29	0·516	0·678	0·093	0·115	1·232	0·690	0·037	0·146	1·88	1·63	2·05	1·85	0·545	0·552	2·59	2·40	1·7	2·5	74	73	5·88	4·57
Liverpool	2188	2916	21·3	19·5	9·2	9·2	5·67	4·61	0·520	0·483	0·128	0·104	0·288	0·253	0·075	0·133	1·01	0·97	1·24	1·17	0·748	0·644	1·98	1·81	6·8	6·5	36	37	4·24	4·56
Manchester	**3435**	**4773**	32·7	31·4	10·4	12·8	4·01	3·62	0·451	0·415	0·162	0·166	0·191	0·166	0·261	0·190	1·06	0·96	1·20	1·13	0·506	0·426	1·71	1·56	9·9	9·6	43	43	3·11	2·84
Newport	251	323	21·4	22·9	9·7	9·4	4·43	4·56	0·557	0·668	0·242	0·218	1·034	0·913	**0·033**	**0·034**	1·86	1·83	2·12	2·11	0·667	0·709	2·79	2·82	3·8	4·0	63	62	5·40	5·44
Nottingham	480	895	16·0	17·6	7·4	9·3	5·37	3·47	0·535	0·432	0·109	0·101	0·349	0·246	0·147	0·112	1·14	0·89	1·21	**0·95**	0·621	0·435	1·83	**1·38**	9·8	7·7	**34**	40	3·99	3·02
Oldham	322	456	15·7	13·2	8·9	9·6	4·40	3·55	0·461	0·580	0·048	**0·032**	0·387	0·316	0·211	0·208	1·11	1·14	1·26	1·24	0·537	0·441	1·79	1·68	7·9	6·7	41	47	3·77	3·36
Portsmouth	981	1225	**37·0**	28·3	13·2	12·4	3·92	3·96	0·642	0·745	0·245	0·180	0·237	0·212	0·176	0·208	1·30	1·34	1·85	1·67	0·388	0·380	2·24	2·05	6·5	7·7	57	52	3·79	3·58
St. Helens	36	65	9·2	13·9	5·9	6·9	6·17	5·75	0·799	0·601	0·275	0·111	...	...	0·644	0·269	...	3·04	...	3·24	...	1·254	6·38	4·49	-0·25	1·9	103	78	11·32	8·40
St. Pancras	1520	1997	26·0	27·4	11·8	14·9	5·29	4·59	0·840	0·845	0·094	0·071	0·496	0·397	0·276	0·222	1·70	1·54	2·48	2·56	0·427	0·381	2·91	2·95	7·5	6·0	55	64	4·80	4·58
Southampton	192	265	20·6	10·6	8·4	9·2	5·49	5·43	1·200	1·171	0·138	0·126	0·514	0·432	0·101	0·138	1·95	1·87	2·13	1·98	0·974	0·825	3·10	2·81	6·5	5·9	57	52	5·33	5·48
Southport	376	589	17·8	27·9	10·6	11·4	4·26	3·82	0·399	0·318	0·090	0·090	0·603	0·408	0·110	0·097	1·20	0·91	1·49	1·13	0·527	0·428	2·02	1·56	6·2	8·0	47	41	4·18	3·26
South Shields	124	308	9·6	16·0	11·1	10·9	4·73	5·08	0·672	0·456	0·238	0·179	1·580	0·586	0·172	0·137	2·66	1·36	2·78	1·62	1·165	0·784	4·05	2·40	0·4	4·3	94	59	8·03	4·74
Stafford	56	68	9·0	11·0	8·0	7·3	5·59	5·08	**0·320**	**0·247**	**0·039**	0·050	1·357	1·210	0·220	0·088	1·94	1·59	2·38	2·07	0·804	0·708	3·19	2·77	2·9	3·4	57	55	8·06	6·88
Sunderland	270	472	13·0	16·0	8·5	12·7	3·77	3·54	0·411	0·532	0·114	0·117	0·591	0·431	0·270	0·181	1·39	1·26	1·45	1·41	0·853	0·673	2·31	2·09	3·9	5·4	61	59	4·55	3·72
Taunton	140	171	14·8	12·2	9·7	8·9	5·60	6·26	1·380	1·225	0·223	0·192	0·638	0·532	0·190	0·140	2·43	2·09	2·93	2·58	1·000	0·800	3·93	3·38	4·5	7·6	68	54	6·41	5·65
Tunbridge Wells	259	335	23·7	16·0	12·0	12·0	5·40	5·29	1·290	0·969	0·106	0·078	0·415	0·359	0·072	0·087	1·88	1·49	2·00	1·64	0·578	0·861	2·57	2·50	**11·1**	11·3	48	47	4·10	3·98
Wakefield	...	105	...	7·9	...	7·9	...	5·40	...	0·533	...	0·131	...	1·184	...	0·124	...	1·97	...	2·39	...	1·196	...	3·58	...	2·8	...	67	...	7·51
Walsall	96	138	12·9	11·0	7·1	8·0	5·10	4·80	0·695	0·622	0·217	0·220	0·551	0·435	0·543	0·381	2·00	1·66	2·37	1·87	1·360	1·018	3·74	2·89	2·7	4·5	73	60	6·77	5·41
Whitehaven	189	206	28·8	31·5	12·7	13·1	4·24	3·94	0·558	0·476	0·092	0·091	0·359	0·391	0·134	0·172	1·14	1·13	1·76	1·67	0·392	0·378	2·15	2·05	9·0	8·3	51	52	3·55	3·41
Wolverhampton	291	372	15·0	19·2	10·4	10·1	5·16	5·00	0·507	0·613	0·183	0·217	0·684	0·644	0·449	0·177	1·82	1·65	2·01	1·81	0·781	0·844	2·82	2·65	7·1	7·9	55	53	4·81	4·42
Worcester	429	474	25·9	28·8	6·6	6·3	3·52	3·62	0·742	0·614	0·082	0·107	0·535	0·482	0·353	0·100	1·70	1·30	1·93	1·55	**0·364**	0·477	2·29	2·00	3·4	4·5	65	55	4·44	4·15
Yarmouth	190	233	15·8	17·1	9·9	10·0	5·07	5·07	1·360	1·236	0·251	0·246	0·455	0·400	0·104	0·220	2·17	2·10	2·57	2·42	0·781	0·726	3·35	3·15	4·3	5·4	66	62	5·75	5·29
Average	563	760	18·6	18·9	9·57	10·5	4·82	4·48	0·729	0·692	0·159	0·141	0·644	0·505	0·215	0·183	1·71	1·53	2·01	1·81	0·724	0·648	2·80	2·46	5·74	6·22	58	55	5·19	4·58
Per cent. increase	35		1·61		9·71		...		...		...		...		...		...		...		...		...		8·36		...		...	
Per cent. decrease	...		...		...		7·05		5·08		11·3		21·6		14·9		10·5		9·95		10·5		12·1		...		5·17		11·8	

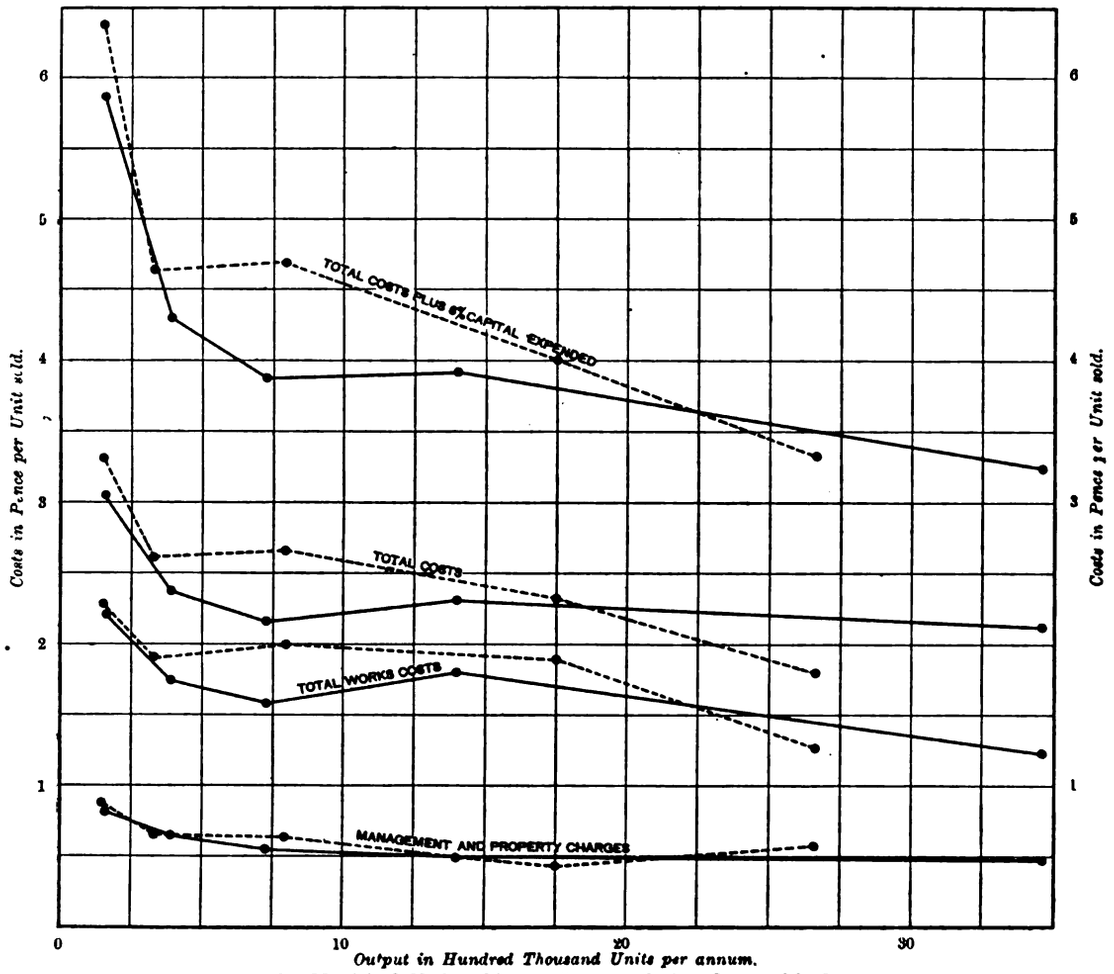
TOTAL COSTS PLUS 6% CAPITAL EXPENDED
TOTAL COSTS
TOTAL WORKS COSTS
MANAGEMENT AND PROPERTY CHARGES
Costs in Pence per Unit sold.
Costs in Pence per Unit sold.
Output in Hundred Thousand Units per annum.

FIG. 4.—Municipal Undertakings. Curves relating Costs with Output.
Dotted lines 1897, full lines 1898.

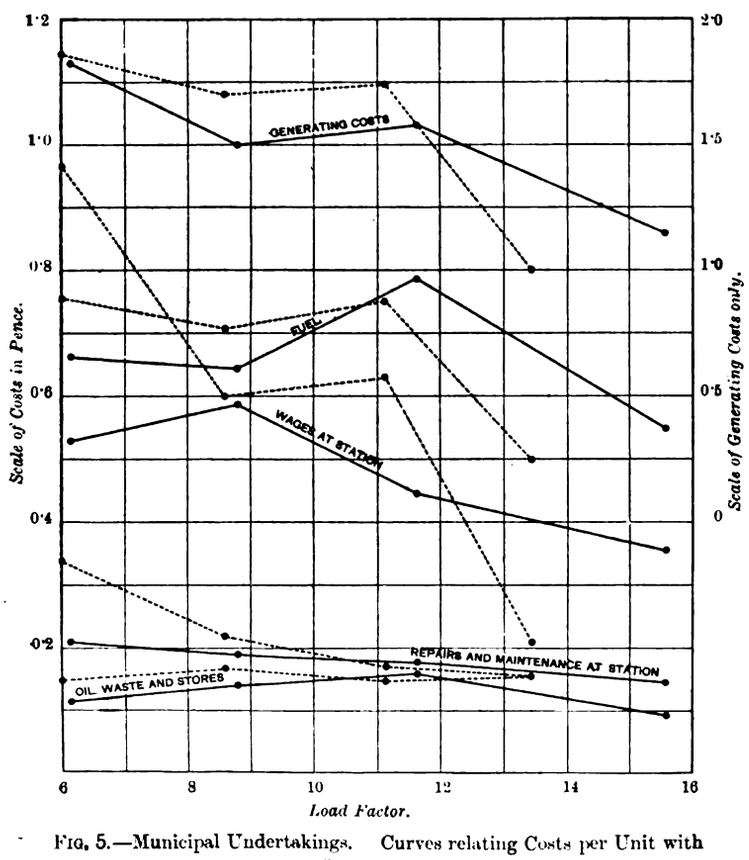

FIG. 5.—Municipal Undertakings. Curves relating Costs per Unit with Load Factor.
Dotted lines 1897, full lines 1898.

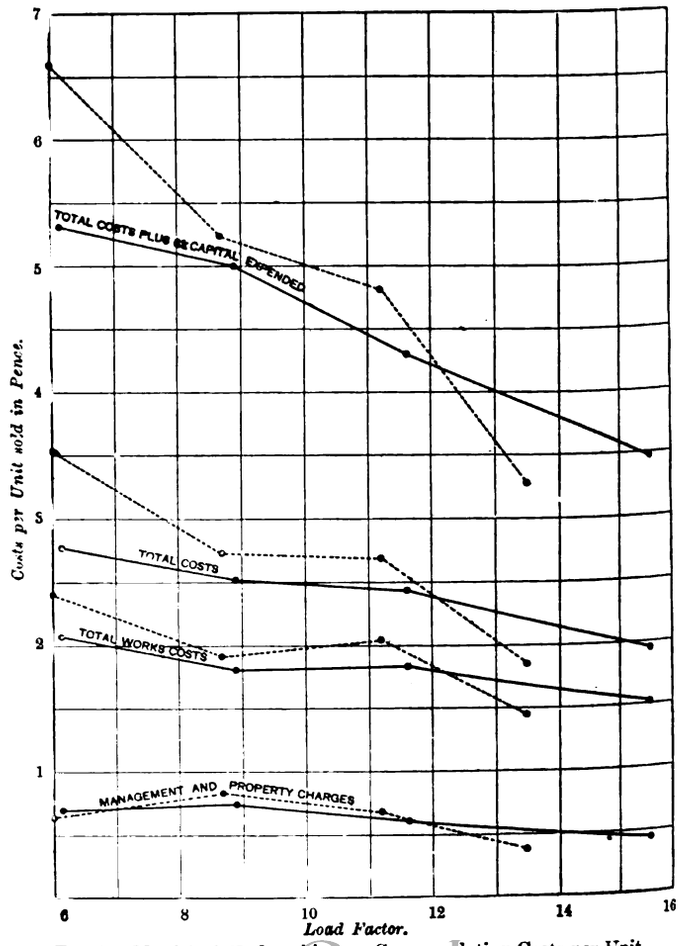

FIG. 6.—Municipal Undertakings. Curves relating Costs per Unit with Load Factor.
Dotted lines 1897, full lines 1898.

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Although in 1898 Edinburgh lost the first place in respect of total costs, which was assumed by Nottingham, yet, taking into account the capital charges, the former still holds, as in 1897, the place of honour in the list, and shows also the lowest generating costs, management and property charges, station wages, and average total revenue per unit sold.

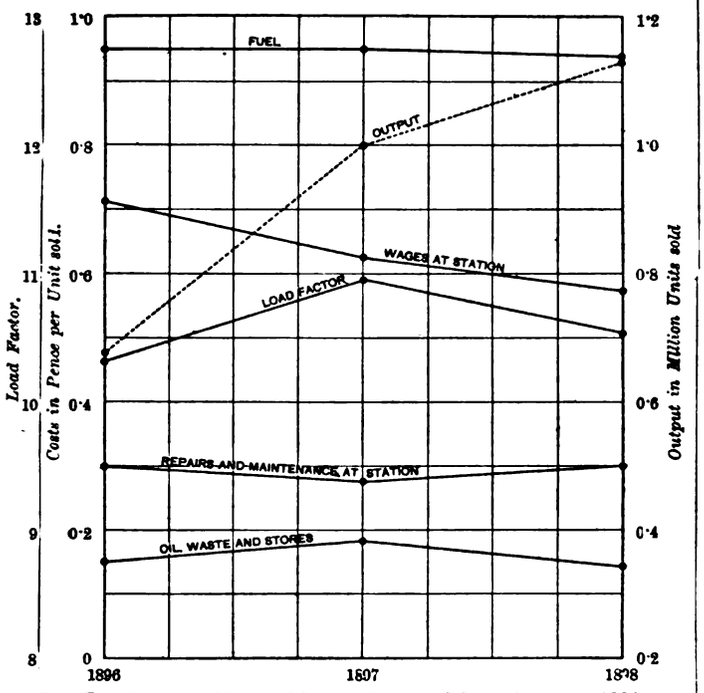

FIG. 7.—Company Undertakings. Curves of Costs for years 1896, 1897 and 1898.

It will be noticed that in 1897 the highest load factor in the list was that of Edinburgh at 18·8, and although in 1898 this had risen to 15·3, this value was exceeded by Halifax with a factor of 18·8. In both years Stafford carried lowest fuel costs, the respective figures being 0·32d. and 0·25d. per unit; and while in 1897 this place also had the foremost position in respect of "oil, waste, water, and stores," Oldham assumed priority in 1898. Newport has done excellently by keeping lowest repairs and maintenance costs, especially when it is considered that in this matter it has shown a splendid

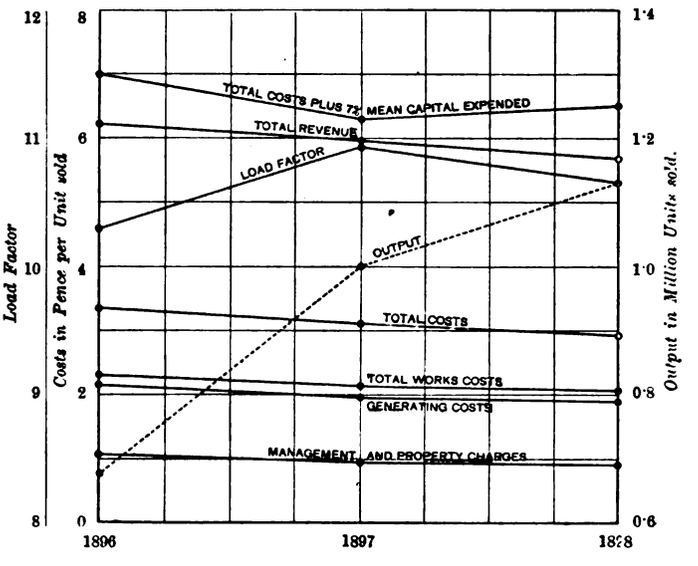

FIG. 8.—Company Undertakings. Curves of Costs for years 1896, 1897 and 1898.

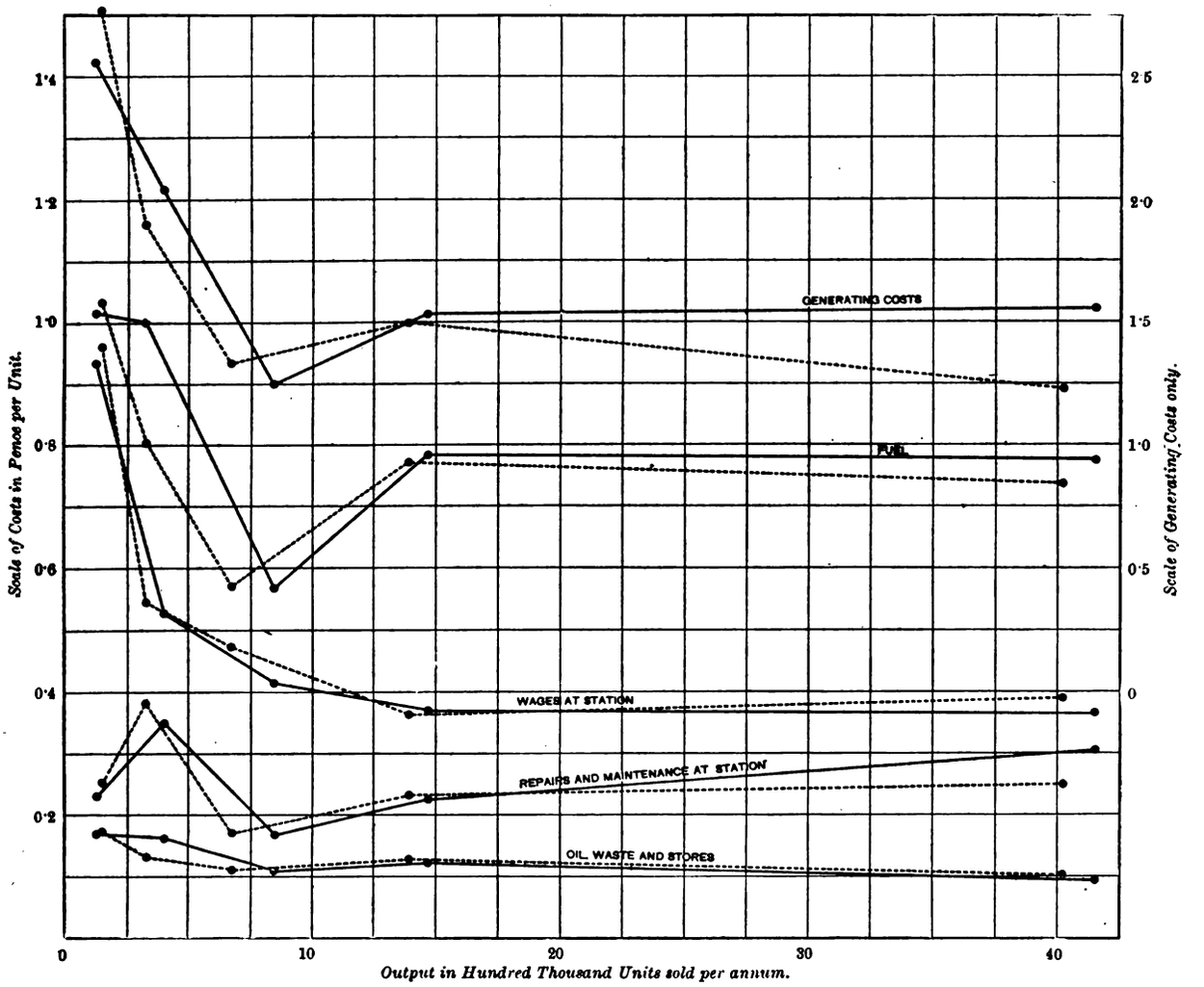
GENERATING COSTS
FUEL
WAGES AT STATION
REPAIRS AND MAINTENANCE AT STATION
OIL, WASTE AND STORES
Scale of Costs in Pence per Unit.
Scale of Generating Costs only.
Output in Hundred Thousand Units sold per annum.

FIG. 9.—Company Undertakings. Curves relating Costs with Output.
Dotted lines 1897, full lines 1898.

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record since supply was started there. In the item of works costs, as well as in total costs, Nottingham has appropriated the place Edinburgh held in 1897; but although the former's capital expenditure per kilowatt of plant capacity is lower than that of the latter, yet Edinburgh takes foremost place in the column of total costs plus capital charges, probably as a result of its relatively high load factor—the units sold per 8 c.p. lamp capacity being 28·4, as against Nottingham's 17·6. Tunbridge Wells in 1897 and Hampstead in 1898 stand with the highest ratio of working profit to capital; but both, especially the latter, have total revenue figures above the average; and the same thing occurs to discount the credit of priority of Nottingham and Liverpool in 1897 and 1898 respectively in the column "Ratio of total costs to revenue."

both of higher total costs and capital expenditure. Figs. 1 and 2 give the average results of working of about 33 municipal stations in 1896 and of about 50 stations in 1897 and 1898. In both figures the corresponding average outputs in units sold per annum per station and the average load factor are given, and it may be observed that the latter as well as the former have risen, and, probably as a result, all the costs have fallen; but while the increase in the average output and load factor in 1898 as compared with 1897 was greater than in 1897 relatively to 1896, yet the fuel charge has fallen less steeply—a result doubtless due to the generally higher price of coal in 1898.

In Figs. 3 and 4 curves are given showing the various items of cost in relation to the annual output for the years 1897 and 1898. The points of the curves are the means of groups

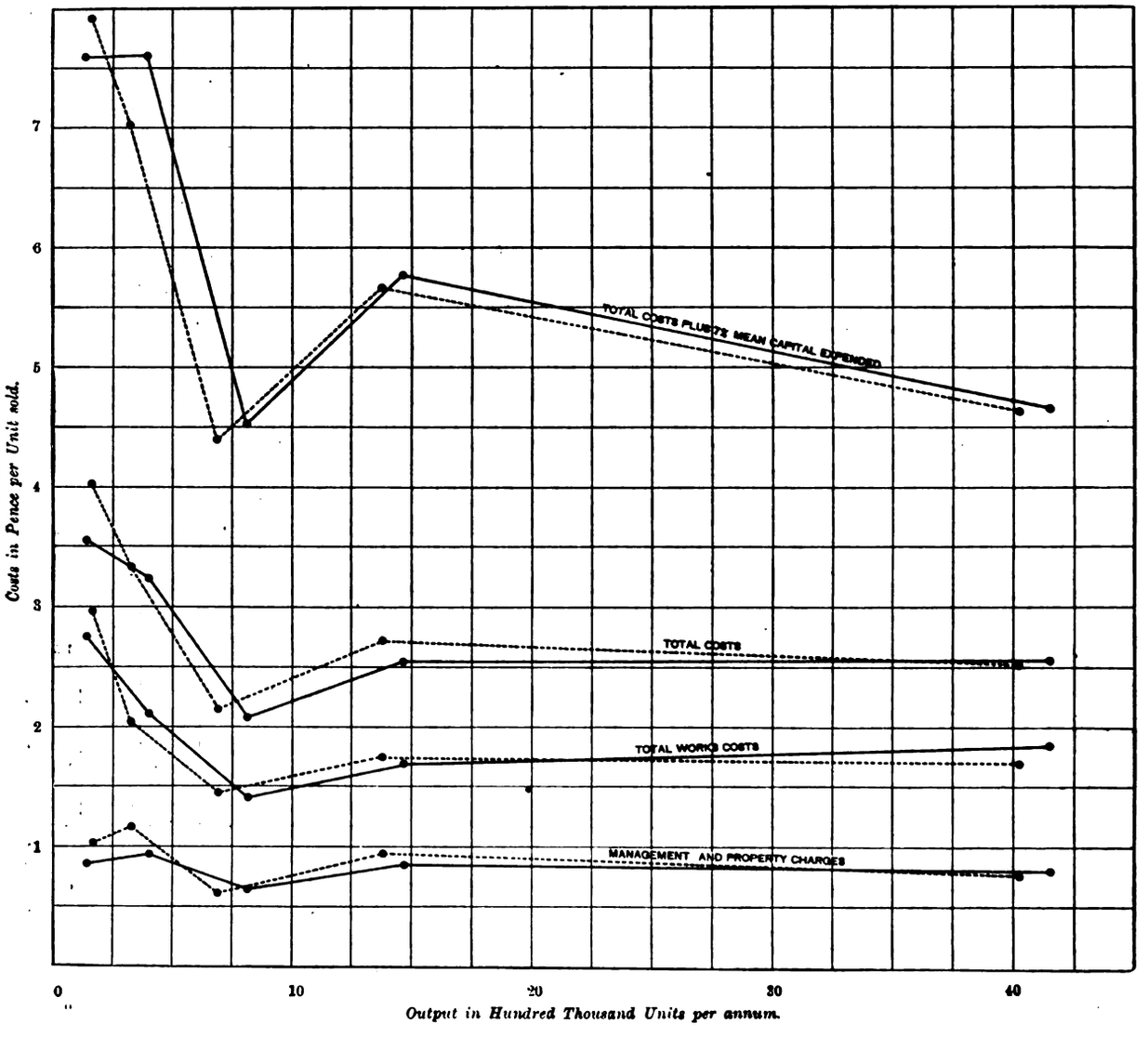

FIG. 10.—Company Undertakings. Curves relating Costs per Unit with Output.

Dotted lines 1897, full lines 1898.

In Table II. the stations having the six lowest total costs, plus estimated capital charges in Table I., are set out in the order of priority, together with other interesting particulars. It may be noticed that in both years Edinburgh, Manchester, and Brighton take positions in the order named, but in 1898 Glasgow has to give place to Nottingham, Whitehaven to Chester, and Aberdeen to Halifax, all in consequence of the influence of the load factor and capital expenditure on the ultimate financial results. It is interesting to note that Manchester, although blessed with a higher output and load factor, has to take second place to Edinburgh, by reason

of stations with outputs of the same order of magnitude; the dotted curves relate to the results of 1897, while the full lines indicate the 1898 results. Figs. 5 and 6 indicate the effect of load factor on the various items of cost. The curves are self-explanatory, but it may be remarked of them, as also of the corresponding curves relating to company undertakings, that they tend to show, as might have been expected, that while the costs decrease with increased output and load factor, there is a decided indication of a limiting minimum value for the costs, beyond which, however much the output be increased, there is little influence on the costs. The

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rate of decrease of the costs as the load factor increases appears, however, to be much more constant, and it is of course obvious that the load factor has a continued and vital influence on the capital charges, and therefore on the ultimate financial results of undertakings. The item of "Repairs and maintenance at the station" appears to be more sensitive to variation of load factor than of output.

Electric Supply Undertakings Worked by Companies.

Table III. gives the results of the working during the years 1897 and 1898 of about 29 concerns worked under company control. The record figures in the list are here again picked out in heavy type. The Charing Cross station still appears with the highest load factor, but the value has dropped from 21·7 in 1897 to 17 in 1898, while the Kensington and Knightsbridge station has taken the lead in the number of units sold per 8 c.p. lamp capacity—viz., 34·1. Prescot has the distinction of carrying the lowest average total revenue per unit both in 1897 and in 1898, the figures being 3·42d. and 3·81d. per unit respectively.

In both years Sheffield takes first place in low fuel costs, this item being 0·32d. and 0·30d. per unit in 1897 and 1898 respectively. These results compare well with the average of over 0·9d. per unit obtaining during both years. Sheffield was also first in 1897 in "oil, waste, water, and stores," but gave place to Norwich in this respect in 1898. Similarly, while Chelsea had lowest "wages at the station" in 1897, Notting Hill took precedence in 1898. Prescot again appears to the fore in low "repairs and maintenance at the station" and "management and property charges," while Sheffield's achievements in low fuel costs have won for that station first place in the two years in generating, works, and total costs.

As in 1897, the St. James's station comes out again best in the percentage ratio of working profit to capital, and also in the column representing total costs plus the estimated charges on capital account—a result no doubt largely due to a high load factor and output in combination.

It is very satisfactory to find Sheffield coming out with the lowest ratio of costs to revenue in both years, although with output and total revenue figures well below the average in the list.

In Table IV. are set out, in the order of priority in respect of low total costs plus estimated capital charges, the six towns in each year having the lowest figures. Sheffield, although third in 1897, is excluded from the table in 1898

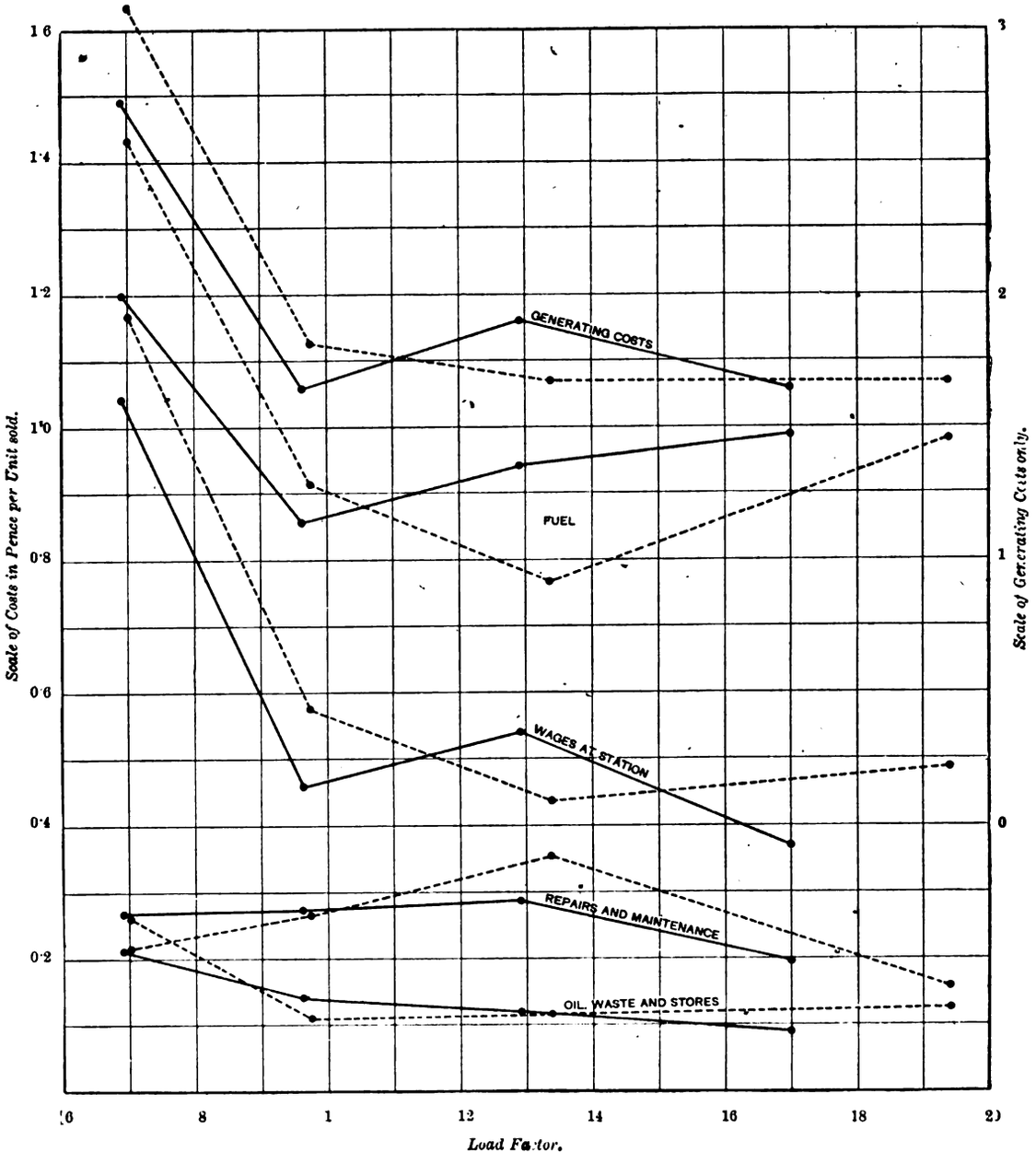

FIG. 11.—Company Undertakings. Curves relating Costs per Unit with Load Factor.

Dotted lines 1897, full lines 1898.

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TABLE III.

Place.	Output in 1,000 units sold.		Units sold per 8 c.p. lamp capacity.		Load factor. units sold × 100 / max. dem. × 8760		Total Revenue per unit sold.		Fuel costs per unit sold.		Oil, waste, water and stores per unit sold.		Wages at generating station per unit sold.		Repairs and maintenance at station per unit sold.		Generating costs per unit sold.		Works costs per unit sold.		Manag'm'nt and property charges per unit sold.		Total costs per unit sold.		Working profit % of mean capital expended.		Ratio of total costs to revenue (per cent.).		Total costs plus 7 % of the mean ex. capital pr unit sold.	
	1897	1898	1897	1898	1897	1898	1897	1898	1897	1898	1897	1898	1897	1898	1897	1898	1897	1898	1897	1898	1897	1898	1897	1898	1897	1898	1897	1898	1897	1898
Birmingham	1184	1722	25·3	26·3	...	10·7	5 14	4 66	0·722	0·689	0·145	0·120	0·440	0·396	0·166	0·219	1·48	1·42	1·72	1·46	0·837	0·734	2·56	2·20	6·3	7·6	50	47	5·43	4·48
Bournemouth	339	415	16·7	14·3	8·0	8·2	6·99	6·90	0·928	0·778	0·321	0·196	0·826	0·524	0·224	0·179	2·30	1·68	2·52	1·87	1·100	0·929	3·62	5·80	5·7	7·4	52	41	7·72	6·66
Cambridge	222	260	13·5	15·9	8·9	8·6	7·18	6 80	1·190	1·097	0·145	0·160	0·834	0·792	0·452	0·292	2·62	2·34	2·66	2·39	1·090	0·896	3·75	3·29	7·7	8·4	52	48	6·85	6·22
Charing Cross	2616	3246	32·7	33·3	21·7	17·0	4·49	4·44	0·950	0·988	0·092	0·089	0·368	0·374	0·157	0·194	1·57	1·65	1·78	1·81	0·498	0·512	2·27	2·33	7·2	7·5	51	53	4·41	4·41
Chelsea	1062	1220	17·7	17·3	9·0	10·0	6·19	6·17	0·875	0·884	0·143	0·130	0·298	0·345	0·182	0·240	1·50	1·64	1·84	1·94	1·060	0·953	2·90	2·83	6·0	5·5	47	47	6·76	7·06
City of London	6073	6940	19·1	19·1	9·6	8·7	6·79	5·92	0·864	0·939	0·148	0·129	0·394	0·348	0·362	0·305	1·78	1·74	2·28	2·10	0·936	0·926	3·21	3·03	7·3	6·3	47	51	6·65	6·25
Clerkenwell	261	447	...	8·0	9·2	10·5	6·58	6·03	...	1·423	...	0·300	...	...	...	0·583	...	...	...	...	...	...	4·26	4·76	1·4	1·0	65	79	...	13·93
Dover	234	423	14·3	24·4	9·2	13·6	5·38	4·36	1·670	1·360	0·095	0·065	0·834	0·556	0·266	0·184	2·95	2·25	3·38	2·47	0·787	0·451	4·17	2·92	2·1	3·8	78	67	8·26	5·57
Hastings	339	364	28·9	31·0	12·5	12·7	6·30	6·76	1·570	1·912	0·142	0·265	0·560	0·638	0·498	0·420	2·77	3·24	3·18	3·65	0·687	0·929	3·86	4·58	6·6	6·0	61	68	6·43	7·11
House-to-House	811	975	18·4	21·4	11·4	12·1	6·16	6·14	0·735	0·686	0·084	0·108	0·612	0·591	0·069	0·148	1·51	1·53	1·59	1·60	1·005	1·067	2·60	2·67	8·2	8·4	42	44	5·62	5·56
Hove	268	350	20·6	16·8	9·9	9·8	6·51	6·50	0·720	0·883	0·107	0·123	...	...	...	...	...	...	1·72	1·85	1·210	1·025	2·93	2·88	6·2	7·3	45	44	6·97	6·35
Kensington and Knightsbridge	1898	2081	27·1	34·1	14·2	12 6	5·56	5·34	0·692	0·760	0·115	0·093	0·347	0·368	0·360	0·680	1·51	1·91	1·68	2·80	0·966	0·961	2·65	3·04	9·5	7·7	48	57	4·79	5·12
Newcastle	661	804	24·5	19·8	10·3	10·8	4·60	4·38	...	...	...	...	...	...	...	...	1·28	1·18	1·53	1·35	0·574	0·594	2·11	1·94	8·1	9·1	46	44	4·12	3·82
Newcastle District	601	743	15·1	18·7	12·3	12·7	4·53	4·46	0·651	0·590	0·198	0·168	0·436	1·407	0·163	0·175	1·45	1·34	1·66	1·53	0·600	0·495	2·26	2·02	8·0	9·1	50	45	4·23	3·90
Northampton	115	138	12·8	8·8	7·2	8·0	6·91	6·71	1·070	1·071	0·190	0·264	1·440	1·328	0·260	0·540	2·96	3·22	3·03	3·22	0·920	0·786	3·94	4·01	5·3	4·0	57	60	7·83	8·71
Norwich	572	741	20·6	21·6	10·0	9·7	4·86	4·55	...	0·705	...	0·050	0·424	0·300	0·302	0·214	1·49	1·28	1·49	1·57	0·514	0·657	2·00	2·23	9·4	8·1	41	49	4·14	4·24
Notting Hill	355	456	17·7	18·2	13·1	11·3	7·86	7·07	0·664	0·775	0·093	0·127	0·328	0·280	0·418	0·438	1·50	1·62	1·52	1·64	1·700	1·603	3·22	3·25	6·5	6·0	41	46	8·24	7·69
Oxford	344	374	17·4	19·0	12·6	12·2	5·99	6·00	0·650	0·652	0·071	0·054	0·602	0·552	0·571	0·595	1·90	1·85	2·08	2·03	1·120	0·964	3·20	2·93	5·0	5·4	53	50	7·12	6·85
Pontypool	...	52	...	10·2	...	6·5	...	6·16	..	0·560	...	0·117	...	1·212	...	0·056	...	1·94	...	2·34	...	0·779	...	3·12	5·3	7·2	73	51	...	6·06
Prescot	134	84	27·1	10·6	17·0	13·7	3·42	3 81	1·016	1·326	0·158	0·160	0·621	1·027	...	0·054	1·80	2·57	1·97	2·82	0·260	0·334	2·23	3·1t	5·1	1·2	65	83	3·87	6·99
Preston	371	448	19·7	27·2	9·9	9·5	5·06	4·90	0·345	0·346	0·081	0·089	0·425	0·381	0·212	0·129	1·06	0·95	1·28	1·15	1·118	0·927	2·40	2·07	5·8	7·1	48	42	5·59	4·85
Reading	124	160	10·6	13·7	6·8	6·0	6·20	6·17	1·590	1·296	0·179	0·172	1·590	1·220	0·192	0·180	3·56	2·87	3·90	3·03	1·510	0·907	5·41	3·94	1·1	3·1	87	64	10·65	9·01
Richmond	139	166	14·6	18·3	8·6	8·9	7·72	7·37	1·080	1·002	0·173	0·090	0·653	0·528	0·413	0·240	2·32	1·86	2·58	1·99	1·280	1·226	3·86	3·22	5·2	6·0	50	44	9·05	8 08
St. James'	3028	3449	25·2	28·7	15·6	13·9	5·41	4·89	0·516	0·509	0·073	0·066	0·407	0·378	0·299	0·164	1·30	1·13	1·42	1·24	0·800	0·740	2·23	2·00	16·2	16·2	41	40	3·61	3·26
Scarborough	211	217	12·9	10·3	8·4	9·0	5·88	5·97	1·290	1·194	0·076	0·112	0·876	0·811	0·251	0·275	2·49	2·46	2·74	2·67	0·786	0·763	3·53	3·43	6·0	6·1	60	58	6·29	6·36
Sheffield	747	978	25·8	18·2	9·6	10·4	5·24	4·64	0·322	0·302	0·061	0·109	0·440	0·368	0·162	0·151	0·98	0·93	1·10	1·02	0·453	0·503	1·55	1·52	10·9	6·0	30	33	3·92	5·15
Wandsworth	...	471	...	16·8	...	8.2	..	5·62	...	1·019	...	0·259	...	...	...	0·346	...	2·38	...	...	...	...	...	3·00	...	2·3	...	53	...	10·85
Windsor	52	106	6·0	12·1	6·1	7·3	7·72	7·71	2·133	1·884	0·383	0·311	0·844	0·406	0·203	0·293	3·56	2 90	3·59	3·03	1·632	1·200	5·22	4·23	3·3	6·7	68	55	10·52	7·88
Westminster	4356	5065	31·0	28·6	13·6	13·1	5·92	5·58	0·632	0·694	0·096	0·087	0·392	0·355	0·200	0·217	1·32	1·35	1·42	1·46	0·923	0·946	2·34	2·41	12·5	11·3	40	43	4·34	4·37
Average	1005	1134	19·8	19·4	10·95	10·54	5·95	5·72	0·953	0·940	0·182	0·143	0·625	0·579	0·277	0·298	1·96	1·90	2·14	2·074	0·937	0·845	3·12	2·96	6·71	6·61	53·1	52	6·29	6·44
Per cent. increase	12·84		...		...		...		...		...		...		7·58		...		...		...		...		...		...		2·38	
Per cent. decrease	...		2·02		3·65		3·87		1·36		21·4		7·36		...		3·06		3·08		9·8		5·13		1·49		2·07		...	

TABLE II.

1897.						1898.						
Place.	Output in 1,000 units sold.	Units sold per 8 c.p. lamp capacity.	Load factor.	Total costs per unit.	Capital expended per kilowatt capacity.	Total costs + 6% of mean capital expended per unit	Place.	Output in 1,000 units sold.	Units sold per 8 c.p. lamp capacity.	Load factor.	Total costs per unit.	Capital expended per kilowatt capacity.	Total costs + 6% of mean capital expended per unit
Edinburgh	2,894	28·1	13·8	1·44d.	£87·1	2·73d.	Edinburgh	4,175	28·4	15·3	1·41d.	£84·0	2·59d.
Manchester	3,435	32·7	10·4	1·71d.	106	3·11d.	Manchester	4,773	31·4	12·8	1·56d.	102	2·84d.
Brighton	1,993	30·5	12·9	1·77d.	102	3·18d.	Brighton	2,649	26·5	12·7	1·68d.	74·1	2·90d.
Glasgow	2,114	32·3	5·0	2·15d.	90·3	3·27d.	Nottingham	895	17·6	9·3	1·38d.	78·6	3·02d.
Whitehaven	189	28·8	12·7	2·15d.	88·9	3·55d.	Chester	474	25·5	15·5	1·52d.	76·1	3·10d.
Aberdeen	287	15·0	8·9	2·17d.	79·3	3·75d.	Halifax	629	14·4	18·8	1·65d.	51·8	3·14d.

TABLE IV.

1897.							1898.						
Place.	Output in 1,000 units sold.	Units sold per 8 c.p. lamp capacity.	Load factor.	Total costs per unit.	Capital expenditure per kilowatt capacity.	Total costs + 7% of mean capital expended per unit	Place.	Output in 1,000 units sold.	Units sold per 8 c.p. lamp capacity.	Load factor.	Total costs per unit.	Capital Expenditure per kilowatt capacity.	Total costs + 7% of mean capital expended per unit
St. James's	3,028	25·2	15·6	2·23d.	£65·5	3·61d.	St. James's	3,449	28·7	13·9	2·00d.	£67·8	3·26d.
Prescot	134	27·1	17·0	2·23d.	89·3	3·87d.	Newcastle	804	19·8	10·8	1·94d.	75·5	3·82d.
Sheffield	747	25·8	9·6	1·55d.	133	3·92d.	Newcastle Dist.	743	18·7	12·7	2·02d.	70·1	3·90d.
Newcastle	661	24·5	10·3	2·11d.	91·9	4·12d.	Norwich	741	21·6	9·7	2·23d.	89	4·24d.
Norwich	572	20·6	10·0	2·00d.	89·3	4·14d.	Westminster	5,065	28·6	13·1	2·41d.	111	4·37d.
Newcastle Dist.	601	15·1	12·3	2·26d.	60·4	4·23d.	Charing Cross	3,246	33·3	17·0	2·33d.	131	4·41d.

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in consequence of the heavy capital expenditure on extra plant in that year.

The two Newcastle stations appear in both years, and have taken second and third positions in 1898, in the place of Prescot and Sheffield.

It is to their credit to find three London stations—viz., the St. James's, Westminster, and Charing Cross—appearing in this list, considering the conditions under which their capital is expended and also their by no means relatively favourable position for cheap fuel. It is to be noted that in the case of company undertakings 7 per cent. of the mean expended capital has been taken as a fair estimate of the total capital charges.

Figs. 7 and 8 give the mean costs of about 25 company stations in 1896, and of about 29 in 1897 and 1898. Inasmuch as the mean load factor of 1898 was lower than that of 1897, while the average output was of course higher, these curves afford an interesting indication of the respective influence of output and load factor on the costs. It may be noticed that the average "repairs and maintenance at the station" item increased in 1898 as compared with 1897, although attended with a higher mean output—indicating apparently the dominating influence of the diminished load factor. "Wages at the station" appear to be influenced alike by output, and by load factor, while "fuel" and "oil, waste, water and stores" are apparently less dependent thereon.

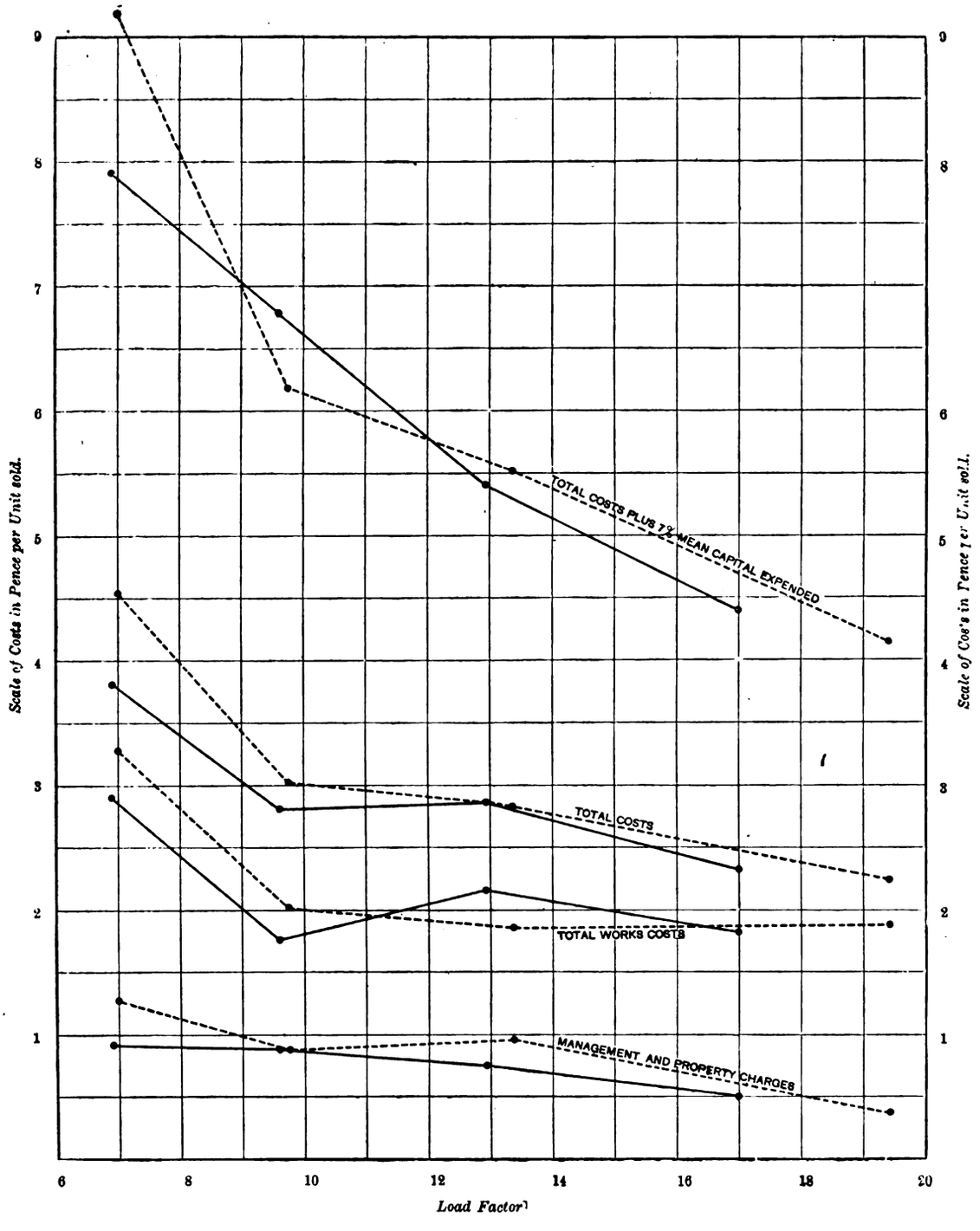

FIG. 12.—Company Undertakings. Curves relating Costs with Load Factor.
Dotted lines 1897, full lines 1898.

In Figs. 9 and 10 the mean results of 1897 and 1898 are plotted against output, while in Figs. 11 and 12 the costs are plotted against load factor values. These curves are dependent on the London concerns for their points at high output and load factor. Thus, there were seven stations in Table III. both in 1897 and in 1898 with outputs above 1,000,000 units sold, and of these six in each year were London undertakings. The rise in the cost curves at outputs above 800,000 units is thus to a great extent accounted for.

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Oldest Electrical Journal (established as a weekly Journal 1861—1878)

Published every Friday, Price Sixpence; Post Free, Sixpence-Halfpenny
Editorial, Publishing and Printing Offices,

I, 2 & 3, SALISBURY COURT, FLEET ST., LONDON,

Telephone: 949 Holborn. *Telegrams:* "Electrician Newspaper London."

All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher "The Electrician," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "The Electrician" *Printing and Publishing Company, Limited, and be crossed* "Coutts and Co."

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1899.

The most important event of the year that has gone by, although occurring only in the latter part of the period, has already had a great influence on all things political, social, and commercial. It will not fail to have its effect on the industry and science with which we are more intimately concerned, for a great war, such as that now waging in South Africa, always causes a depression in the industrial world; but for the present at any rate no marked falling off of prosperity in the electrical industry has been occasioned by it. There has been, as in previous years, marked progress in this industry and an improvement in our knowledge of electrical science, but we have not been able to chronicle during 1899 any epoch-making discovery or invention.

Commencing our review of the year's progress with an examination of the condition of the business of electric lighting, a mere glance at the statistical information which we publish in this issue suffices to show the large increase both in the area in which electric light and power is now supplied and in what may perhaps be called the "lamp-density" of the supply in those parts of the country in which a public supply of electrical energy is no novelty. The municipalising movement is as strong, if not stronger, than ever in the provinces; and the same tendency is apparent in the metropolis, although there it has had less effect. So many large electric supply undertakings have been transferred to local authorities by the companies which have been owning them that the number of lamps now supplied by companies in the provinces is actually less than it was last year, and for the first time our diagrams show a larger aggregate number of municipally-supplied lamps than of company-supplied. A great deal of attention has been directed to electric lighting in London. In the City the monopoly held by a single company is to be ended if a second company makes use of the provisional order it has been at such pains to obtain; and farther west the company with the largest number of consumers in the metropolis has been connecting up additional lamps at a faster rate than it could erect plant to supply them. These troubles are only passing ones, however, and the constant demand for more lamps is fortunately resulting in the erection of new generating stations built according to the most modern and best practice. While this is gratifying, however, it is to be regretted that the British manufacturer is still unable to keep pace with the demand for plant, and the consequence is that a quantity of electrical machinery is being ordered from abroad.

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The 200 volt lamp is gradually superseding the one for lower pressures, and its manufacture is now well past its experimental stage. The Nernst lamp, on the other hand, is not yet on the market, although specimens of it were exhibited by Mr. JAMES SWINBURNE in February. The English patent rights of this lamp are owned by a German firm, but this did not prevent the flotation of "The Nernst Electric Light Ltd.," with a capital of £320,000 (of which £270,000 is paid to the vendors), for the exploitation of the Australasian, African, Asiatic, and South and Central American patent rights.

Electric traction, like electric lighting, has been steadily gaining ground, but there is still wanting greater incentive to its further extension. If only the hindrance of the Tramways Act of 1870 were removed, private enterprise would enter more largely into this field. Notwithstanding their necessary shortness of tenure, however, many lines owned by companies are being built and several are already opened. In other cases advantage is being taken of the Light Railways Act to secure a longer lease of life for new electric lines, but in this considerable caution is being shown, as the precise boundary line between a light railway and a tramway remains to be defined. Local authorities, no doubt, will acquire gradually the majority of the tramways in this country, as they have acquired the majority of electric lighting undertakings; and already they have shown considerable zeal in equipping electrically the old horse tramways acquired after 21 years of, for the most part, hardly successful working by private companies. There is a growing tendency to combine lighting and traction undertakings, and this is not confined to municipalities, for the past year has seen the birth of a number of new "electricity in bulk" projects by limited companies. Some of these, notably the General Power Distributing Co., met with serious and fatal opposition at the hands of combinations of municipalities, but others were more fortunate, so that this year and next will see the completion of some fine examples in this country of economical power distribution by means of electricity. Two and three phase systems are coming to the front for such purposes, while for distribution single phase is giving place to continuous current. During the year several supply stations have replaced their alternating-current machinery either wholly or in part by continuous-current plant, and this movement is likely to continue. Inventors are still endeavouring to devise an efficient surface-contact system of electric traction, and the results obtained with the experimental line recently opened in Tours will be watched with interest. Before leaving the subject of electric traction, we may mention that the large network of underground electric railways in London is getting nearer to completion, while, on the other hand, electric traction on ordinary roads has made little progress. The London Electric Cab Co. has ceased operations, and there has been no important improvement in the construction of such vehicles. No doubt, when our manufacturers are less burdened with orders for plant of standard design, they will pay more attention to this branch of heavy electrical engineering.

In the lighter branches of electrical engineering, telegraphy and telephony, the greatest interest still centres in Hertzian wave telegraphy. Ever and anon we hear of greater distances being overcome by this method of signalling, and the maximum distance as yet attained (90 miles, from Wimereux to Chelmsford) makes it clear that the waves must in some way be deflected from their straight course. More systematic experimental research is required, however, especially with a view to finding a method, both efficient and capable of accurate adjustment, for producing syntony between two apparatus. The use to which wireless telegraphy might be put in warfare has been amply proved by recent events in South Africa. The Admiralty have already fitted some warships with apparatus for Hertzian telegraphy, and it is probable that the successful trials at the naval manœuvres will lead to its extensive adoption in the Navy. We cannot leave this subject without mentioning Prof. J. C. BOSE's valuable researches with regard to the cohering and subsequent recovering action of various metals, and the publication by Prof. HUGHES of the experiments in wireless telegraphy he made 20 years ago. In land-line telegraphy we have heard of enormous speeds of signalling being attained by the new Pollak-Virág system of transmitting and receiving, and some picture telegraphs have undergone successful experiments in America. The English companies have added to their submarine cable network during the year, and both France and Germany have decided to add to their small number of submarine lines. In the former country the Chamber has expressed its approbation of a number of projected routes, and Germany has had a new cable-ship built for it in this country, and intends to lay an Atlantic cable. Much is being spoken of Pacific cables, and there is more than one scheme on foot for laying one or two of these. Nothing definite has been done, however. In telephony, the most important thing to report is new legislation. An Act has been passed prolonging the National Telephone Co.'s licence and empowering local authorities to erect telephone exchanges under certain conditions. Both these alterations to the existing state of affairs are to be deplored. Several local authorities have applied to the Postmaster-General for licences under the new Act, and although none have been granted as yet, it is evident that we shall soon have examples of this new branch of municipal trading. The Post Office is, at the same time, preparing to compete actively with its licensee in the metropolis, and warning the London Vestries not to grant underground facilities to its rival.

The whole electrical profession, and not merely its telegraph section, saw with regret, in February, Mr. W. H. PREECE's retirement from the position he had filled for so long; and his subsequent elevation to the rank of K.C.B. was greeted with general satisfaction. Sir WILLIAM PREECE has by no means retired from active service to his profession, for he still continues as consulting engineer to the Post Office, and has also resumed his consulting work in the heavier branches of electrical engineering. Among other retirements we may mention that of Lord KELVIN from the chair he had so long filled at Glasgow University, and Major CARDEW from the position of electrical adviser to the Board of Trade. No more popular successors to them could have been chosen than Prof. ANDREW GRAY and Mr. A. P. TROTTER.

Before proceeding to consider the year's advance in electrical science, we must briefly refer to the good work done by the Institution of Electrical Engineers, particularly in its organisation of local centres, its summer visit abroad (which we trust will now be an annual event), and the formation of committees to report on standardisation and other matters of supreme importance to the electrical industry.

Electrical science has contributed its full share towards the general progress in 1899. In January, Dr. WEHNELT announced the discovery (or the timely rediscovery) of the electrolytic interrupter which now rightly bears his name. In July, Lord KELVIN startled scientists by announcing somewhat laconically in a telegram to the Royal Society of Edinburgh that "an electrified body is set into rotation by the generation of a magnetic field around it." To our disappointment, the venerable leader of scientific thought subsequently explained

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that the assertion made in his telegram was not founded on direct observation; but the attention of many research workers and mathematicians being now turned in this direction, it is to be hoped that something will soon be done towards a closer physical conception of the mechanism of the ether. Experiment in this field of research has been made, however, by Mr. C. E. S. PHILLIPS, whose exhibition of luminous rings excited by varying magnetisation in a vacuum tube elicited great admiration in scientific circles. It seems probable that in the explanation of the Phillips' phenomenon lies the key to much that is obscure in molecular physics and ether phenomena. Prof. J. J. THOMSON's address at Dover, on the occasion of the first official *réunion* of the British and French Associations for the Advancement of Science, marks the climax of a beautiful research, and should encourage physicists to continue their efforts in a kindred subject—viz., to investigate more fully the nature of the Röntgen and the even more mysterious uranium rays. The long-wished-for National Physical Laboratory has at last been granted by the Treasury. In our last annual summary we were able to mention the report of the committee appointed to consider the matter, and since then the recommendations have taken definite shape, and a National Physical Laboratory is to be established as an extension of Kew observatory, managed by an executive committee nominated by the Royal Society.

The year in which the centenary of VOLTA's famous discovery was appropriately celebrated will also be remembered for the loss of two most eminent scientists, BUNSEN and WIEDEMANN. Among other losses during the year were: Captain SAMUEL TROTT, BENJAMIN SMITH and F. C. WEBB, three of our early telegraph workers; Baron DE REUTER and Sir DOUGLAS GALTON; and FRANK KING, L. EPSTEIN, and P. B. ELWELL, to whom the secondary battery industry is indebted; and another electro chemist of repute, HAMILTON Y. CASTNER.

OUR ELECTRIC UNITS: WHAT SHALL WE DO WITH THEM?

BY DR. J. A. FLEMING, F.R.S.

(*Continued from p. 326.*)

Before passing on to consider the merits or demerits of the suggested alterations in our electric and magnetic units from a practical point of view, it may be well to note the relation, as regards magnitude, between them and the absolute C.G.S. electromagnetic units.

One matter which contributes to increase difficulty in connection with calculations based upon the present accepted B.A. system is that when reductions to C.G.S. units are necessary the memory is burdened by having to recall many different factors in reducing values expressed in practical units to equivalents in absolute C.G.S. electromagnetic units. Thus, we have to remember that whereas one (present) ohm is equal to 10^9 C.G.S. units, one (present) volt is equal to 10^8 C.G.S. units, and one (present) ampere to 10^{-1} C.G.S. units. One watt and one joule are each equal to 10^7 C.G.S. units. Again, one (present) farad is 10^{-9} and one (present) henry is 10^9 C.G.S. units; one coulomb is 10^{-1}, and one ampere-turn is $10/4\pi$ of a C.G.S. unit of magnetic potential difference. All this variety is troublesome to bear in mind, and unless the factors are impressed by constant use, one is under the necessity of often referring to the electrical pocket books or tables of units. In the proposed system greater simplicity is attained. We note at once that *the dekampere*, *the dekacoulomb*, and the unit of flux, which is generally called *a line*, are of the same magnitude as the corresponding absolute electromagnetic units in the C.G.S. system; in other words, the conversion factor is unity.

The deciohm, *the volt*, *the decihenry*, and the new units of power and work respectively equal to 10 watts (*a dekawatt*) and 10 joules (*a dekajoule*) are all equal to 10^8 C.G.S. electromagnetic units. The *dekafarad* alone is equal to 10^{-8} of a C.G.S. electromagnetic unit of capacity. If therefore we suppose it possible to christen the dekampere by the name of the (new) ampere, and so on for all the others, we have the following table of equivalents:—

Proposed name for the new practical unit.	*Equivalent in present reckoning to*	*Equivalent to the below stated number of C.G.S. electromagnetic units.*
The new ampere	1 dekampere	1
The new coulomb	1 dekacoulomb	1
The line	1 line of force	1
The volt	1 volt	10^8
The new ohm	1 deciohm	10^8
The new henry	1 decihenry	10^8
The new watt	10 watts	10^8
The new joule	10 joules	10^8
The new farad	1 dekafarad	10^{-8}
The gauss	1 dekampere-turn	4π
The new unit of magnetic force	1 dekampere-turn per centimetre	4π
The new unit of magnetic pole strength		$1/4\pi$

At first it would no doubt be necessary to insert the word "new" in each case before the name of the new unit. Thus, we should speak of "the new ampere," "the new ohm," "the new watt," bearing in mind that these are respectively equal to the present dekampere (10 amperes), deciohm (0·1 ohm), dekawatt (10 watts), dekajoule (10 joules), and so on. Afterwards we should discard the word "new" and simply appropriate the present name in proportion as practical measurements became more and more expressed in the altered units.

In the next place, we may consider the intrinsic advantages of changing the size of our present units. The size of the ampere as a unit of current was fixed at a time when the only currents to be measured were not very large. The ampere is a convenient unit for measuring small laboratory currents or electric lamp currents, but it is becoming too small as a unit in measuring the very large currents put out from power and electric supply stations. The dekampere (10 amperes) would in these cases be more convenient in size, just as a yard is more convenient than an inch for expressing the length of short walking distances or rifle ranges.

In the same way, the dekawatt (10 watts) and dekajoule (10 joules) would be more convenient for measuring most quantities of power and energy with which we have now to deal in electrical engineering. The Board of Trade unit would then become 100 of the new watt-hours, but if still defined as 1,000 watt-hours would then really be equivalent to ten times the present amount. If sold at prices from 4d. to 6d. per 1,000 (old) watt-hours, the price of the Board of Trade unit (=1,000 (new) watt-hours) would then be 3s. 4d. to 5s., a price which would assimilate it to not unusual figures for the price of gas per 1,000 cubic ft.

The use of the deciohm instead of the present ohm as our unit of resistance would enable us to express in a slightly more convenient manner the value of the low resistances now much used for current measurement. The important unit of electromotive force, the volt, remains unchanged in size. Also the unit of magnetic flux. This can be called *the line*, as at present, or if a larger unit is at any time required, 10^8 lines or C.G.S. units can be taken as a practical unit and called *the weber*, as already sanctioned, without upsetting any simplicity or symmetry—or the use of the same exponent in powers of ten.

The only new unit which is inconveniently large is the (new) farad. This difficulty can be met by taking as the practical unit of capacity 10^{-8} of the farad, a capacity equal in magnitude to one-tenth of our present microfarad. This would prove really a convenience. Most capacities per mile of cables in use are a fraction (generally about 0·3) of a microfarad per mile. Hence, if the practical unit of capacity were

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0·1 of the present microfarad or 10^{-8} of the proposed new farad, it would be for cable work not an inconvenient size. It might be called a *faradet*, or by some such easily pronounced diminutive title. It would be easy to remember that this practical unit is the same fraction (10^{-8}) of the new farad that the latter is of the C.G.S. electromagnetic unit of capacity.

The practical unit of magnetic potential or magnetomotive force would be the present dekampere-turn or new ampere-turn. The new values of permeability of iron and other metals would be 4π times larger than the present values for the same values of the induction or flux density.

Since dynamo designers generally reckon magnetising forces in ampere-turns per centimetre, and not in C.G.S. measure, and since no electrical engineer has anything to do with the measurement of magnetic pole strength, the only two cases where the 4π factor enters at all are of no consequence. The whole system works out very conveniently from the point of view of theory.

Let us examine it also from the point of view of practice. Owing to the enormous number of resistance coils, bridges, voltmeters, ammeters, electric lamps and house meters now in use, no change in our practical system of measurement is possible which involves throwing upon the scrap heap this valuable stock or making in it expensive changes in readjusting or re-marking. It is this which has rendered the practical adoption of Mr. Heaviside's most valuable rational system of units so far impossible. There is no serious difficulty in making changes in tables or books. A mere change in a table of numbers is a simple matter, and can be carried out when a new edition is required without much cost.

If, however, the General Post Office, the Cable Companies, the Electric Lighting Corporations, or the electricians generally were asked to adopt a new unit of resistance, which in magnitude is $4\pi/10$, or to 1·2566... times the present ohm, or a new unit of current which is $10/\sqrt{4\pi}$ or 2·8205... times the present ampere, or a new unit of electromotive force which is $\sqrt{4\pi}$ or 3·5441... times the present volt in size, that proposal, involving as it would the entire reconstruction or recalibration of every resistance coil, ammeter, or voltmeter in existence, would not be entertained for a moment as a practical proposition, any more than a suggestion to make the standard yard equal to 3·1415ft. or to πft. instead of 3ft. as at present.

On the other hand, the proposal to adopt a new unit of current which is in magnitude ten times the present unit *involves no change in the ammeters in use which cannot be effected in a few minutes and at a trifling cost.*

To convert a present-day ammeter, with scale engraved say to read 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 15, &c., amperes, all that has to be done to make it read dekamperes or "new amperes" is to put a decimal point with pen and ink or a centre punch before or between the figures, and transform the scale into one which reads ·1, ·2, ·3, &c., 1·0, 1·5, &c.

The ammeter then reads in the new units.

The voltmeters require no change at all; neither do instruments for reading magnetic flux in lines or C.G.S. units.

In the case of resistance coils and bridges, all that has to be done to effect the required change is to add a cypher after every figure. Thus, if a plug Wheatstone's bridge is marked with plug holes 1, 2, 3, 4 ohms, 10, 20, 30, 40 ohms, &c., all that has to be done to make it read in deciohms is to alter the figures by adding cyphers into 10, 20, 30, 40, 100, 200, 300, 400, &c.

These readings then become deciohms, or are "new ohms."

In the case of meters of all kinds, wattmeters or joulemeters, the addition of a decimal point or the rubbing out of a cypher is all that is required to make readings in present watts or joules become readings in dekawatts or dekajoules or the new watts or new joules respectively. The same treatment alters house meters reading in present Board of Trade units into new Board of Trade units, the new being ten times as large as the old. As regards other changes, tables and curves of permeability and magnetism curves will require to be altered by multiplying all the stated permeability values by 4π $\left(=12\frac{4}{7}\text{ nearly}\right)$ and dividing the values representing corresponding magnetic or magnetising forces in C.G.S. units by 4π. Hence, 1 C.G.S. unit of magnetic force becomes nearly 0·08 of a unit in the new reckoning. Good wrought-iron will have a permeability of 24,000 to 36,000 or so, and the permeability of air will be 12·566...

These suggested changes, involving as they do no great expense and no sacrifice or reconstruction of instruments, are not outside the possibility of adoption. The practical man will, however, ask, What advantages are we to obtain by adopting the reform? Are they worth the trouble of the change? No dogmatic reply need here be framed in answer to this question. The matter is merely put forward tentatively, in order to secure discussion. To illustrate some of the advantages of the change the following simple problems involving measurements in the above units may be discussed: Consider the case of an iron ring wound over with primary and secondary circuits, which is in reality the typical dynamo or transformer. Let the section of the ring be S square centimetres, the mean perimeter L, the number of primary turns N_1, and the number of secondary turns N_2.

Let the primary circuit be traversed by a current A_1 (new) amperes. Then the magnetomotive force acting on the iron will be A_1N_1 (new) units, and the magnetic or magnetising force is A_1N_1/L (new) units.

To measure the total magnetic flux produced in the core, connect the secondary circuit to a ballistic galvanometer calibrated so that its throw or deflection measures electric quantity in (new) coulombs or present dekacoulombs. Then, if F is the total flux in the core in *lines* and R_2 the total resistance of the secondary circuit, including the galvanometer, in (new) ohms, we have $FN_2 = 10^8R_2Q$, where Q is the total electric quantity in (new) coulombs discharged through the galvanometer by the creation or destruction of the flux F. If the flux is measured in *webers* (call it W), then the equation becomes $WN_2 = QR_2$. Hence, if the flux density $= F/S = \mathbf{B}$, as usual, we have

$$\mathbf{B} = 10^8R_2Q/N_2S,$$

and if the corresponding magnetic force $= \mathbf{H}$, we have

$$\mathbf{H} = A_1N_1/L.$$

The permeability of the iron is given in new units by the value of $\mathbf{B}/\mathbf{H}$. If the endless solenoid is wound on a non-magnetic ring core, then the inductance of the coil is equal to $10^{-8} \times N_1^2S/L$ new henrys or old decihenrys.

If a cyclical magnetisation curve is taken, and a hysteresis loop plotted on squared paper in terms of ampere turns and corresponding total flux, the area of this loop, taken in terms of a rectangle one side of which is the length taken for 10^8 lines of flux and the other side is the length taken for a (new) ampere-turn, gives us in (new) joules the work done in making one complete cycle of magnetism in the core.

If the ring has air-gaps in it, as in the case of a dynamo, then the total ampere-turns required to produce a given flux in the circuit is given by the condition

$$\Sigma(AT) = \Sigma(FR),$$

where AT stands for ampere turns, F for total flux, and R for the reluctance of each part of the circuit. This equation is analogous to the well-known Kirchhoff's corollary of Ohm's law in the case of the electric circuit, and it is simply a statement of the *additive* property of magnetomotive force—viz., that the sum of all the magnetomotive forces acting on the circuit is equal to the sum of all the products of total flux and reluctance in and of the separate parts of the circuit. Applied to the dynamo with two air-gaps, it simply becomes the well-known Hopkinson equation—

$$AT = Z\left\{\frac{L_a}{S_a\mu_a} + \frac{2L_g}{S_g\mu_g} + \frac{vL_m}{S_m\mu_m}\right\},$$

where the suffixes *a*, *g*, and *m* refer to the armature, air-gap, and magnets respectively.

In the suggested new and rational units the permeability μ_g of the air-gap is $4\pi = 12{\cdot}57...$ and the Hopkinson equation becomes

$$\text{Total (new) ampere-turns on the field} = \text{total flux thro' armature}\left\{\frac{L_a}{S_a\mu_a} + \frac{2L_g}{12{\cdot}57S_g} + \frac{vL_m}{S_m\mu_m}\right\},$$

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where v is the leakage coefficient, and L, S, μ are length, section, and permeability of the several parts of the circuit respectively. The 12·57 is the permeability of the air-gap in new units. The quantity in the bracket may be considered to be the expression for the combined or resultant reluctance of the whole dynamo circuit.

Consider, in the next place, the case of a very long iron bar magnetised in a still longer or endless solenoid, so as to avoid considering disturbing effects from the ends. If we employ the ordinary or B.A. units, then it can easily be shown that the total flux proceeding from the pole of the magnet is 4π times the strength of the pole. It follows, as a consequence that H is the magnetising force in the iron and I its magnetisation and B the flux density in the iron, that

$$\mathsf{B} = \mathsf{H} + 4\pi\mathsf{I}.$$

In this, the ordinary form, the equation is physically uninterpretable. If, however, we adopt the new units, then, since the new unit magnetic pole is $1/4\pi$ of the C.G.S. unit pole, whilst the new unit of magnetic flux is the same as the C.G.S. unit, it follows at once that in the new system the strength of the pole is numerically equal to the flux proceeding from it, and the pole strength is numerically equal to the product of the section of the magnet and its magnetisation. If therefore the section of the solenoid and the iron are the same, the total flux through the iron must be that due to its intrinsic magnetisation added to that which would exist in the same space if the iron were not there. In other words, we must have the relation

$$\mathsf{BS} = \mathsf{B}_0\mathsf{S} + \mathsf{I}\,\mathsf{S},$$

S being the section of the iron or solenoid, B the total flux density, B_0 the flux density in the space when the iron is removed, and I the magnetisation of the metal. Hence

$$\mathsf{B} = \mathsf{B}_0 + \mathsf{I}.$$

This is merely an expression of the fact that there is an identity in nature, and therefore an additive property in the physical states of the space before and after the iron is placed in the solenoid, in regard to the effect produced on an embracing secondary circuit when that state is annulled.

If μ stands for the permeability of the whole core and μ_0 for that of the space or ether if the bar is removed, and κ for the susceptibility of the metal, then, since $\mathsf{B} = \mu\mathsf{H}$ and $\mathsf{B}_0 = \mu_0\mathsf{H}$, and $\mathsf{I} = \kappa\mathsf{H}$, we have

$$\mu = \mu_0 + \kappa,$$

but by assumption $\mu_0 = 4\pi$, therefore

$$\mu = 4\pi + \kappa.$$

This equation is merely the expression for the fact that the numerical value of the permeability of the space or ether, added to that of the susceptibility of the metal, is the value of the total or resultant permeability. In the form in which the equation presents itself when B.A. units are used—viz.,

$$\mu = 1 + 4\pi\kappa,$$

it is physically unintelligible. Hence, without extending illustrations, it will be seen that in the new units all physical equations present themselves in simple and intelligible forms. The student is not perplexed by the introduction of unmeaning constants such as the omnipresent 4π in the accepted system, and the necessary calculations are made in cases requiring numerical values with the least possible trouble.

(To be concluded.)

BOOKS RECEIVED.

(Copies of any of the undermentioned works can be had from *The Electrician* office post free, on receipt of published price.)

"Annuaire pour l'An 1900." (Paris: Gauthier-Villars and le Bureau des Longitudes.) 1f. 50c.

"Proceedings of the Seventh Annual Meeting of the Society for the Promotion of Engineering Education, held in Columbus, Ohio, August, 1899." (Philadelphia: Published by the Society.)

"Alphabetical Lists of United States Patentees and Inventions for the quarter ending June 30, 1899."

"Goupe-Work and Indented Wood-Work." By Charles Godfrey Leland and Rev. F. C. Lambert, M.A. (London: Dawbarn and Ward (Ltd.), 6, Farringdon-avenue, E.C.) 6d. net.

CHRISTMAS LECTURES AT THE ROYAL INSTITUTION.

The customary course of lectures adapted nominally to a juvenile auditory was opened at the Royal Institution on Thursday, December 28, 1899. The lecturer for this year is Mr. C. Vernon Boys, F.R.S., who has selected for the subject of his lectures "Fluids in Motion and at Rest." The following is a brief account of the first three lectures:—

Lecture I.—Thursday, December 28, 1899.

Mr. Boys explained that by the term "fluids" he was to be understood to include all liquids, gases, and vapours. He referred, in the first instance, to the properties of fluids at rest, but only sufficiently to form a suitable introduction to the main portion of his lectures—fluids in motion. The most characteristic feature of a liquid at rest is that its surface was always level, no matter what the shape of the containing vessel might be. The spirit level, an instrument which can be made so sensitive as to detect a gradient of 1in. in one mile, and the artificial horizon used by astronomers were shown as illustrations of the practical applications of this hydrostatic principle. The next property of fluids referred to was the increase in pressure with the depth. This was experimentally illustrated for the case of liquids, and was shown also to be entirely independent of the shape of the containing vessel, the only factor determining the pressure at any point in any given liquid being its distance from the surface. The balancing of fluids of different density contained in the limbs of a U-tube was then explained, and its application to the principle of the common barometer elucidated. On the question of buoyancy Mr. Boys showed that light liquids and light solids would float on liquids of greater density. The application of a heavy liquid like boro-tungstate of cadmium to the testing of diamonds, rubies, and sapphires, by the fact that these stones if genuine will sink in this solution, was explained. A balloon rises because filled with a gas, coal gas or hydrogen, lighter than air. The principle of transmissibility of fluid pressure was then discussed, and its application to the case of hydraulic engines shown. The expansion of liquids by heat was then touched on, and its utilisation to the heating of public buildings described.

Lecture II.—Saturday, December 30, 1899.

Fluids, like all other bodies, possess inertia—*i.e.*, they resist any tendency to produce in them change in their state of motion or of rest. The sound heard in the case of the water-hammer was explained to be due to the absence of any air or other foreign gas tending to deaden the sound of the impact of the liquid against the walls of the vessel. A bottle filled with sound milk and closed with an air-tight stopper, after having been exhausted of air could be kept for an indefinite period before use. So long as the milk remained good a sound similar to that obtained in the case of a water-hammer could be obtained by striking the bottle smartly. The existence of one pathogenic organism in the original milk would in a short time generate foreign gases in the space above the milk, and the sound would be deadened. A bottle filled a month ago, with milk which was still good according to the above test, was shown. A method of picking up water, invented by Mr. Ramsbottom, on the London and North Western Railway was explained and illustrated by means of a small model tender lent by Mr. Webb. The property of inertia of liquids enabled Lord Kelvin to suggest a means of determining if an egg were boiled or not. If the former, the whole egg would, if set spinning, spin like a solid body, and could be stopped very rapidly. An unboiled egg, on account of the fluidity of its contents, was more difficult to spin and more difficult to stop. If the hand be pressed on it for a short time, and then removed, the egg will resume its spinning. The other characteristic of inertia—resistance to change of direction—was next referred to, and illustrated by spinning a vessel of coloured water, when the beautiful cup-shaped surface assumed on the water, due to the centrifugal force

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superposed on the force of gravity, was clearly seen. Since the centrifugal force was proportional to the square of the speed, the height to which the liquid rose was also proportional to the square of the speed. By a very ingenious simple addition Mr. Killingworth Hedges devised a speed indicator depending on the above principle, but in which the height of the liquid was in simple proportion to the speed. Spinning especially dirty solutions is a very good method of filtering them, and is in use in chemical laboratories. A further application to the case of cream separators was experimentally illustrated. Here the milk is spun in a large can at a high rate: the cream, being lighter, will tend to accumulate on the inside, while the "blue milk" will be forced outwards and can be drawn off separately. The viscosity of liquids was the next matter touched on. Its importance was explained for the case of lubricating oils, and Mr. Boverton Redwood's method of testing given. Treacle, pitch, and ice were given as extreme examples of viscous liquids.

Lecture III.—January 2, 1900.

The existence of viscosity in gases was illustrated by means of the old guinea-and-feather experiment. The formation of vortex rings was next shown in both gases and liquids. In the latter case, on account of the small tank available, alcohol was used instead of water, because of its much smaller viscosity. The rate of flow of a liquid through an orifice was next shown to be equal to the velocity acquired by a heavy body in falling through a height equal to the head. A direct method of measuring this velocity was shown by observing the trajectory of the issuing jet. Prof. Hele-Shaw's method of illustrating the stream-lines of a perfect fluid were then shown, and the exceptional beauty of the appearances elicited the most enthusiastic applause. Prof. Hele-Shaw had come down specially from Liverpool to work his apparatus. The question of perfect fluids drew from Mr. Boys the statement that an imaginary fluid, as much more perfect than the ether as the ether was more perfect than pitch, would still not be a perfect fluid. Next, the behaviour of liquids passing out from a diverging orifice was demonstrated. The peculiar paradoxical behaviour of liquids in passing through a tube of varying section was then shown and fully explained. The pressure of the liquid is greatest where the bore of the tube is greatest, and least where the bore is least. By reducing the bore sufficiently the pressure may be reduced sufficiently for the water to boil. The principle of the Venturi water meter was then explained, and a working model shown. A carefully tapered tube is used, through which the water passes, and from measurements of the pressure at the narrowest point, and at other points equidistant on either side, the total flow can be calculated. The "Venturi" meter was explained to be the invention, not of Venturi, but of an English water-works engineer.

(*To be concluded.*)

LAMP CONNECTION DIAGRAMS.

While still retaining the title "Lamp Connection Diagrams," it is well to explain this year that the increasing number of combined lighting and traction stations renders the motor load an important factor. The diagrams are compiled from the figures in the large sheet table which is issued as a supplement to the present number. Diagram 1 shows the continued growth of the lamp connections in the metropolis, and these are for the most part literally lamp connections. The Metropolitan Electric Supply Co., occupying as it does the best area, is still far beyond the others. It would have been more expedient had the slight bend in its curve been more pronounced. The City of London Co. has increased its connections at a greater rate than last year, in spite of the severe attacks upon it, and the Westminster Co.'s curve continues its upward course. The Kensington and Knightsbridge Co. and the Hampstead Vestry are increasing their business at a greater rate than in previous years, while the St. Pancras Vestry, whose station is, we believe, fully loaded until new plant has been erected, seems to have refrained from adding connections as rapidly as the last two years. The tendency of the Notting Hill curve to "approach saturation" during the previous two years is shown to have been but a temporary phase, and the company

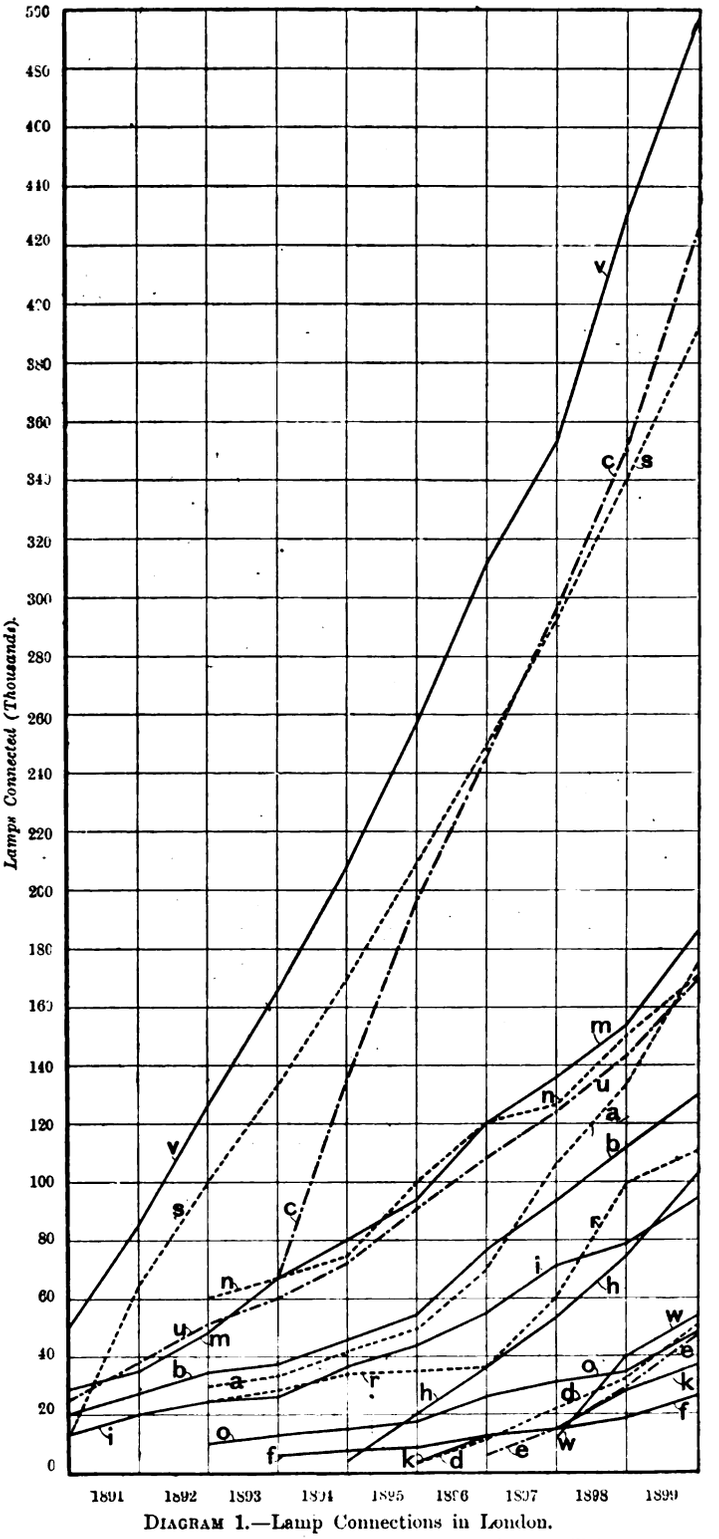

DIAGRAM 1.—Lamp Connections in London.

a Charing Cross Co.
b Chelsea Co.
c City of London Co.
d County of London and Brush Provincial Co. (Clerkenwell).
e County of London and Brush Provincial Co. (Wandsworth).
f Crystal Palace Co.
h Hampstead Vestry.
i Brompton and Kensington Co.
k Islington Vestry.
m Kensington & Knightsbridge Co.
n London Electric Supply Corporation.
o Notting Hill Co.
r St. Pancras Vestry.
s Westminster Corporation.
u St. James' and Pall Mall Co.
v Metropolitan Co.
w Shoreditch Vestry.

is no doubt anxious to have in operation as soon as possible the station it is building in Shepherd's Bush conjointly with the Kensington and Knightsbridge Co.

Diagram 2 shows the increase in connections year by year in London and the provinces. The total in the United

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Kingdom is now an equivalent of 6,869,000 8 c.p. lamps, an increase of nearly 1½ million over last year, the increase during 1898 having been 1¼ million.

It has been necessary to draw Diagrams 3 and 4 on a smaller scale this year than last. Diagram 3 demonstrates the large increase in the connections to combined alternating and continuous-current stations, attributable to a large extent

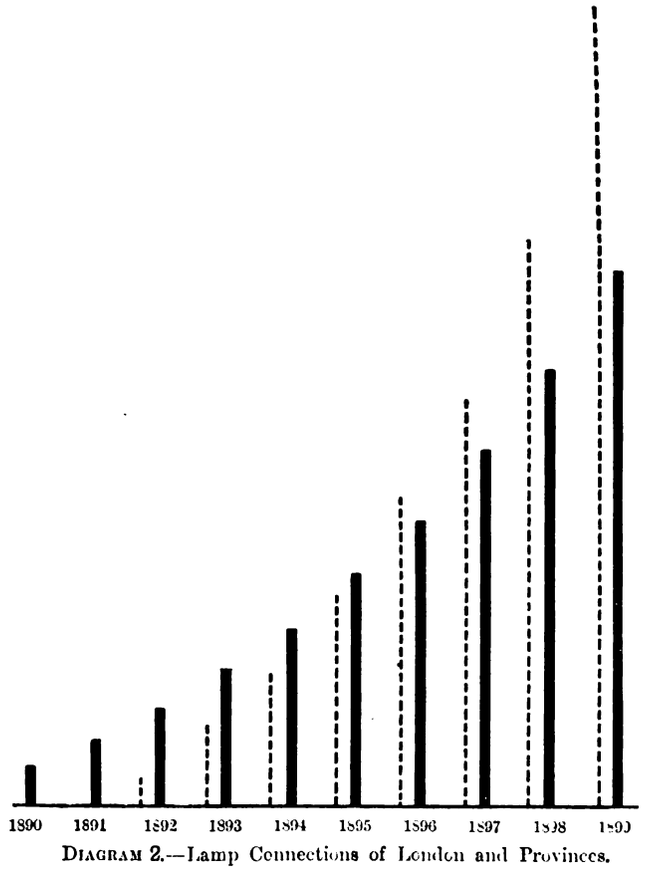

DIAGRAM 2.—Lamp Connections of London and Provinces.
London (——————). Provinces (- - - - - - - - - -).
Scale: 1in. = 1,000,000 lamps.

to traction loads. Fig. 4 is perhaps the most interesting of all the diagrams this year. The large growth of municipal electrical supply concerns in the provinces and the simultaneous transfer of company supply stations to local authorities is apparent by an increase in the length of the left-hand dotted line, and actually a decrease in the corresponding

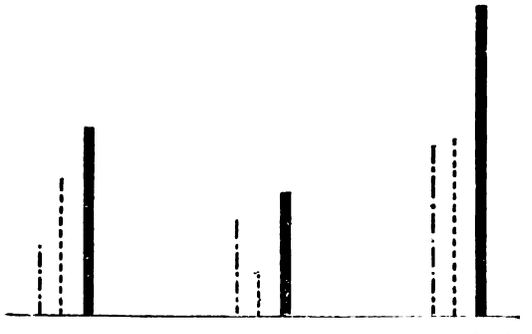

DIAGRAM 3.—Lamp Connections to Continuous and Alternating Current Stations.
Alternate current (— — — — — —). Continuous current (——————).
Alternate and continuous (— · — · — · —).
Scale: 1in. = 2,000,000 lamps.

full line. In London the companies still hold their own, but now the total municipal lamp connections in the United Kingdom exceed those of the companies, the figures being 3,798,000 and 3,071,000 respectively.

Below are given, in a tabulated form, the figures from which the diagrams have been drawn. They are compiled from the supplement table, and include all public supply stations in the United Kingdom. In the few instances where accurate figures were not forthcoming from the station engineers, we have estimated them from data in our possession.

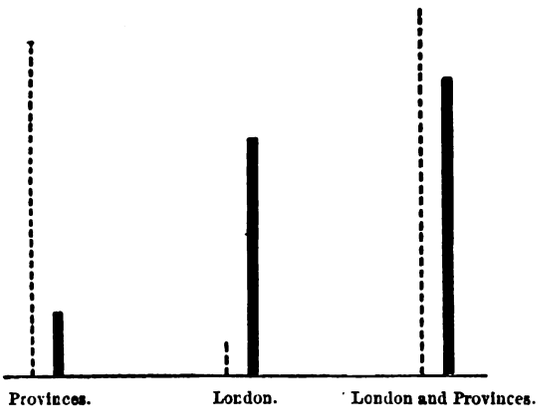

DIAGRAM 4.—Municipal and Company Lamp Connections.
Municipal (— — — — — — —). Company (——————).
Scale: 1in. = 2,000,000 lamps.

Table I.—*Details of Lamp Connections in London and Provinces.*

LONDON (2,765,000)	Municipal (338,000)	1S	171,000	
		1S 1S	167,000	
		1S 1S 1S	none	
	Companies (2,427,000)	1S	1,116,000	
		1S 1S	290,000	
		1S 1S 1S	1,021,000	
PROVINCES (4,104,000)	Municipal (3,460,000)	1S	1,631,000	
		1S 1S	1,156,000	
		1S 1S 1S	673,000	
	Company (644,000)	1S	311,000	
		1S 1S	254,000	
		1S 1S 1S	79,000	

Table II.—*Approximate Lamp Connections of Alternating and Continuous-Current Stations.*

—	1S	S	—	Totals.
London.....	1,021,000	457,000	1,287,000	2,765,000
Provinces.....	752,000	1,410,000	1,942,000	4,104,000
Totals	1,773,000	1,867,000	3,229,000	6,869,000

Table III.—*Approximate Municipal and Company Lamp Connections.*

—	Municipal.	Company.	Totals.
London	338,000	2,427,000	2,765,000
Provinces	3,460,000	644,000	4,104,000
Totals.....	3,798,000	3,071,000	6,869,000

PROGRESS OF ELECTRIC SUPPLY IN DUBLIN.

We reprint below the text of the report presented by Mr. Robert Hammond to the Corporation of Dublin on the projected extensions of electricity supply works in the Irish capital. As we announced in our issue last week (p. 348), this report was accepted by the Corporation, which has decided upon immediate extensions on the lines laid down by Mr. Hammond:—

December 7, 1899.

To the Chairman and members of the Electric Lighting Committee of the Dublin Corporation.

GENTLEMEN: 1. I have pleasure in reporting to you upon the cost of—

(1) Laying down an electricity supply works at Pigeon House with capacity sufficient to supply 100,000 lamps of 8 c.p., all alight at one time, or say 150,000 lamps fixed on consumers' premises.

(2) Utilising your present site at Fleet-street as a distributing centre.

(3) Making an important extension of your distributing mains for private supply.

(4) Largely extending your public arc lighting.

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2. I have had the advantage of repeated conferences with Mr. Harty, your city engineer, and with Mr. Ruddle, your electrical superintendent, and I feel that I have now ample data to enable me to lay my report before you.

My first task has been to devise a plan by which the scheme of high-pressure feeding and low-pressure distribution, recently designed by Prof. Kennedy, shall be completely utilised, and also by which we can avail ourselves to the full of the excellently situated site in Fleet-street as a distributing centre.

4. Particulars of the existing low-pressure schemes will be found in the schedules.

5. After carefully considering the problem, I have come to the conclusion that the transmission from Pigeon House should be by means of three-phase currents under an E.M.F. of 5,000 volts and with 50 or 60 complete periods per second. I propose three trunk mains of such a section that they could deliver into the distributing centre at Fleet-street an amount of electrical energy sufficient for 100,000 lamps of 8 c.p. all alight at one time, or say 150,000 lamps fixed on consumers' premises.

6. The system at present in use is the single-phase alternating, the current being supplied to the five sub-stations by five high-pressure feeders at an E.M.F. of 2,000 volts, with 83 complete periods per second.

7. I propose to deal with the present system by the conversion at Fleet-street of a portion of the three-phase 5,000 volts alternating to single-phase 2,400 volts alternating. It will be noticed that I raised the pressure from 2,000 volts to 2,400 volts, by which means I increase the carrying capacity of the distributors by 50 per cent., at a cost of about £2,000 for new lamps, &c. The capacity of these distributors is at the present 1,695 kw., capable of coping with 56,500 lamps of 8 c.p. alight at one time, or say 85,000 fixed on consumers' premises.

8. I deal with the remainder of the energy delivered to Fleet-street from Pigeon House by transmitting it unchanged in phase and E.M.F. to 19 sub-stations.

This schedule shows: Position of feeder points. Routes taken from Fleet-street to feeding-points. Length of feeders. Sectional area of same. Carrying capacity. Capacity of distributors radiating therefrom.

By the plan of running a separate feeder from Fleet-street to each sub-station, the regulation of the pressure at the sub-stations would be rendered extremely simple, and the maximum of safety and efficiency would be ensured. The capacity of the 19 feeders would be 3,681 kw., capable of coping with 126,000 lamps of 8 c.p. alight at one time, or say 190,000 fixed on consumers' premises.

9. At the feeding points there would be sub-stations built in convenient spots under the roadway or pathway, and easily accessible therefrom. I propose to build the sub-stations of such a size that they could accommodate additional transformers. I set out in Schedule IV. the number of transformers that should first be erected therein. Their total capacity would be 2,400 kw., of which 1,800 kw. would be in use and 600 kw. treated as a reserve.

10. I have, in conference with Mr. Harty, settled a list of streets which it is proposed to light with arc lamps. The list is set out in Schedule V., which gives the number of arc lamps proposed for each street and the approximate distance apart. The totals are: North side 184, south side 228, total 412; which with those at present in use (81), gives a grand total of 493.

11. I have also conferred with Mr. Harty upon the extent to which new distributing mains should be laid. In the city of Dublin, as the committee are aware, the paving and roadwork have been carried out with exceptional solidity, and, on Mr. Harty's advice, I have taken 10s. per yard run as the cost of breaking up and reinstating. As the outlay on this head will have to be so high, it would seem prudent to adopt the principle of laying distributing main for private supply wherever a trench is opened for the reception of the arc lighting mains. It is true that the adoption of this principle will lead to the laying of distributing mains in many cases in most unpromising positions; yet in view of the certainty of the time arriving when gas as an illuminant will disappear from Dublin, double expense and inconvenience will be avoided if the work be done now. Acting on this principle, Schedule VI. has been prepared. It sets out the particulars of the proposed new distributing mains, and gives name of street, location of main, approximate number of premises, approximate rateable value of each side of street, length of main, sectional area.

The summary shows:—

	Premises served.	Length of main.
North side	2,404	23,870
South side	3,032	29,944
Totals	5,436	53,823

(Say over 30 miles.)

12.—Estimated Capital Expenditure.

I.—*On Feeding and Distribution for Private Supply.*

Three trunk mains from Pigeon House to Fleet-street	£12,057
Apparatus at Fleet-street	4,425
Increasing capacity of present distributing mains by 50 per cent.	2,000
19 feeders from Fleet-street to sub-stations	9,645
Erecting sub-stations	4,750
Transforming devices, switchgear, &c., in sub-stations	11,360
Distributing mains for private lighting	19,724
Total for materials	£63,961
Trenching and reinstating	29,611
	£93,572
Add—Allowance for slack in cables, and deviations from straight runs, contingencies, engineering fees, &c.	9,428
	£103,000

13. I have provided for the laying of the above cables on the solid system. The high-pressure cables would be laid in iron culverts, and the low-pressure cables in wooden troughing, in both cases filled in with a bituminous compound. In certain districts wooden troughing is apt to rot, but there need be no fear on this score in Dublin, where it will be laid under six inches of granite slabs, the slabs being laid in a bed of cement and cemented together. No place that I have ever had to deal with is so admirably adapted for a system of distributors laid in wooden troughing as in Dublin. Of course the same system of distributors laid in iron troughing would undoubtedly prove a more permanent piece of work, the mechanical protection afforded by iron being much greater than that afforded by wood; but considering the excellent conditions that exist in Dublin, I recommend the saving of the £6,000 which represents the extra cost of the iron troughing over wooden troughing.

II.—*Public Arc Lighting.*

Separate mains under control from Fleet-street, connections to lamps, transforming devices, &c., &c.	£22,150
Trenching and reinstating where no trenches are already made to receive private lighting mains	3,620
500 posts, lamps, &c.	11,000
Add allowance for slack and deviations of cable from straight runs, contingencies, engineering fees, &c.	3,730
	£40,500

I submit a map showing the existing and the proposed (i.) Distributing mains for private supply. (ii.) Feeders. (iii.) Public arc lamps.

III.—*Works at Pigeon House.*

14. The Pigeon House site is admirably adapted for the erection and economical working of an electricity supply works designed on modern lines. At some future time the works may require for condensing purposes as much as 500,000 gallons of water per hour, and the site is so formed that this quantity can be most conveniently handled, it being drawn in cold on one side and discharged hot on the other. Coal can be delivered by ship or steam alongside the wharf, and lifted from the ship's hold by mechanical means, and similarly deposited into the coal bunkers, and thence into the mechanical stokers fixed on the boiler fronts.

15. I submit a plan showing how the works would be laid out. It will be seen that there is space sufficient to erect the plant in the way that will secure the most economical working—viz., with the boiler and engine centres in one straight line.

16. In order to secure this result, and to comply with the conditions laid down by Mr. Harty with regard to leaving clear space between the works and the wharf for a 40ft. roadway, the boiler house will not have sufficient width to accommodate Lancashire boilers; some form of water-tube boiler therefore will be used. I propose to adopt a revolving chain grate which will automatically convey the ashes to the ashpit when full duty has been extracted from the fuel.

17. The engine house has a width of 45 feet, and is large enough to accommodate Corliss gear slow-speed plant. This class of plant works with the highest economy of coal and with the lowest cost of upkeep. I have accordingly included provision in my estimate for it. As the cost of the four sets would only be about £5,000 more than that of those of the high-speed type, the saving in interest, &c., on capital by their adoption would be more than counterbalanced by the saving in working expenses.

18. I have already stated that the transmission to Fleet-street will be by means of three-phase currents under a potential of 5,000 volts. It will be necessary to decide whether the electrical energy so transmitted will be generated at that voltage, or whether the generation shall be at low-pressure, say 500 volts, with transformation at the works by static transformers to the line voltage. High-pressure alternators are obviously subjected to much greater strains than low-pressure ones, but the use of the latter involves the interposition of transformers at a cost of about £6,000, which should be saved if possible. At Pigeon House during tempestuous weather it will be difficult to free the air entirely from salt, which may attack the insulation, and thus militate against the use of the high-pressure machines.

19. I have provided for buildings not only to accommodate the proposed plant, but also to accommodate one more set. When further plant has to be laid down, the buildings are so designed that extensions can be made on easy lines. From the key plan it will be seen that there is space for a 300ft. engine-house, capable of accommodating plant up to 8,000 kw. It will also be seen that I provide for the ultimate use of two chimneys, the one now proposed being similar to the one recently erected by me at Leeds.

Buildings.—(Foundations for plant, chimney, &c.)	£20,000
Boiler House Plant.—(Six water-tube boilers, chain mechanical stokers, superheaters, feed pumps, injectors, motors, shafting, feed heaters, feed water meters, coal crane and conveyors, coal bunkers)	11,670
Engine House Plant.—(Two 1,000 kw. slow-speed plants, two 500 ditto, two steam exciters, step-up transformers, transformer switchboard, main switchboard, exciter switchboard, surface condensers, air pumps, overhead crane to lift 25 tons, workshop equipment, oil, filter spaces, &c.	53,900
Pipe work and feed tank	3,500
Telephone to Fleet-street	330
	£89,400
Add—Contingencies, engineering fees, &c.	6,600
	£96,000

20. In addition to the sums set out, it will be necessary to provide for the cost of connecting on new consumers. This sum would, of course, only be expended gradually.

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IV.—*Meters and House Connections.*

Provisional sum	£15,000

Summary of Estimated Capital Expenditure.

I. Mains, &c., for private supply	£103,000
II. Public arc lighting	40,500
III. Works at Pigeon House	96,000
IV. Meters and house connections	15,000
	£254,500

Financial Results.

21. The proposed plant has a capacity of 3,000 kw., but it would be prudent to treat one set as "reserve." This would leave 2,000 kw. available, or say, with 10 per cent. extra at top load, 2,200 kw. Of this, 300 kw. would be used for the arc lamps, leaving for the private lighting 1,900 kw., capable of dealing with 63,300 lamps of 8 c.p. all alight at one time, or say 95,000 lamps fixed on consumers' premises.

Revenue—95,000 lamps using say 16 units each per annum, 1,520,000 units at average price of 4½d. £28,500
Meter rents, say 1,000
500 arc lamps at £18 9,000
£38,500

(Carbon and trimming being paid by the lighting authority.)

Expenditure—Cost of generation and distribution :—

Private lighting	1,520,000 units
Public arc lighting	1,125,000 „
	2,645,000 units at 1·5d. £16,531

Gross profit (to provide for interest and sinking fund)... £21,969

22. When the demand justified the laying down of an additional 1,000 kw. set, the output for private lighting could be increased by 760,000 units. The gross profit arising therefrom would increase the above £21,969 to £31,469.

PROVISIONAL ORDER APPLICATIONS.

During October and November we gave particulars of the provisional electric lighting order notices, and in the present issue we give a complete list of the applications which have been deposited with the Board of Trade before Dec. 21st. The necessity of making a deposit of £50 has not, on this occasion, deterred many promoters from proceeding with their applications. Of the 108 orders only six affect the metropolis.

ELECTRIC LIGHTING.

LONDON.

District.	Applicants.
Battersea (portions of)	County of London Electric Lighting Co.
Lambeth (part of)	South London Electric Supply Corporation.
Limehouse	District Board of Works.
Marylebone	Marylebone Electric Supply Co.
Mile End Old Town	Vestry.
St. George-in-the-East	Vestry.

THE PROVINCES.

Allerton, Much Woolton, Little Woolton, Childwall and Garston	Liverpool District Lighting Co.
Banbury	Electrical Power Distribution Co.
Barmouth	District Council.
Barnard Castle	Northern Counties Electricity Supply Co.
Barnet	District Council.
Barnstaple	Corporation.
Basingstoke	Corporation.
Berwick-upon-Tweed	Urban Electric Supply Co.
Birkenhead (Bidston-cum-Ford and Noctorum)	Corporation.
Bishop Auckland	Urban Electric Supply Co.
Bonchurch (Isle of Wight)	Ventnor Electric Light and Power Co.
Boston	Corporation.
Brecon	Corporation.
Bredbury and Romiley	District Council.
Bridge of Allan and Dunblane	Urban Electric Supply Co.
Bridlington	Corporation.
Brierfield	District Council.
Brierley Hill	District Council.
Broughty Ferry	Burgh Commissioners.
Caterham & Warlingham	Urban Electric Supply Co.
Cheadle and Gatley	District Council
Cheltenham (Charlton Kings and portions of rural districts of Cheltenham & Winchcombe)	Corporation.
Chester-le-Street	County of Durham Electrical Power Distribution Co.
Clacton	District Council.
Cleckheaton	District Council.
Cleethorpes	District Council.
Cobham, Stoke d'Abernon and part of Byfleet	Cobham Gas Co.
Cowpen	Northern Counties Electricity Supply Co.
Dartmouth	Urban Electric Supply Co.
Egremont	District Council.
Elland	District Council.
Enfield	Urban Electric Supply Co.
Erdington	District Council.
Exmouth	District Council.
Farnham	District Council.
Felixstowe and Walton	District Council.
Freshwater and Totland (I.W.)	Freshwater and Totland (I.W.) Electricity Supply Co.
Gosforth	Newcastle-upon-Tyne Electric Supply Co.
Gosport and Alverstoke	District Council.
Grantham	Urban Electric Supply Co.
Harrow-on-the-Hill	District Council.
Hebburn	District Council.
Heston and Isleworth	District Council.
Hyde	Corporation.
Hythe	Corporation.
Jarrow, Hebburn and Felling	County of Durham Electrical Power Distribution Co.
Kendal	Corporation.
Leek	District Council.
Littleborough	District Council.
Liversedge	District Council.
Llandilo	District Council.
Llanrwst and Geirionydd	Llanrwst Electricity Supply Co.
Long Eaton	District Council.
Lytham	District Council.
Malton	Northern Counties Electricity Supply Co.
Maryport	District Council.
Midland Electric Power Distribution and Lighting (Extension) Order (Smethwick, Oldbury, Perry Barr and Stourbridge, Upper Penn, and Bushbury)	Midland Electric Corporation for Power Distribution.
Nantwich	District Council.
Neath, Briton Ferry and Aberavon	Electrical Power Distribution Co.
Newark	Corporation.
Newhaven	Rev. H. G. Bonnewell and others.
Nuneaton & Chilvers Cot'n	District Council. [Co.
Ogmore and Garw	Ogmore Valley Electric Light and Power Supply
Ormesby	District Council.
Ormskirk	District Council.
Penrith	District Council.
Penzance	Corporation.
Prestwich	District Council.
Pwllheli	Corporation.
Ramsgate	Corporation. / Isle of Thanet Elec. Tramways and Lighting Co.
Redcar	District Council.
Redruth	Urban Electric Supply Co.
Romford	District Council.
Royal Leamington	Midland Electric Light and Power Co.
St. Helens (I.W.)	Capt. Bax.
Sandgate	District Council.
Seaford	Rev. H. G. Bonnewell and others.
Seaham Harbour	County of Durham Electrical Power Distribution Co.
Sevenoaks	Electrical Power Distribution Co.
Sheerness	Electrical Power Distribution Co.
Sleaford	Urban District Council.
South Blyth	Northern Counties Electricity Supply Co.
Southwold	Corporation.
Sowerby Bridge	Urban District Council.
Spennymoor	Northern Counties Electricity Supply Co.
Staines, Egham and Chertsey	Electrical Power Distribution Co.
Stamford	Urban Electric Supply Co.
Sudbury	Corporation.
Teddington and Twickenham	Richmond (Surrey) Electric Light & Power Co.
Thirsk and Sowerby	Northern Counties Electricity Supply Co.
Totnes	Totnes Electricity Supply Co.
Tunstall, Golden Hill and Chell	District Council.
Twickenham and Teddington	Twickenham & Teddington Electric Supply Co.
Uxbridge (except parish of Northolt), Iver, Denham, & Gerrards Cross	Uxbridge and District Development Syndicate. [tion Co.
Wallington (Croydon)	County of Surrey Electrical Power Distribu-
Wellingborough	Electrical Power Distribution Co.
Weybridge	Urban Electric Supply Co.
Whitefield	District Council.
Witney	Witney Electric Supply Co.
Woking and Horsell and portion of Chertsey	Woking Electric Supply Co.
Wormit and Woodlaven	Tayside Electric and Gas Light Co.

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ELECTRIC TRAMWAYS PROVISIONAL ORDERS.

The following applications have been lodged with the Board of Trade for provisional orders to construct and work electric tramways. Of the 86 applications (compared with 19 in 1898), 27 are by local authorities and 9 by companies. This list represents only the applications for Board of Trade orders, the majority of applications for electric tramway powers being by private bill. A list of these private bill applications appeared in *The Electrician* during November.

District.	Applicants.
Ashton-under-Lyne	Corporation.
Batley	Corporation.
Bedford	Corporation.
Bootle	Corporation.
Bournemouth	Corporation.
Bredbury and Romiley	District Council.
Camborne and Redruth	Urban Electric Supply Co.
Ealing	District Council.
East Ham	District Council.
Garston	Garston and District Tramways Co.
Hemel Hempstead	British Electric Traction Co.
Houghton-le-Spring and District.	United Kingdom Tramway, Light Railway and Electrical Syndicate.
Huddersfield	Corporation.
Hull	Corporation.
Hurst	Urban District Council.
Kearsley	District Council.
Leamington & Warwick	Leamington and Warwick Omnibus and Tramways Co.
Liverpool	Corporation (extensions).
Middleton	Corporation.
Plymouth	Corporation.
Portobello and Musselburgh.	Drake and Gorham Electric Power and Traction Co.
Portsmouth	Corporation.
Prestwich	District Council.
Radcliffe	District Council.
Reddish	District Council.
Rothesay	British Electric Traction Co.
St. Helens	Corporation.
Southampton	Corporation.
Surbiton	District Council.
Taunton	Taunton and West Somerset Electric Railway and Tramways Co.
Walthamstow	District Council.
Warrington	Corporation.
Weston-super-Mare	Weston-super-Mare & Dist. Electric Supply Co
Whitefield	District Council.
Wigan	Corporation.

ELECTRICAL JOINT STOCK COMPANIES OF 1899.

The following are the more important limited liability companies connected with the electrical and allied industries registered during the past year, with their capital:—

Adams-Randall Telephone Patents	£60,000
Adelaide Development Co.	25,000
American Automobile and Motor Co.	80,000
Anglo-Russian Syndicate	100,005
Angus Electric Light and Power Co.	25,000
Argentina Electric Traction Co.	500,000
Auckland Electric Tramways Co.	150,000
Automatic Magneto-Electric Ignition Co. (France and Belgium)	15,000
Automatic Electrical Advertising Syndicate	4,500
Belliss and Morcom (successors to Belliss and Co.)	300,000
Benjamin Goodfellow	50,000
Blackburn, Starling and Co.	12,000
Blackpool and Garstang Electric Light Railway Co.	10,000
Blast Furnace Power Syndicate	100,000
British Electric Works	135,000
British Pioneer Electric Light and Power Co. of India	3,000
British Thermophor Syndicate	25,000
British Westinghouse Electric and Manufacturing Co.	1,500,000
B. Rhodes and Co.	10,000
Browett, Lindley and Co.	120,000
B. R. Rowland and Co.	6,000
Buenos Ayres Electric Tramway Co.	350,000
Buller's Telegraphic Construction Co.	400,000
Burmah Electric Works Syndicate	2,000
Cecil Wray and Co.	5,000
City of Carlisle Electric Tramways Co.	60,000
Cole, Marchent and Morley	100,000
Commercial Telegraph Construction Syndicate	5,000
Compass Trading Co.	5,000
Cotsworth Arc Lamp and Electric Lighting Syndicate	25,000
County of Durham Electrical Power Distribution Co.	100,000
County of Surrey Electrical Power Distribution Co.	50,000
County of Sussex Electrical Power Distribution Co.	£50,000
Davis and Timmins	110,000
Davy Improved Arc Lamp Syndicate	2,100
D. H. Bonnella and Son	15,000
Dublin Electric Lighting Syndicate	5,000
Edwards Electrical Co.	10,000
Electrical Castings and Fittings and Engineering Co.	30,000
Electrical Corporation	30,000
Electrical Industries	5,000
Electrical Luminiscriptor Co.	75,000
Electrical Maintenance and Accessories Syndicate	10,000
Electrical Transmission Co.	30,000
Electrical Wool Pulling Syndicate	15,000
Electric Battery Case and Fittings Syndicate	12,000
Electric Canal Haulage Co.	3,000
Electric Coin Freed Meter Dimming Syndicate	5,000
Electric Lighting and Traction Co. of Australia	300,000
Electric Light Insurance and Maintenance Co.	10,000
Electric Resistance and Heating Co.	120,000
Electric Timber-Seasoning and Preservation Co.	150,000
Electromotors	50,000
Elmore's Trust	400,000
Engineering and Electric Works Co.	5,000
English Electric Manufacturing Co.	385,000
English Electro-Metallurgical Co.	700,000
Entwistle and Stephens	25,000
Epicyclic Manufacturing Co.	20,000
Epstein Electric Accumulator Syndicate	10,000
Ferrolite Electric Syndicate	30,000
Fladbury Electric Light and Power Co.	2,000
French Victoria Accumulator Co.	60,000
Freshwater and Totland (I. W.) Electricity Supply Co.	15,000
Galloways	300,000
Garston and District Electric Supply Co.	25,000
Garston and District Tramways Co.	5,000
General Engineering Co.	15,000
Giddings and Dacre	90,000
Giffre Electro-Chemical and Power Co.	140,000
Gramophone	150,000
Harry South and Co.	10,000
Harvey and Williams	60,000
Heaton and Smith	25,000
Helios Electrical Construction Co.	10,000
Hiram S. Maxim Automobile Syndicate	35,000
Horsfall Destructor Co.	100,000
Hudswell, Clarke and Co.	100,000
Imatra Water-Power Co.	100,000
Ingleton Electric Lighting and Power Co.	4,000
Interchangeable Flash Sign Syndicate	5,000
International Telephone Manufacturing Co.	200,000
Irish Electric Railways Co.	2,000
John Jenkins and Sons	70,000
Joseph Booth and Sons	75,000
Joseph Rhodes and Sons	52,500
Julius Sax and Co.	18,000
Kalgoorlie Electric Power and Lighting Corporation	225,000
Kalgoorlie Power Syndicate	10,000
Lancashire Dynamo and Motor Co.	100,000
Leecoll Electric Battery Co.	60,000
Llanelly and District Electric Lighting and Traction Co.	50,000
Llanrwst Electricity Supply Co.	5,000
Lloyd Manufacturing Co.	20,000
London Electrical Fittings Co.	3,000
Longford Wire Co.	100,000
Loughborough and District Electric Traction Syndicate	1,000
Lux Syndicate	2,030
Macroom and District Electric Lighting Syndicate	5,000
Manchester and Liverpool Electric Railway Syndicate	40,000
Marine Propulsion and Electrical Generation Syndicate	50,000
Mather and Platt (re-registered)	775,000
Maxim Electrical and Engineering Export Co.	100,000
Mechanical and Electrical Power Co.	5,000
Medical Electro-Thermic Generator Co.	20,000
Metal Electro Amalgamating Syndicate	20,000
Middleton Engineering Works	10,000
Midland Electrical and General Engineering Tool Co.	15,000
M'Laughlin and Harvey	50,000
Morecambe Electric Launch and Power Syndicate	3,000
Monobloc Accumulator Syndicate	20,000
Nalder Bros. and Thompson	20,000
Neild's Sleeve Electric Joint Syndicate	5,000
Nernst Electric Light	320,000
Newcastle Engineering Co.	15,000
Newhaven and Seaford Electric Lighting Co.	20,000
New Rottingdean Electricity Co.	2,000
North Metropolitan Electrical Power Distribution Co.	50,000
Norwich Mutual Telephone Co.	20,000
Parsons Foreign Patents Co.	60,000
Passenger Communication Co.	6,000
"Perfect" Arc Lamp and Accessories Co.	10,000
Phodyne Electrical Co.	10,000
Pioneer Electric Light and Power Co. for China	3,000
Pioneer Electric Light and Power Co. for Japan	3,000
Poole and District Electric Traction Co.	100,000
Prism Globe Co.	50,000

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Pulford Bros.	£3,000
Queen's Dock Electric Works	5,000
Recording Telegraphs	7,500
Renewable Electric Lamp Co.	150,000
Rennie and Prosser	5,000
Rhea Insulite Syndicate	15,000
River Plate Construction Co.	120,000
Road and Tramcar Electric Traction Co.	12,000
Robert Stephenson and Co.	500,000
Robert W. Blackwell and Co.	200,000
Royce (re-registered)	110,000
Rubber and Vulcanite Co.	12,500
Sampson and Co.	25,000
Scottish Wireless Electric Syndicate	3,000
Search Light Syndicate (of America)	30,000
Shanghai Tramways Syndicate	5,000
Shipham and Co.	15,000
Sloan Electrical Co.	15,000
Southern Electrical Installation and Wiring Co.	10,000
South Staffordshire Tramways (Lessee) Co.	150,000
"Steady" Arc Lamp Co.	20,000
St. Helens Cable Co.	50,000
Street Lighting Co.	30,000
Sturtevant Engineering Co.	60,000
Sun Electrical Co.	50,000
Surprise Arc Lamp Syndicate	2,000
Suspended Electric Railway Co.	60,000
Tayside Electric and Gas Light Co.	25,000
Telepantograph Syndicate	10,000
Telephone and Switchboard Syndicate	10,000
Telephone and Switchboard Syndicate (Continental)	10,000
Thanet Constructional Co.	300,000
Thomas Harrison	2,000
Totnes Electricity Supply Co.	10,000
Traction Company of the United Kingdom	150,000
Trafford Power and Light Supply Co.	100,000
Tramway Traction Co. of South Australia	60,007
Tyneside Electric Power Co.	100,000
United Kingdom Tramway, Light Railway and Electrical Synd.	20,000
United States and Canadian Rhea Rubber and Insulite Synd.	30,000
Vaughan and Son	50,000
Western Telegraph Co. (absorbing Brazilian Submarine and Western and Brazilian Telegraph Cos.)	1,000
West London and Provincial Electric Supply Co.	150,000
Westmacott, Stewart and Co.	6,000
Westminster Automatic Telephone Syndicate	50,500
West of England Electric Installation Co.	25,000
Weston-super-Mare and District Electric Supply Co.	50,000
William James Glover and Co. (established 1818)	100,000
William Whiteley	900,100
Wilsons and Mathiesons	115,000
Woodhouse and Baillie Riviera Electricity Co.	50,000
World Gas and Electric Syndicate	3,000
W. R. Sykes Interlocking Signal Co.	100,000
Yale Electric Power Co.	10,000

PUBLIC COMPANIES WOUND UP, DISSOLVED, &c., IN 1899.

The following are the principal electrical and engineering limited liability companies which have been wound up (either voluntarily or compulsorily) or dissolved during the past year. The asterisk denotes that the company was wound up by order of the Court.

Akester Electro-Motor and Accumulator Co.
Alliance Meter Co.
Anders Telephone Co.
Automatic Electric Meter Syndicate.
Berry's Electrical Co.
Binko, Ridsdale and Co.
Blot Electric Accumulator Co.
Bournemouth and District Electric Supply Co.
Britannia Motor Carriage Co.
British and Foreign Chemical Co.
British Electrical and Industries Co.
British Electrical Cycle and Motor Engineering Co.
British Hermite Electro Bleaching Co.
British Light Railways.
Brook Time Checking Clock Co.
Bullers (reconstruction).
*Chitty Dynamo and Motor Co.
Cottonwood Water Power and Electric Co.
Denison Auto Telegraph Machine Syndicate.
Direct Electric Generator (Foreign Rights) Syndicate.
Direct Electric Generator Syndicate.
Direct Telephone Exchange Syndicate.
*Dobsons and Curtis Bros.
Dutton and Co. (reconstruction).
Economic Electric Specialty Co.
Electric Date and Time Stamp Co.
*Electric Exploitation Co.
Electric Lighting Extension Syndicate.
Electric Light Insurance and Maintenance Co. (reconstruction).
Electric Transformer System Co.
Electric Trust.
Electrical and General Exploring Syndicate.
Electrical Investments Trust.
Electrical Pioneer Syndicate.
Electrical Plant.
Electrical Time Recording Co.
Electricity.
Elmore's Wire Manufacturing Co.
Elmore's Foreign and Colonial Patent Copper Depositing Co.
Elmore's French Patent Copper Depositing Co.
Elmore's American and Canadian Patent Copper Depositing Co.
Faraday Electrical Engineering Co.
Globe Electric Co.
G. R. Blot and Co.
Hastings and St. Leonards-on-Sea Electric Light Co.
Heath, Snoxell and Co.
H. G. Ellis and Co.
Hiram S. Maxim Electric Lighting and Engineering (Pioneer) Syndicate.
Hope-Jones Electric Organ Co.
Improved Incandescent Electric Lamp (Foreign Patents) Syndicate.
Improved Lighting Syndicate.
*J. H. Pickup and Co.
Kelvinside Electricity Co.
Leatherhead Electric Lighting and Power Co.
Leeds and London Electrical Engineering Co.
Lineff Electric Traction and Lighting Syndicate.
Lithanode Electric Storage Co.
London and Hampstead Battery Co. (reorganisation).
London and Lancashire Electrical and General Engineering Co.
*Madras Electric Tramways Co.
*Mannesmann Tube Co.
Maxim Foreign and Colonial Motor Syndicate.
Mexican Gas and Electric Lighting Co.
Nalder and Hilton.
Nernst Lamp (Pioneer Co.) (reconstructed).
New Electricity Supply Co. of Croydon.
New Motive Power Syndicate.
Niagara Battery Co.
North Eastern Telephone Co.
Northern Counties Electric and Motor Co.
Omnibus and Tramcar Electric Lighting Co.
Phæton Electrical Co.
Phœbus Electric Battery Syndicate.
Phœbus Solder and Electric Soldering Fluid Co.
Pittsburgh Reduction Syndicate.
Porcelain Electrical Fittings Co.
Power Accumulator Syndicate.
Practical Primary Electric Battery Syndicate.
Prism Globe Syndicate (reconstruction).
Railways Electric Supply Syndicate.
Randall Telephone Syndicate.
Rogers Arc Lamp Co.
Rottingdean Electric Lighting and Power Co. (reconstruction).
Round's Accumulator Syndicate.
Self-Generating Electric Vehicle Light Syndicate.
Sheffield Electric Light and Power Co.
Shropshire Electric Light and Power Co.
Single Wire Multiple Telephone Signal Co.
South Manchester Electric Supply Co.
Standard Dynamo and Motor Manufacturing Co.
Tayler-Smith Electric Co.
Vril Launches.
W. and J. Robinson and Co.
Walton-on-Thames Electric Lighting and Power Co.
Western Counties Electric Light and Power Syndicate (reconstruction).
*Williamson and Joseph.
X-Ray Syndicate.
Yorkshire House-to-House Electricity Co.

CORRESPONDENCE.

ELECTRIC WIRING AT BONN.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I venture to suggest that the editorial note in the first page of your issue of Dec. 29, dealing with the Bonn electricity supply, is too sceptical, if not entirely misleading. When recently on the Continent collecting information about "earthed" wiring, I secured at first hand the information you would seem to require. The description of the Bonn works appeared in the German technical press over a year ago, and although it may have been the first town to adopt 200 volt pressure, it is by no means the first Continental town to employ a continuously "earthed bare middle" or

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"uninsulated return"; in fact, several other important towns have had similar 100 volt systems in extended use for years past, and now that their experience is so "matured," I hope shortly to be permitted to bring their points of success more prominently before English electricians.

Again, judging from the ever conservative (some say unprogressive) manner in which you look upon electric wiring developments, you may consider it "reasonable" to infer that the house wiring is carried out "with both poles insulated"—but in this particular case, however, I am able to advise you that the actual practice belies your editorial judgment. I trust it will tend to reassure, rather than "alarm" you, when I state in Bonn, as in five or six other Continental towns, it is already common practice in house wiring to run one insulated conductor (300meg. quality) inside a plain or brass-armoured insulating conduit (known there as Bergmann tube) as the "outer" and form the "return" with *a perfectly bare copper wire* of equal carrying capacity. This bare copper wire is stapled up on to wall or plaster, either behind or by the side of the insulating tube, and is quite usual in passages or corridors, whilst in the rooms the Continental practice of stretching flexible cord on porcelain insulators is followed. I should be interested to read your explanation of what (to me) is paradoxical, why Continental practice allows wiring of this nature and yet absolutely *prohibits* the "wood-casing" practice you so zealously champion for England. As you will allow, I persistently challenge the survival of wood-casing on the double ground of safety and economy; and whilst bowing to your intimation that under the first head I seek to make a mountain of what you desire recognised as a molehill, I soothe myself with the thought that your comment has heretofore been based on negative and incomplete rather than upon positive and painful experience. The recent letters in *The Times*, referred to in your leading article, prove at least that the public are inclined to view critically any insidious electrical fire, no matter how trivial or infrequent.

Under the second head I still insist that our present methods of wiring are "penny wise and pound foolish," but, without support from a literary and technical authority like yourself, it must be left to time and a relatively greater advance of the electrical industry in other countries to overcome the inertia of English prejudice and conventionality.

I would add that if, as your editorial implies, you really believe "the popularity of the electric light is clearly threatened" by the momentary combination of events, you should fully consider whether the jeopardised "prestige" could not be restored by a complete and satisfactory solution of the "electric wiring question." For, given a rational and standardised method of wiring, which could compete in cost, convenience, and efficiency with gas-piping, our supply stations would be assured of and would duly prepare for a steadily increasing load. Capitalists and the dependent manufacturers would with one accord lay themselves out to profit by the certain and definitely increasing business. The public would be provided with a low cost and reliable means of applying electricity to the hundred and one possible uses, and the whole field of utilisation could be so thoroughly exploited that the electrical industry would gain a clear start on its path of resistless progress.—Yours, &c.,

London, E.C., Jan. 2. FRED BATHURST.

[While thanking our correspondent for his interesting information concerning the system of house-wiring employed at Bonn, we cannot but express our surprise at the tone of his letter. We can find nothing in our last issue, or in any other, to support his statement that we "zealously champion" wood-casing practice; nor have we criticised adversely Mr. Bathurst's present system—of wiring, at all events. The few electrically-caused fires that have taken place in this country (much fewer than in Germany, for instance) have always been traceable to bad workmanship, which might render any system dangerous. With regard to the last paragraph of Mr. Bathurst's letter, we do not seriously believe that even an exclusive employment of the system of wiring by "insulated conduits" would materially affect the balance-sheets of electric supply undertakings.—ED. *E.*]

LEGAL INTELLIGENCE.

Disher v. Mullar.

At Southwark (London) Police-court, last Friday, the magistrate, Mr. Taylor, heard the complaint of Mr. Robert J. Disher, electrical engineer, Spitalfields, against Mr. R. Mullar, Grange-road, Bermondsey, managing director of Mackey's Electric Lamp Co., who was summoned for non-payment to complainant of wages amounting to £1. 12s. 7d. (46 hours at 8½d.) in lieu of notice.

Mr. DISHER said defendant discharged him without notice on Dec. 20, because he threatened to smash up an accumulator which he had invented, and which partly belonged to defendant. He was annoyed because defendant had promised to do something with the invention, and had neglected to do so. The accumulator was a novelty, and on test showed such results as no other accumulator had ever done. He was taken on by defendant in February, upon a promise that Mackay's would test the accumulator, and if they found it a good thing would take it up, and meanwhile they gave him employment at 8½d. per hour, although the proper wages for such a man as himself was 1s. 1½d. Although he threatened to smash the accumulator, he thought a great deal of it.

Mr. MULLAR said he engaged complainant at 8½d. per hour to set up accumulator cells. Disher originally asked 50s. a week, but witness refused, as it was a custom of the trade to pay by the hour. It was not usual to give a week's notice. He dismissed complainant without notice because he said he did not intend to do any more work after that week, and threatened to destroy the work which he had done.

The MAGISTRATE: Was the accumulator his or yours?—It was ours; we had paid him for it. We had, in fact, bought it. He brought it to us and said it was a good thing, and we said we would try it at our convenience. He wanted employment, and we put him on. On Dec. 20 he asked what we proposed to do about the accumulator, and I informed him we had not tested it. He said he would smash it, and I told him to go. I paid him a sovereign for it.

COMPLAINANT: Yes, on the condition that it was sold to them for a test. It had cost me £3. 10s. It was not sold outright. He was engaged to fit up apparatus which defendant had bought cheap, and he asked for the job of looking after the installation afterwards, but defendant said he could not decide that yet. The witness put up the machinery and shafting at the works, and in his opinion several of these machines were in a dangerous condition. They were not insulated, and anybody touching the wires would be knocked down.

NORMAN SMITH, electrical engineer, said, as to the custom of the trade, that except in special cases, where men were engaged by the year, the rule was payment by the hour; but men would not be summarily discharged except for misconduct.

The MAGISTRATE: That is a point for the complainant. Upon what ground were you (complainant) justified in threatening to destroy the cell?—I kept "her" all day at 3 volts, discharging 25 amperes. There is no other accumulator ever made that has done it.

But why did you threaten to destroy it?—Because I could see no way to any justice being done to me in regard to this accumulator. They thought they had got it entirely away from me, whatever it is worth; and I say that if it is properly taken up it is worth £25,000. I could see that I was being entirely robbed of a good thing.

The MAGISTRATE said complainant was not entitled to assert his rights in the way he did. He said that complainant was a weekly servant, and entitled to a week's notice, but he was not justified in threatening to smash up the accumulator when he had sold it. Complainant estimated that it was worth £25,000. He hoped it might prove to be of that value, and if so, the complainant would be able to get some money out of it, but that was a matter for a civil court. It was wrong of complainant to threaten to smash up the invention, when it was clearly the property of his employers. That misconduct would justify summary dismissal, and he regretted to be unable to find for complainant. But for that misconduct he should have done so. Summons dismissed.

Duthie v. P. C. Middleton and Co.

In the Aberdeen Sheriff's court, on 22nd ult., Sheriff Robertson closed the record in an action brought by William Duthie against P. C. Middleton and Co. to grant interim interdict against defenders from carrying on the works known as Cults electric supply station in such a manner as to cause the chimneys or steam pipes connected with the works to send forth smoke or steam so as to be injurious and destructive to the property and pertinents of pursuer adjacent to the works. By the alleged nuisance pursuer states he is often deprived of the use of his bleach-green, and prevented from opening the back door and back windows of his house; his shrubs and trees are blackened, and during the season his flowers are seriously and sometimes completely destroyed. The defenders, in answer, state that their furnaces are of the best construction for consuming smoke, are fed with best steam coal, and are carefully fired. The three engines are high-pressure engines, and no appreciable steam is now discharged from the works. The smoke from the furnace is common coal smoke, reduced to a minimum by their construction and careful firing. The new chimney-stalk, recently erected removes all cause of annoyance either from smoke or steam.

Failure of Electricity Supply.

At the Marylebone (London) Police-court, on Friday, the Metropolitan Electric Supply Co. were summoned before Mr. Plowden, at the instance of the Marylebone Guardians and the Marylebone Vestry, for having, on Dec. 7, 9, 11, 12, and 14 last, made default in the supply of electric energy to the workhouse and Vestry premises.

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Mr. MUIR, who appeared for the company, said he must admit the default, which, of course, was tantamount to a plea of guilty. He hoped, however, to show that the company had done all that human foresight could devise to prevent the breach, which was an accident; and that for the future measures had been taken by which, humanly speaking, it would be impossible for the accident to recur. The company, which was the oldest of its kind, was started in 1888, and commenced to supply the public with electricity in 1889. The demands made upon the company had exceeded all expectations. The number of lamps supplied in 1892 was 78,000, in 1897 187,000, or more than double. Acting under expert advice, the company had laid down steam plant to the extent of hundreds of horse-power, which it was now seen should have been thousands. In February, 1898, a site was secured at Willesden, on which an extensive, completely-equipped generating station was now approaching completion. Contracts were entered into for the erection of works upon a scale unprecedented in Europe. But, unfortunately, difficulties cropped up in connection with the execution of the works, and from various causes the time limits in various contracts were broken. Owing to these delays, the company had applied to another electric supply company and had obtained some assistance, but the supply soon failed, as the company borrowed from needed all the current they could produce for their own customers. When that source of supply failed the troubles of the defendant company commenced. There was also a difficulty in securing Welsh coal for the furnaces because of the Government demand for steam coal. Other coal had to be used, and that reduced the power output of the works. There had been an unprecedented increase since 1897 in the number of lamps, equal to 20 per cent., or 80,000 lamps, in addition to what they had already to provide for. One of the engines at the new Willesden station would supply 90,000 lamps, and had that been started in 1898, as contracted for, the deficiency now complained of by the parochial authorities and other consumers would not have occurred. The object of this prosecution being to ensure the fulfilment of the company's contract, he hoped, after the statement he had made, that the magistrate would not inflict any penalty at this period, but adjourn the summons until after the dark days had passed. If no more stoppages took place, he hoped the penalties would be minimised to the last degree; but if there should be further several stoppages, which he did not at all anticipate, then the learned magistrate would inflict a heavy penalty. The deficiencies had not happened as the result of any niggardly or cheese-paring policy on the part of the company. The St. Pancras Vestry controlled their own electric lighting, and they had experienced similar difficulties.

The MAGISTRATE (Mr. Plowden) said it was clear the company never contemplated, when it started, its future greatness, and when that fact became clear it made frantic and praiseworthy efforts to meet the emergency, efforts which had not been a complete success. As Mr. Manisty, on behalf of the local authorities, had agreed to the suggestions made by Mr. Muir, the summons would stand adjourned for three months.

TRADE NOTES AND NOTICES.

[Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week]

NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers, or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London:—

NOW READY.

"The Electrician" Electrical Trades' Directory and Handbook for 1899.—The *Second Edition* of the "Big Blue Book" for 1899 is now ready. The volume contains the large Sheet Tables of Electricity Supply Stations and Electric Railways and Tramways. The price of the Directory and Handbook is now reduced to 5s. post free 5s. 9d.; abroad, post free, 6s. 6d. (United States 7s. 6d).

"SUBMARINE CABLE-LAYING AND REPAIRING."—By H. D. Wilkinson, M.I.E.E., &c., fully illustrated; price 12s. 6d. This work gives a detailed technical summary of modern practice in manufacturing, laying, testing, and repairing submarine telegraph cables.

"PRACTICAL NOTES FOR ELECTRICAL STUDENTS."—By Messrs. A. E. Kennelly and H. D. Wilkinson. Price 6s. 6d., post free. The authors give in a clear and concise manner a good summary of the general principles of electrical science.

"MAGNETIC INDUCTION IN IRON AND OTHER METALS."—By Prof. J. A. Ewing. Price 10s. 6d., post free. *New Edition nearly ready.*

"THE INCANDESCENT LAMP AND ITS MANUFACTURE."—By Gilbert S. Ram. Price 7s. 6d., post free. The principles underlying the manufacture of the incandescent lamp are carefully and fully dealt with in this volume.

"THE STEAM ENGINE INDICATOR AND INDICATOR DIAGRAMS."—Edited and enlarged by W. Worby Beaumont. Price 3s. 6d., post free. This work is a concise guide to the objects, construction, and use of the steam engine indicator and to the interpretation of indicator diagrams.

"THE ART OF ELECTROLYTIC SEPARATION OF METALS."—A second issue of Dr. Gore's book is now ready, price 10s. 6d., post free. The author treats fully both the theoretical principles of the art of electrolytic separation of metals and the practical rules and details of technical application on a commercial scale. The work is adapted to the use of the manufacturer as well as the student.

"THE MANUFACTURE OF ELECTRIC LIGHT CARBONS."—A Practical Guide to the establishment of a Carbon Manufactory. Fully illustrated, price 1s. 6d.; post free, 1s. 9d. In this work the author gives useful hints as to the manufacture of electric light carbons, including the preparation of material, firing, saturating, and coring, together with a description and estimate of cost of the plant required.

"THE CENTENARY OF THE ELECTRIC CURRENT, 1799-1899."—By Dr. J. A. Fleming. Price, paper covers, 1s. net, post free 1s. 3d.; strong cloth, 2s. 6d., post free.

"LOCALISATION OF FAULTS IN ELECTRIC LIGHT MAINS."—By F. C. Raphael. Price 5s., post free. The book deals with the important subject of localising faults in electric light and power cables; and the various methods of insulation testing are here collected and discussed.

"MOTIVE POWER AND GEARING FOR ELECTRICAL MACHINERY."—By E. Tremlett Carter, C.E., M.I.E.E. Price 12s. 6d., post free. In this comprehensive work an account is given of the scientific principles and modern practice in the use of engines for dynamo driving, not only for isolated power plants, but also for public electric lighting and power stations. The various forms of gearing in the power station and for electric motors are also dealt with; and the book contains, in addition, numerous tables giving exact data of the equipment and working of electric power stations.

"THE MANUFACTURE OF CARBONS FOR ALL ELECTRICAL PURPOSES."—by Francis Jehl. 10s. 6d., post free. This is a practical handbook giving a complete description of the art of making carbons for electric lighting, electrodes, &c., with particulars of the various gas generators and furnaces used in carbonising. The work also contains particulars of the cost, &c. of erecting and working carbon works, and plans of a model factory.

"DRUM ARMATURES AND COMMUTATORS," by Mr. F. Marten Weymouth, also ready. Price 7s. 6d., post free. Prospectus on application. This is a complete treatise on the theory and construction of drum winding, and of commutators for closed coil-armatures, together with a *résumé* of the principal points involved in their design, and an exposition of armature reactions and sparking.

"WIRELESS TELEGRAPHY: SIGNALLING ACROSS SPACE WITHOUT WIRES BY ELECTRIC WAVES." A Review of the Work of Hertz and his Successors.—By Dr. O. J. Lodge, with a large number of illustrations. New and Enlarged Edition, 5s. nett. *Now ready.*

"ELECTROMAGNETIC THEORY."—By Oliver Heaviside. *Vol. I.*, 12s. 6d. *Vol. II.*, 12s. 6d.

IN THE PRESS.

"THE ELECTRIC ARC."—By Mrs. Ayrton.

"SECONDARY BATTERIES, THEIR DESIGN AND MANUFACTURE."—By E. J. Wade.

"PRIMARY BATTERIES: THEIR CONSTRUCTION AND USE."—By W. R. Cooper. *Nearly ready.*

"PRACTICAL TELEPHONY."—By Dane Sinclair and F. C. Raphael.

"'THE ELECTRICIAN' WIREMAN'S POCKET-BOOK."—Edited by F. C. Raphael. *Nearly ready.*

TENDERS INVITED.

The *Barking* District Council invite tenders for the supply of two continuous-current transformers and switchgear, underground cables and roadwork, for their Creeksmouth extension. An advertisement contains further particulars, and copies of specification, &c., can be obtained at the offices of the clerk to the Council (Mr. Edwin H. Lister). Plans can also be inspected, but not obtained, at the offices of the consulting engineer (Mr. W. C. C. Hawtayne), 9, Queen-street-place, London, E.C., after Jan. 7. Tenders (addressed chairman of Council) must be in before noon of Jan. 23.

The Corporation of the city of *Melbourne* require tenders for the supply and delivery of plant and the superintendence of its erection, and the carrying out of the work in connection with the electric lighting of the city. The specifications include (1) boilers; (2) steam engines, dynamos, equaliser, booster, and switchboard; (3) feeders, mains, and arc light leads; (4) accumulators. An advertisement elsewhere gives further particulars, and copies of the specifications &c., can be obtained from the Agent-General for Victoria, 15, Victoria-street, London, S.W., on and after 28th inst. The specifications and drawings can also be seen at but not obtained from the office of Dr. A. B. W. Kennedy, 17, Victoria-street, S.W. Further information as to local conditions, &c., can be obtained up to Jan. 10 from Mr. A. J. Arnot (city electrical engineer of Melbourne), First Avenue Hotel, London, W.C.

The *Ilford* Urban District Council require tenders for (*a*) water-tube boilers, fittings, economiser, feed pumps, &c.; (*b*) pipe work, &c.; (*c*) engine, steam dynamos, motor and boosters; (*d*) batteries; (*e*) main switchboard and connections; (*f*) overhead travelling crane; (*g*) underground mains, conduits and roadwork; (*h*) arc lamps and posts; (*k*) station lighting. Copies of the specification, &c., can be obtained at the offices of Mr. J. W. Benton, clerk to the Council, Council Offices, Ilford, and further information can be had of Mr. W. C. C. Hawtayne, consulting engineer to the Council, 9, Queen-street-place, London, E.C. Tenders (addressed to the chairman) to be delivered before 12 noon of 20th inst. An advertisement contains some further particulars.

The *Newcastle-upon-Tyne* Corporation invite tenders for the construction of about 11 miles of double-track tramway—rails, fastenings and poles being supplied by the Corporation. An advertisement gives further particulars, and specifications, &c., may be

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inspected at the offices of the city engineer after Jan 3. Tenders (addressed New Tramways committee) must be in by noon of Jan. 24.

The *Belfast* Electric committee invite tenders for the supply and erection of 400 kw. steam dynamos. Specifications, &c., can be obtained on application to Mr. Victor A. H. M'Cowen, city electrical engineer, and tenders must be lodged at the office of the town clerk (Sir Samuel Black) by Thursday, Feb. 8. An advertisement contains further particulars.

The *Tunbridge Wells* Corporation invite tenders for a 400 kw. steam alternator. An advertisement contains further particulars. Specifications can be obtained on application to the borough electrical engineer (Mr. Horace Boot), and tenders must be sent in to the town clerk (Mr. W. C. Cripps) by 25th inst.

The *Sheffield* Electric Light committee invite tenders for the supply and erection of extensions to the steam and exhaust pipes, and an independent jet condenser. Specifications, &c, may be obtained from the engineer and manager (Mr. William Johnson), Commercial-street. Tenders, addressed to the town clerk (Mr. Henry Sayer), must be in not later than noon of 20th inst. An advertisement contains further particulars.

The *Aberdeen* Electric Lighting committee invite tenders for the supply of a 420 kw. direct-coupled continuous-current dynamo. Specifications, &c., from the city electrical engineer (Mr. J. Alex. Bell) after the 8th inst. An advertisement contains further information, and tenders must be sent in by 22nd inst.

The *Plymouth* Corporation invite tenders for the supply and erection of a 500 kw. high-speed steam dynamo, motor-generators, &c, 500 kw. high-speed steam alternator, 260 accumulator cells, four Lancashire boilers, and high and low-pressure, paper-insulated and lead-covered mains, &c. Further particulars are set out in an advertisement, and conditions, &c., can be obtained from the borough electrical engineer (Mr. John H. Rider), Prince-rock, Plymouth. Tenders must be delivered to the town clerk (Mr. J. H. Ellis) by Wednesday, 31st inst.

The *Companhia de Mocambique* invite tenders for plant for the electric lighting of Beira (Portuguese East Africa), including the monopoly for working same for 25 years. An advertisement contains further information, and full particulars can be obtained at the offices of the company, 13, Austin Friars, London, E.C., 45, Rua do Alecrim, Lisbon, and 7, Rue Lafayette, Paris.

The *Salford* School Board invite tenders for electric lighting of their new schools in Grecian-street North, Lower Broughton. Tenders (addressed chairman of Board) to the clerk by noon Jan. 8.

The *Tunbridge Wells* Corporation invite tenders for surface condensing plant for their electricity supply station. Tenders to Mr. W. C. Cripps, Town Hall, Tunbridge Wells, by Jan. 15.

The *Bermondsey* (London) Vestry invite tenders for the construction, supply, and erection of a dust destructor, with furnaces, flues, water-tube boilers, economiser, fans, and forced draught appliances. Tenders to Mr. F. Ryall, Town Hall, Bermondsey, before noon of Jan. 13.

The *Barnes* District Council invite tenders for the supply and erection of: (*a*) Boilers; (*b*) steam dynamos and switchboards; (*c*) storage batteries; (*d*) cables, &c. Tenders to Mr. J. Eustace Anderson, High-street, Mortlake, London, S.W., by noon of Jan. 9.

Tenders are invited for the erection of electricity station buildings at *Chiswick*, for the Aberystwith and Chiswick Electricity Supply Corporation. Tenders to Secretary, 3, Crown-court, Old Broad-street, E.C., by 15th inst.

The *Tunbridge Wells* Corporation require tenders for the enlargement of their electric lighting station. Tenders by 15th inst.

The municipal authorities of *El Ferrol* (Corunna), Spain, invite tenders for the concession for the electric lighting of the town for 15 years. Tenders by 17th inst. to el Secretario del Ayuntamiento.

The *Berga* (Spain) municipal Council require tenders for the electric lighting of the town for 20 years. Tenders by 18th inst. to el Secretario del Ayuntamiento.

TENDERS RECEIVED AND ACCEPTED.

The Sheffield Corporation have now, on the reiterated recommendation of the Lighting committee, accepted the tender of Messrs. J. Schofield, Sons and Co. for the construction of seven transformer chambers at £2,298. 1s. 6d. The matter was referred back about a month ago, on the ground that Messrs. Schofield did not pay trade union wages.

The Hammersmith (London) Vestry have accepted the tender of Mr. T. L. L. Hellyar for the wiring of the Vestry stables and depot in Fulham Palace-road.

Yesterday the sub-committee of the Glasgow Corporation which has considered the tenders sent in for the supply of tramway cables reported that, having discussed a report on the sample cable submitted by the three lowest tenderers, and also a letter from the National Conduit and Cable Co. (Ltd.) offering to extend the guarantee of their cables from five years, as mentioned in the specification, to ten years, the sub-committee agreed to recommend the acceptance of the offer of the company, it being the lowest price—viz., £150,617. 0s. 11d. This recommendation was unanimously adopted by the Council.

BUSINESS NOTICES.

Mr. Bernard P. Scattergood, late head of the electrical testing department of Messrs. John Fowler and Co. (Leeds) (Ltd.), and Mr. Claude Johnson, jun., late of Messrs Johnson and Phillips, have entered into partnership as electrical engineers at Westminster Buildings, East-parade, Leeds.

Messrs. G. E. Meek and J. T. Davies (trading as Meek and Davies), electrical engineers, &c., 15, Hill-street, Dorset-square, London, N.W., have dissolved partnership. Debts by Mr. J. T. Davies.

The partnership between Mr. Charles Jennings and Mr. George Schultz, trading as Chas. Jennings and Co., 90, Cannon-street, London, E.C., has been dissolved by mutual consent. The business will be continued by Mr. Schultz under the style of Geo. Schultz and Co.

The offices of Messrs. J. C. Lyell and Co. have been removed from 55 to 53, Victoria-street, London, S.W., the stores remaining at 55 as hitherto.

APPOINTMENTS VACANT AND FILLED.

The Council of the Borough of West Ham invite applications for a meter inspector for their electricity department. An advertisement contains further particulars, and forms of application may be obtained at the offices of the borough electrical engineer (Mr. J. K. Bock), Central Station, Abbey-road, West Ham. Applications must be lodged with the town clerk (Mr. Fred. E. Hilleary), by Jan. 15.

An outside assistant is required for the Hull electricity works. Applications to the city electrical engineer (Mr. A. S. Barnard). See advertisement.

A switchboard attendant is required for the Wakefield electricity works. An advertisement contains further particulars, and applications must be sent in to the city electrical engineer (Mr. Robert Blackmore) by 9th inst.

The Brighouse Corporation invite applications for the position of consulting electrical engineer to the borough. Applications to Mr. James Parkinson, Municipal Offices, before Jan. 10.

An assistant lecturer is required for the physics department of the Technical College, Huddersfield. Applications to principal.

The Bury St. Edmunds Corporation have appointed Mr. A. H. Roe, of Bradford, as resident electrical engineer at a commencing salary of £150 per annum, increasing to £185 after six months. Mr. Roe will assume his duties about the middle of February, when the committee hope to have completed the electricity supply works.

Mr. F. G. Poulton, who has acted as clerk of the works during the construction of the Hereford electricity works, has been appointed resident electrical engineer, at a salary of £150 per annum.

Mr. J. M. M'Elroy, at present secretary of the Tramways committee, has been appointed general manager of the Manchester tramways department, at £400 per annum.

BANKRUPTCIES, LIQUIDATIONS, &c.

At a meeting of Nalder Bros. and Co. (Ltd.), at 101, Southwark-street, London, S.E., on Dec. 12, it was resolved that the company, having attained the object for which it was formed, be wound up voluntarily, and that in the distribution of assets each shareholder shall receive one share at least in the Langdon-Davies Electric Motor Co. (Ltd.) for each share held in Nalder Bros. and Co. (Ltd.), and that Mr. F. B. O. Hawes be appointed liquidator. These resolutions were confirmed at a subsequent meeting. The liquidation does not affect in any way the instrument business formerly carried on by the firm at Red Lion-street, Clerkenwell, E.C., and now at Prince's-mews, Gt. George-street, S.W., London.

The first meeting of the creditors of F. B. de Fos Paynter, electrical engineer, 2, Faversham-road, Catford (trading at 5, Roman-road, Chiswick), will take place on 10th inst., at 24, Railway Approach, London Bridge, S.E, and the public examination on 30th inst., at the Court House, Burney-street, Greenwich.

Personal.—Mr. C. P. Sparks, chief engineer to the County of London and Brush Provincial Co., has been appointed consulting engineer to the Richmond (Surrey) Electric Light and Power Co.

Electric Bells and Accessories.—Messrs. Coxon, Schmahl and Burrell, 18, Grainger-street, Newcastle-on-Tyne, have just issued a neat catalogue of electric bells and accessories manufactured by J. Buscher, of Solinjen, Germany, for whom the first-named firm are sole agents. A number of artistic designs of fancy pushes are included in this list.

Westinghouse Plant.—Circulars 1,005-6-7-8-9 relating to Westinghouse plant are to hand. These circulars describe and illustrate multipolar generators and motors for direct-current lighting and power, lightning arresters for alternating and direct-current circuits,

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direct-current series arc lighting generators, belt-driven single-phase alternators, and belt-driven polyphase alternators.

Damp-proof Fittings.—Messrs. John Davis and Son, of Derby have introduced alterations and improvements on the earlier type of their damp-proof switch, cut-out, junction box, and ceiling rose fittings, which have now been made more decorative than formerly, and are suitable for inside as well as outside work. For interior purposes the cover is polished brass, and for cellars, stables, and out-

Wall Plug.

Switch

side work generally is made up in cast-iron, enamel painted. Our illustrations show the wall plug and switch fittings, which are provided for two wires; but all these fittings are constructed for installations where the wiring is contained in tubes, the tube itself being screwed into the fittings. The switch and cut-out are made for any voltage up to 250.

Calendars.—The Eastern Telegraph Co. have just issued a very useful and interesting pocket companion, bound in bright red. In addition to particulars of the company's cable routes and collecting offices and a calendar for 1900, the rates for telegrams to all parts of the world and the times when these messages can be accepted for various countries is given. There is also an excellent map showing the empires of the world and the cable system of the Eastern and associated companies

We welcome the always useful desk-pad and diary sent out by the Electrical Power Storage Co. This is an excellent form of advertisement, and in addition insures the owner against railway accident for £500. Useful postal information is given, and a mass of particulars relating to the various types of cells manufactured by the E.P.S. Co.

The Direct Spanish Telegraph Co. issue a hanging tear-off pad illustrated with the Spanish Arms and with portraits of the Queen-Regent and the young King of Spain. The calendar is well got up, and is very attractive.

An elaborate hanging calendar is issued by the Rugby Portland Cement Co., giving some excellent views of the company's extensive works at Rugby and some tablet illustrations of prehistoric flora and fauna.

A novelty in the way of calendars is sent us by Messrs. Julius Sax and Co. (Ltd.), 119, Coldharbour-lane, London, S.E., a firm which was established in the electrical industry as far back as 1855. The calendar takes the form of an imitation trembling bell set. Copies of the calendar can be obtained on request.

The Gloucester Wagon Co. forward the "Gloucester" Diary and Directors' Calendar for 1900, its fifth year of publication. This company has large dealings with the railway undertakings of the country, and the useful list of stations and junctions attended by the company's wagon-repairers introduces the diary, which is accompanied by a good deal of information relating to the city of Gloucester.

Messrs. Shand, Mason and Co., the fire engine experts, send a calendar for 1900, which is notable for giving a chronological list of the great conflagrations of the past. A pictorial display of the scene after the great fire at Cripplegate, London, in 1897, is given.

Hazell's Annual.—The 1900 issue of Hazell's Annual is to hand, and contains a great deal of new matter especially relating to politics and home and foreign affairs. New maps illustrate the new Alaska boundaries, the Anglo-French settlement in Africa, and the Transvaal war. A number of new biographies have been added, and the book has been brought up-to-date to the early part of December. Amongst the biographies is one dealing with the career of Mr. Marconi, who, we are informed, is "the inventor of wireless telegraphy," whatever that may mean. The place of Mr. Marconi's birth and the date of his birth are, we believe, both inaccurate. Also Mr Marconi's mother was not an Englishwoman. In a review of the year 1899, under the heading "Electricity," we are informed that "the London County Council are considering a municipal telephone system for the metropolis," that, "on the whole, electric traction appears to be making progress, but it would be unwise to indulge in sanguine expectations," that "a new and valuable electric lamp, the 'Nernst,' has been invented (presumably during 1899) *and is in extensive demand.*" No mention is made as to where these lamps are to be obtained. The Wehnelt interrupter is referred to as being a distinct step towards obtaining from continuous currents alternating currents of any desired high frequency. In a publication like "Hazell's Annual," where much of the matter is, notwithstanding extreme compression, well edited, it would be well if the scientific and extra-technical portions were given over to experts to compile or revise. For instance, the above items taken after but a very cursory glance, show that the writers have the facts at hand, but their method of presentation is a slovenly one. We have nothing but praise for the get-up of the book. The information is of the most varied and exhaustive character, and the labour of editing is in most respects excellently performed. The publishers are Messrs. Hazell, Watson and Viney, London. Price 3s. 6d.

"Cassier's Magazine."—The January issue contains articles on "The Union of Electric Lighting and Traction Plants," "Third-Rail Conductors for Electric Lines," "Power Losses in the Machine Shop," and "A Century's Progress in the Steam Engine."

Exhibitions.—The English Education Exhibition will be opened this (Friday) afternoon, at 3 p.m., by H.R.H. the Prince of Wales, at the Imperial Institute, London. Among the exhibits will be scientific instrument making, electrical wiring, engineers' pattern making, brass finishing, &c.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Dec. 23 to Jan. 2, with the ports of destination :—

Africa—Beira, £105 (telegraph material); Cape Town, £638; Durban, £1,329 (including £974 telegraph apparatus); East London, £180. *Argentina*—Buenos Ayres, £404. *Australasia*—Adelaide, £75 (telegraph material); Brisbane, £304; Fremantle, £3,807 (including £3,795 telegraph material); Melbourne, £343; Sydney, £818. *Belgium*—Antwerp, £130; Brussels, £191; Ostend, £209. *Brazil*—Rio Janeiro, £396 (telegraph material). *Canada*—Montreal, £47. *Ceylon*—Colombo, £31. *China*—Shanghai, £36. *Colombia*—Santos, £1,009 (including £644 telegraph material). *Egypt*—Alexandria, £77. *France*—Boulogne, £38. *Germany*—Hamburg, £214 (including £200 telegraph material). *Gibraltar*, £87. *Holland*—Amsterdam, £60; Rotterdam, £1,462. *Hong Kong*, £1,505 (including £830 (telegraph cable). *India*—Bombay, £121 (including £94 telegraph wire); Calcutta, £520. *Norway*—Christiania, £768 (including £354 telegraph cable). *Port Amelia*, £1,155 (telegraph material). *Portugal*—Lisbon, £83. *Russia*—Reval, £45; St. Petersburg, £317 (including £242 telegraph paper). *Siam*—Bangkok, £1,220. *Spain*—Pasages, £24. *Straits Settlements*—Singapore, £495 (including £347 telegraph material). *Sweden*—Gothenburg, £39 (telegraph wire); Stockholm, £180. *United States*—New York, £821 (including £809 telegraph apparatus). **Total (for 11 days), £19,278, against £8,163 (for six days) last year** (Dec. 23 to Jan. 3).

MUNICIPAL, FOREIGN, AND GENERAL NOTES.

Aberdeen.—At the next Council meeting the Gas and Electric Light committee will recommend the erection of an additional 700 H.P. steam dynamo at the electricity works.

On Tuesday the Corporation fixed the price of electric current for the ensuing six months at 6d. per unit for the first hour's daily maximum demand and 3d. after for lighting. For power the charges will be 3d. and 1d. respectively.

Bath.—The Local Government Board have sanctioned the borrowing of an additional £25,000 for electric lighting purposes. Application was made for a loan of £26,000, but the Board had deducted £1,000 in respect of the provision for fittings, as they considered the cost of these should not be defrayed out of borrowed money. The loan has been sanctioned on the understanding that no part of it is to be expended on the provision of incandescent lights, and that no payments are to be made out of it to any salaried officer of the Corporation. Before a further application for a loan for electric lighting purposes will be entertained, the Board will require a statement to be furnished showing how the present loan has been expended. The loan has been granted for a period of 25 years instead of 50, the period asked by the Council.

Birmingham.—The formal transfer of the undertaking of the Birmingham Electric Supply Co. to the Corporation took place on Monday, when a cheque for £420,000, the amount of the purchase price, was handed over to the representative of the company. The Corporation also take over the staff of the company, and Mr. J. C. Vaudrey becomes city electrical engineer.

Blackpool.—At the Council meeting on Tuesday it was decided to borrow a further sum of £6,000 for new electric tramcars.

Bootle.—The Corporation are making experiments in street lighting and in the first instance have decided to place 10 ampere arc lamps on the columns in Stanley-road and two 32 c.p. incandescents on alternate columns, the arc lamps to be lighted until midnight and the incandescent lamps after that hour. The

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estimated cost of the new main and feeder required for the public lighting and the Linacre Hospital lighting is £2,500, and the estimated revenue £183, besides that from private consumers.

Boston.—The Council have sealed the application to the Board of Trade for a provisional electric lighting order.

Brighouse.—The Council are recommended to put down refuse destructor works in connection with their electricity works.

Bristol.—A report from the Electric Lighting committee was presented at the meeting of the Corporation on Monday, recommending extensions of the electricity supply undertaking at an estimated cost of £145,150, sanction for the borrowing of which was to be sought. The chairman (Ald. George Pearson) referred to the proposal to acquire land near the Feeder-road for the purpose of erecting a new generating station. He said it was now proposed to ask the Council to grant the money for equipping a small portion of the land with the necessary plant to meet coming requirements. The committee proposed to erect a building about 220ft. by 180ft., with one chimney, and to place there two machines of 1 000 H.P. each. Their engineer (Mr. H. Faraday Proctor) had advised them that these larger units were more economical. On Dec. 22 they had the equivalent of 81,196 8 c.p. lamps connected, an increase of 18,117 for the year. The increase in revenue kept pace with the increase in lamps. They began with a revenue of £6,452 in the first year, but last year it was £20,132, the estimated revenue for the present year being £32,785. They must also take into account that they had made a reduction in the price of current of 15 per cent. to private consumers and 30 per cent. for public lighting It was therefore necessary, in view of the continued demand, to make provision for 1901 and 1902. In March, 1901, their Temple Back station would be fully loaded, and in order to provide for the demand it was necessary that they should begin the proposed extensions as early as possible. They had been in existence for six years, and had had five loans in that time. That was not a wise policy, because it sometimes meant the necessity of giving an order before consent of the Local Government Board had been obtained. The report was adopted after a brief discussion, during which the electric light was turned on for the first time in the chamber.

Buenos Ayres.—The Anglo-Argentine Tramways Co. has asked the Municipal Council to authorise the conversion of the tramways into electric lines.

Burgess Hill.—No tender has been submitted in response to the District Council's invitation for offers for the establishment of electricity works in the district.

Bury St. Edmunds.—The Electric Light committee anticipate being in a position to supply electric current in the last week of February or first week in March. As in most other cases, there has been some delay in the completion of the work owing to difficulty in getting delivery of machinery.

Chelmsford.—To electrical men interest in the city of Chelmsford centres round the extensive works premises of Messrs. Crompton and Co. (Ltd.). This company takes a particular pride in its workpeople and their surroundings, and some very pleasant and happy gatherings are held in connection with the Arc Works employés and their families. Christmas, 1899, will be well remembered in this respect, as nearly 800 persons—young, middle-aged, and elderly—were entertained in the Corn Exchange, the company including the mayor and mayoress, Mr. F. R. Reeves (general manager of the company) and Mrs. Reeves and daughters, the Misses Crompton, Mr. and Mrs. Brunton, Mr. A. H. Pott, Mr. T. J. D. Cramphorn, and many others. Mr. Crompton was unfortunately unable to be present, owing to an engagement with the Electrical Engineers Volunteer Corps, in the successful organisation of which he is so deeply interested. Among the features of the entertainment was a baby show. The thanks of the large assembly were later warmly accorded to Messrs. Crompton and Co.

Croydon.—An inquiry has been held here into the application of the Corporation to borrow £25,000 for electric lighting. There was no opposition. The Board of Trade has sanctioned a loan of £50,000 for purchasing the undertaking of the Croydon Tramways Co. The lines are to be equipped electrically, and the necessary powers are being applied for.

Dover.—There was a profit of over £2,000 on the working of the municipal electric tramways during the past year.

Dufftown (N.B.).—Proposals for the erection of electricity works have been submitted to the Burgh Commissioners by Messrs. Townsend and Morton. The scheme will be considered at the next meeting of the commissioners, and in the meantime a canvass is to be made in order to ascertain the support likely to be accorded the project.

Electric Organ.—A new organ has been erected at the Eastbourne Presbyterian Church by Messrs. Bryceson Bros. Electricity is employed for blowing the organ, current being taken from the town mains.

Glasgow.—A dense fog prevailed in the city on the 27th ult., when 46,000 units of electric current were supplied, against 28,000 units on the corresponding day last year.

At the Corporation meeting yesterday (Thursday) a statement by the general manager of the tramways (Mr. John Young), that it was impracticable to undertake the Alexandra-parade electric tramway extension at present, was received. The matter is, however, to be further considered by the committee.

Grantham.—The Council have consented to the application of the Urban Electric Supply Co. for a provisional order.

Halifax.—The Tramways committee have been authorised to construct several additional electric tramway extensions.

Hammersmith (London).—The Vestry on Wednesday evening referred to their Electric Lighting committee a communication from the London County Council setting out the resolutions passed by the Council, as reported in *The Electrician* for Nov. 3, p. 61, and Dec. 22, p. 313. There is a strong opposition in Hammersmith to the introduction of the underground system of electric traction in King-street.

Hereford.—At present the equivalent of 1,654 8 c.p. lamps is connected to the electric lighting mains, and there are orders in hand for another 2,500.

Inverness.—The amended scheme of electricity supply, which has been prepared by Mr. E. G. Craven, has been accepted by the Council, and provides for the erection of steam-driven plant. The total estimated cost is put at £25,000. Tenders are to be lodged within three weeks.

Leeds.—The Briggate-Chapeltown and Boar-lane to Headingley electric tramway routes were opened for traffic on Wednesday.

Leigh (Lancs.)—The electricity supply works were formally opened on Tuesday afternoon. Current is supplied on the three-wire system at a pressure of 440 volts, and the total cost of the installation has been slightly over £10,000. The charges for current are 7d. for the first hour's maximum demand and 2½d. after. The question of constructing electric tramways is under consideration.

Leyton.—The Council have made application to the Local Government Board for sanction for a floating loan of £5,000 for extensions of electric lighting mains, &c., as occasion may arise.

Light Railways.—An inquiry will be held at Bath on Monday into the application of the Corporation to construct light (electric) railways in the district, and also into the application of the syndicate who wish to obtain powers for constructing light railways in the city and adjacent districts. Among the members of the syndicate are Sir James Sivewright and Mr. L. Hirsch.

An inquiry will be held on Friday next into the application of Mr. Thomas Nevins for power to extend the Cheltenham-Cleeve electric tramway.

Malvern.—A report from Mr. Robert Hammond on the question of electricity supply was considered at the Council meeting on Tuesday. Mr. Hammond advised the erection of electricity works, which would entail an estimated initial outlay of about £30,000. A loss of £200 per year was anticipated for the first three years, but a profit of £355 would probably be made in the fourth year. Some opposition was offered to the proposal, and it was decided to call a town's meeting to discuss the proposal.

Mansfield.—The Council will probably oppose the application to the Light Railway Commissioners for the construction of a light (electric) railway in the district. The Council have had before them a report from their consulting engineer (Mr. R. Quin) as to the proposal to establish electricity supply works, and a meeting is to be held on the 10th inst. with the promoters to discuss the objections to the proposed railway.

Monmouth.—Owing to the increased demand for electric current for private lighting, the Corporation have decided to put down additional machinery.

Private Bill Legislation.—A bill has been deposited which seeks power to incorporate a company for the supply of electricity in the county of Lancaster except the portion north of the river Ribble. The company is to be known as the Lancashire Electric Power Co., and will have a share capital of £3,000,000 in £10 shares, with borrowing powers of £1,000,000. The shares may be divided into preferred and deferred half shares. The first directors, who are also promoters, will be Messrs. W. Paul, W. B. Hopkins, N. Scott Russell, G. B. Samuelson, R. P. Sellon, F. E. Gripper, W. P. J. Fawcus, and four others to be nominated by the above. It is proposed to erect four generating stations. The bill provides that nothing in the Act shall confer upon the company any exclusive rights to supply electricity within the area of supply, nor shall the company at any time hereafter, by reason of any competitive supply, be entitled to any compensation. The profits are to be regulated by a sliding scale on a 10 per cent. basis, and the company are to be entitled to pay an additional 1 per cent. above 10 per cent. in respect of every 5 per cent. charged below the maximum rate per unit allowed by the bill.

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The *South Wales Electrical Power Distribution* bill seeks power to incorporate a company, with a share capital of £750,000 in £10 shares (with the right to divide them into preferred and deferred half-shares), and also authority to raise a further £250,000 by the creation of debenture stock. The first directors will be Sir W. T. Lewis, Messrs. E. P. Martin, R. Forrest, A. Hood, A. T. Walker, A. Keen, E. W. Richards, T. F. Brown, and two other persons to be nominated by them. The proposed area of supply is to be the whole of the county of Glamorgan and so much of the county of Monmouth as lies to the west of the river Usk, including Cardiff, Swansea, and Newport. The company is not to supply electricity, except to wholesale consumers, within the district of any local authority already authorised to provide electricity supply, unless with the written consent of such local authority. Three generating stations are to be erected—viz., in Llantwit Fardre, in Panteg, and in Neath. Clauses as to exclusive supply and profit similar to the last bill are also included.

A discussion arose at the last meeting of the Glamorgan County Council on the above scheme. The Parliamentary committee recommended the Council to obtain expert advice on the subject. Ald. T. J. Hughes said the Council should strengthen the Parliamentary committee, and he hoped they would not adopt a parochial or insular view. Some very small local authorities in the county had obtained Parliamentary powers, but did not exercise them, and these small authorities cried out in alarm when some company was established to compete with them. Small authorities had no right thus to deprive the public of the advantages of electricity. The Swansea Corporation have already decided to oppose the bill.

The *Tyneside Electric Power Co.* seek to incorporate a company for supplying electricity within an area comprising the city of Newcastle, the boroughs of Tynemouth, South Shields, and Jarrow, the urban districts of Willington Quay, Gosforth, Wallsend, Walker, Newburn, Benwell, and Fenham and Weetslade, Blaydon, Whickham, Felling, Hebburn, and Ryton, and the rural districts of Tynemouth and South Shields. It is provided that the company shall not give a general supply of electricity within the city of Newcastle on-Tyne, nor obtain the exclusive right to supply electrical energy within the area of supply. The capital is £500,000 share capital and £166,666 debenture stock. The former is to be divided into 50,000 £10 shares, with the right to subdivide these shares into preferred and deferred half-shares. It is intended to erect generating stations at Wallsend, Hebburn, and Whickham.

The *Liverpool Overhead Railway Co.'s* bill seeks power to construct two short extensions of the line of an aggregate length of just over a mile. The company also proposes to widen the railway near Pierhead station, and power is sought to raise £120,000 additional share and £40,000 further loan capital.

The bill of the *Manchester City Railway Co.* seeks to incorporate the company with a share capital of £2,000,000 (with borrowing powers amounting to £660,000) for constructing a railway 6⅞ miles in length, commencing in Etchells by a junction with the Warrington and Stockport Railway and the Cheshire Lines Committee, near Northenden station, and terminating in Manchester by two junctions with the Manchester and Leeds extension line of the Lancashire and Yorkshire Railway. The period required for the construction of this railway is five years. Power is also sought to enter into agreements with the six companies comprising the Cheshire Lines Committee, or any one of them, for the construction and management of the railway and the supply of rolling stock and plant, and also empowers these companies to subscribe towards the capital of the company. The promoters are Messrs. J. G. Groves, S. L. Gibbon, B. Worthington, J. W. M'Connel, J. W. Howard, and C. Sacré, who, with three other persons to be nominated by them, are to form the first board of directors.

Under the bill deposited by the *South Staffordshire Tramways Co.* it is proposed to confer powers upon their lessees, with the consent of the local authorities, to reconstruct and adapt the tramways for electric traction. The bill also proposes to confirm an agreement for the sale to the Walsall Corporation of the company's undertaking within that borough for £18,500. The purchase is to be completed on Dec. 31 next, and on Jan. 1, 1901, the Corporation agree to lease the lines to the lessee company. Power is also sought to enable the company to sell to any local authority the whole or any portion of the undertaking within the district of such local authority, provided that no sale shall be made unless a lease of the undertaking purchased shall be granted to the company's lessees. The lessees are the South Staffordshire Tramways (Lessee) Co. (Ltd), formed in July, 1899, by the British Electric Traction Co., with the object of taking a lease of these lines.

The *Wirral Railway Co.* have deposited a bill, the preamble of which recites that their railways could be more satisfactorily and economically worked by electricity in addition to or in substitution for steam. The bill proposes to confer power to work the lines by electricity, and for that purpose the company propose to create £180,000 additional capital, with the right to raise a further sum of £60,000 by debentures. The company and the Mersey Railway Co. are to become joint owners of any generating station, and in the event of an agreement being made for the joint use of generating stations, it is proposed to vest the property in a joint committee to be called the Mersey and Wirral Electrical Joint Committee. The company may enter into agreements with the Wallasey District Council, the Birkenhead Corporation, or other public body for the supply of electricity.

The bill of the *Huddersfield Corporation* seeks authority to raise £261,203 for the construction of tramways and £139,147 for the electrical equipment of lines, &c. The new tramways (15 in number) will have a total length of about 23 miles.

Under the *Scarborough Corporation* bill power is sought to raise such a sum as may be required for the purchase of the undertaking of the Scarborough Electric Supply Co., and £32,000 for the construction of tramways.

The *Halifax Corporation* seeks authority to raise £326,800 for tramway purposes and £100,000 for the electric lighting undertaking.

Provisional Order Transfer.—The Durham Corporation give notice of intention to transfer their provisional electric lighting order to the County of Durham Electrical Power Distribution Co. (Ltd.) Power to purchase after 12 years from December next at two years' notice is reserved.

St. Helens.—It appeared, from the minutes of the Electricity Supply and Tramways committee presented at the Corporation meeting on Wednesday, that the Board of Trade were willing, on certain conditions, to sanction the use of electric traction on the Peasley Cross tramway section. An inquiry will shortly be held by Mr. A. P. Trotter into the application to borrow £25,000 for electric traction.

St. Olaves (London).—The London Electric Supply Corporation have obtained the sanction of the District Board of Works for laying additional electric lighting mains, with inspection boxes, in Tooley-street, across Great Queen-street and the Tower Bridge-approach.

Shoreditch (London).—Plans for the proposed new generating station have been submitted by Mr. Manville, consulting engineer to the Vestry, and have been approved by the Lighting committee, who will shortly present a report. The extensive range of buildings in Provost-street, which have been erected by the Vestry as workingmen's dwellings, are to be wired for the electric light on the general request of the tenants.

Singapore.—In *The Electrician* for Aug. 19, 1898, also for Dec. 8 1899, we presented to our readers the position of affairs electrical at Singapore up to the month of October. A meeting of the Municipal Commissioners took place on Nov. 23, when it was announced that the Singapore Gas Co. had reconsidered its refusal to entertain a short contract, and had decided to accept a renewal for a period of two years. It appears probable that this will lead to the ultimate purchase of the company's works by the Commissioners. It is not to be supposed that this decision will be calmly accepted by those who urge that the time has come for the electric light to be introduced, and there is an agitation on foot to upset the latest decision of the Commissioners. In the *Straits Times* for Dec. 4 an interesting note reviews the situation and charges the Commissioners with a desire to purchase "the decaying plant of a dying light"—which is very neatly put. This scandalous waste of public money is creating considerable discussion, and may prove a blessing in disguise, for it will undoubtedly lead to the whole matter being publicly considered.

Southampton.—The electric tramways between Shirley and Southampton were officially inspected by Mr. A. P. Trotter on Saturday.

Stourbridge.—The Council will oppose the application of the Midland Electric Corporation for Power Distribution for a provisional order.

Sudbury.—An electricity supply scheme is under the consideration of the Council, who have lodged an application with the Board of Trade for a provisional electric lighting order.

Sunderland.—The tramways, which are being converted to the overhead trolley system, passed into the hands of the Corporation on the 1st inst.

Sydney (New South Wales).—The Municipal Council have adopted the report of their Electric Lighting committee, recommending that Messrs. Preece and Cardew be engaged to prepare an electric lighting scheme for the city at a fee of 1,000gs., and Major Cardew is to visit Sydney for the purpose of preparing the scheme. The Council have also decided to appoint a resident engineer to be nominated by Messrs. Preece and Cardew. The estimated capital outlay is put at £25,000.

Telephones at Glasgow—At yesterday's meeting of the Corporation a letter from the Postmaster-General was to have been considered, setting forth the conditions on which a licence will be granted for the establishment of a municipal telephone exchange. This item of the agenda paper was not, however, reached. The Postmaster-General points out that the following results are to be aimed at by the municipal licencee: (1) An efficient local service

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within the area covered by the licence; (2) easy access to the postal and telegraphic services of the Post Office; and (3) efficient intercommunication through the Post Office trunk wires between the subscribers to the exchange systems of other licencees and of the Post Office, and the subscribers in the area covered by the licence. The Postmaster-General has no objection to the rates proposed by the Corporation on certain conditions, and is willing to grant the licence from the earliest period in 1900 to Dec. 31, 1913. The specification by the Postmaster-General was submitted by the committee to Mr. A. R. Bennett, who, however, takes exception to several of the clauses. In regard to wires placed underground, the Postmaster-General says the copper to be used shall weigh not less than 20lb. to the mile for short junction and subscribers' circuits, and 40lb. to the mile for junction circuits which exceed two miles in length. Mr. Bennett objects that the National Telephone Co. use wire weighing 12·54lb. to the mile for such underground cables, and 40lb. for longer wires is a condition that is not imposed on the National Co., and a lighter wire serves every purpose. He holds that the Corporation would be handicapped by this condition. Mr. Bennett further asks that powers should be obtained to use any conducting metal except "iron" for the wires, owing to the high price of copper. In the matter of calling up the exchange and ringing off, the Postmaster-General says these operations should be effected by taking off and hanging up the telephone. Mr. Bennett opposes this method out and out, holding that it is an absolutely prohibitory one as regards upkeep, and in addition is about the most impracticable and worrying that could well be adopted. It was tried in Germany, and a change had to be made at great cost, on account of the expenditure on batteries being insupportable. The committee to whom the matter was referred, having considered the report, recommended the Corporation to acquiesce in the Post Office proposals, provided the representations in Mr. Bennett's letter were given effect to. The committee have also considered a letter from the National Co., in which the manager offers to come to Glasgow to give any further information in his power. Before accepting this offer the committee ask if the National Co. are prepared to consider any modification of the rates at present charged, and those proposed in the letter of the company referred to.

Telephone at Manchester.—The question of the Mutual Telephone Co.'s licence, the discussion of which was deferred from Dec. 6, was resumed on Wednesday. A reference to our issue of Oct. 27, p. 25, will show that the Council, at its meeting on Oct. 25, gave preference to a proposal for a municipal exchange for Manchester, and this in spite of its previous more or less general support of the Mutual Co.'s application. It was this see-saw policy of the Corporation which was being discussed on Dec. 6, when the further consideration of the matter was adjourned. Since that time correspondence has passed between the Post Office and the Corporation on the subject of the establishment of a competitive telephone service in Manchester and the neighbouring districts. In a letter dated Jan. 2, 1900, the secretary of the Post Office (Sir G. H. Murray) informs the Corporation that a licence, terminating in 1911, was granted to the Mutual Co. on Dec. 30, 1899, authorising them to transact telephone business in the borough of Salford and in the urban districts of Moss Side, Wilmslow, Stretford, Audenshaw, Gorton, Altrincham, Sale and Swinton and Pendlebury, but not in any other parts of the Manchester area. The Postmaster-General (the letter stated) decided to grant this licence only on receipt of urgent representations that it was necessary for the continuance of the operations of the company that a licence should be obtained on or before Dec. 31, and also on receipt of resolutions of the authorities of the various localities included in the licence in favour of the company's application. In view, however, of the present general uncertainty as to the best mode of providing a new telephone exchange system in the Manchester area, the Postmaster-General has inserted a special condition reserving to himself the right of revoking the licence wholly or in part at any time before 1911.

The letter to the Mutual Co., in which the granting of the licence is announced, sets out that—

Under the Telegraph Act, 1899, the Postmaster-General is prohibited from granting a telephone licence to a company, save with the consent of the local authority for each part of the area in which it proposes to carry on business. When, therefore, the company recently applied for a licence for the Manchester exchange area, the Postmaster-General required the production of satisfactory evidence that the Corporation of Manchester and the other local authorities consented to the grant of such a licence. The result was to show that, while the important county borough of Salford and the authorities of many of the districts round Manchester were favourable to the application, the City Council of Manchester rejected a resolution of consent in favour of one for inquiry into the question of telephonic supply to the city, and instructed a committee to report on the subject. . . . . The company, however, have pressed the Postmaster-General to grant them a licence for Salford and the other districts which have consented to the company's application before the end of the year, on the ground that the subscription for shares in the company was conditional on the obtaining of a licence on or before Dec. 31, 1899. It appears to the Postmaster-General that the position of the Mutual Co. is radically changed when it ceases to enjoy the definite support of the Corporation of Manchester. At the same time the Postmaster-General recognises the exertions of the founders of the company to improve telephonic communication in Manchester, and he would gladly facilitate the operations of the company, so far as he can do so consistently with the promotion of a really effective competition throughout the Manchester area. The Postmaster-General is of opinion that were he at this moment, while the course to be adopted by the city of Manchester is under the consideration of its Council, to grant an irrevocable licence to the company for an important portion of the Manchester exchange area he would be prejudicing the full consideration of the question how effective competition can best be established in the area. He is anxious that when the Corporation of Manchester, the central authority, shall have come to a decision the other local authorities should be able to consider the whole circumstances under conditions which would preserve their freedom to take such action as they might deem best; and in this view he thinks it necessary to reserve to himself the right of revoking, as to any district within the licensed area, any licence he may now grant, in order that the consideration hereafter of the most expedient course may not be prejudiced by any step which he may have now taken in consequence of the peculiar position of the company. The Postmaster-General having been informed that the company is prepared to accept a licence on these terms, such licence has now been executed by the Postmaster-General.

These letters having been read, the town clerk suggested that, in view of these communications, it was desirable for the Council to alter its course of procedure on the question. The Postmaster-General, it was true, had given a licence, but it was a licence that might be revoked on the representation of the Corporation or on representations by other local authorities.—Mr. Brocklehurst said he did not see that the letter conveying the promise of a provisional licence to the Mutual Co. altered the position of the Corporation in the slightest degree. It did not touch the vital point of municipal telephony and the question of the wisdom or unwisdom of the Corporation having full control of the streets. Mr. Alderman Higginbottom said he thought the memorial from the company should be considered along with the question of municipalisation, and that the whole matter should be referred to the Telephone committee, and this course was agreed to.

The Ruskin Hall Movement.—The Ruskin Hall movement is gradually working its way onward. Ruskin Hall, Oxford, although not officially connected with the University, has been founded so as to bring some of the exceptional advantages of Oxford within the reach of working men. It is not intended that a man should rise out of his class to swell the already crowded professional classes. The hope of the institution is that each man, by raising himself, may help to raise, through influence or precept, the whole class to which he belongs. The subjects on which special emphasis is laid are English history, sociology, the law of the English constitution, present day institutions, political economy, industrial history, psychology, English literature, and others of a like nature. The work is carried on in two ways—by residence at Oxford and by correspondence, the latter system having been but recently introduced. Ruskin Hall is open all the year round. A year's residence is recommended, but students are accepted for so short a time as a month. Every student at Ruskin Hall is expected to work two hours a day at cooking, cleaning, &c., as no servants are kept. The cost of board and lodging is thus reduced to 10s. per week or £25 a year. Tuition and tutors' fees, 2s. 6d. a week. Arrangements are also made by which non-residents can also attend lectures. The system of correspondence is intended for men and women who cannot come into residence at Ruskin Hall. Persons wishing to become members should write to the general secretary, Ruskin Hall, Oxford. The fees for membership are 1s. entrance fee and 1s. a month. In addition, an endeavour is being made to form correspondence students into small classes. It is also proposed to found a Ruskin Hall in London and other large centres of population, and "extension" lectures are also to be given in various places. Further particulars of this movement, which deserves every encouragement, can also be obtained from the general secretary.

Tipton.—The Council have decided to acquire the tramways in the parish, and to proceed with their Bill to authorise the electrical equipment of the lines. There are about 6½ miles of tramway, and the total cost of the conversion is estimated at about £60,000.

Uxbridge.—The Council have approved the application of the Uxbridge Development Syndicate for a provisional electric lighting order. The consulting engineers are Messrs. Kincaid, Waller, and Manville, and electric current is to be supplied for public lighting at 3d., and for private lighting at 7d. per unit for the first 92 hours' maximum demand per quarter, and 3d. per unit after. The syndicate will undertake the wiring of premises in the district on the "easy" payment system of 1d. per unit, in addition to the maximum price, and ½d. on the reduced scale. The Council retain the right of purchase.

Water Power in Canada.—At a meeting of the Dominion Mining Development and Agency Co. (Ltd.) the chairman (Mr. E. Hart) said they had sold their interest in the cascade water power property. It required such a large amount of working capital—something like £130,000—that it was beyond their power to raise it, and therefore they thought it best to sell the property at a profit to the London and British Columbia Goldfields (Ltd.) That company was finding all the money required to keep the works going, and had also guaranteed the finding of the necessary working capital. It had also taken steps to obtain independent reports on the property, and a joint report had been made by Messrs. Kincaid, Waller and

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Manville, and the Hon. John Bogart, a well-known New York engineer, which went to show that when the full 6,000 h.p. was developed and the company was actually running, there would be a revenue which would show on the total capital of the company dividends of something like 25 per cent.

Wellingborough.—The application of the Electrical Power Distribution Co. for an electric lighting order has been approved by the Council, who have sealed the agreement with the company for the erection of electricity works.

Wigan.—The foundation stone of the electricity supply buildings was laid yesterday (Thursday) by the mayor (Councillor J. P. Gee). Current is being supplied from a temporary station.

Worthing.—The Local Government Board have sanctioned the application of the Council to borrow £32,500 for electric lighting out of the £36,900 recently applied for. The period of the loan is 25 years. The consulting engineers (Messrs. Burstall and Monkhouse) have been instructed to draw up plans and specifications preparatory to inviting tenders.

Wrexham.—On the recommendation of the Electric Light committee the Council, on Tuesday, accepted tenders for the supply of electricity generating plant. The full list of these tenders appeared in our issue of the 15th ult. Tenders are also to be invited for the erection of a destructor and electricity station buildings. Messrs. W. H. Trentham and G. R. Peers are consulting engineers.

Dinner.—The sixth annual dinner of members of the cable companies' staffs was held on Monday last. Mr. W. James (Commercial Co.) presided, and Mr. J. Salter (Great Northern Co.) occupied the vice-chair. The dinner was followed by a smoking concert, and a liberal collection was made for the Widows and Orphans Fund.

PATENT RECORD.

The following list of Applications for Patents and Specifications published has been compiled for this journal by Messrs. J. C. CHAPMAN and Co., *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs, and Trade Marks may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after the acceptance of the complete Specification. The names within parentheses are those of communicators of inventions. When complete specification accompanies application, an asterisk is affixed.*

December 2, 1899.

24,048. F. RITCHIE. London. Improvements in telautograph apparatus.*
24,049. L. E. WILSON. London. Improvements in intercommunication telephones.
24,058. W. BEIN. London. Improved means for carrying off the gase generated in electrolytic apparatus.

December 4, 1899.

24,085. R. F. HALL. Birmingham. Improvements in terminals and connections for electric cables and like conductors.*
24,095. T. D. CURTIS. Bucks. An improved lamp chimney for either oil lamps, gas or electric lights.
24,116 A. PERRIN. London. Improvements in electric accumulators.
24,126. A. WRIGHT and THE MUTUAL ELECTRIC TRUST (LTD.) London. Improvements in maximum demand indicators.
24,148. J. LEHNE. London. Improvements in electric furnaces for making glass and other analogous substances.*

December 5, 1899.

24,155. R. ALEXANDER. London. Improvements in regulating the light of electric incandescent lamps. (A. B. Vanes, Cape Colony.)
24,172. M. C. CLUTTERBUCK. Brighton. An improved form of mercury voltmeter or electric meter.
24,175. F. W. DICKINSON. Leeds. Improvements in or relating to electrically-propelled motor cars.
24,184. F. J. NEWMAN and J. LEDWINKA. London. Improvements in or relating to electrically propelled vehicles.*
24,195. G. HARRISON, of the firm of D. Young and Co. London. Improvements in and relating to thermostatic electric switches or pushes. (The Auto-Protective Appliance Co., of West Virginia' United States.)*
24,208. H. H. LAKE. London. Improvements in electrically-controlled locking mechanism for collecting and other boxes. (F. Williams, United States.)*
24,228. S. E. GUNYON. London. Improvements in conductors for electrical railways. (H. Privat, Germany.)*
24,230. I. L. ROBERTS. London. An improved anode or other electrode for use in electrolysis, and process of making same.*
24,231. B. KELLERMAN and B. KELLERMAN. London. A new or improved electrical massage rubbing or brushing apparatus.
24,244. E. H. BELDEN. London. Improvements in electric arc lamps.*

December 6, 1899.

24,269. A. MARR. Manchester. Improvements in and relating to electric incandescent lampholders.
24,273. J. E. FARROW. South Shields. Improvements in methods of quickly establishing connection, transmitting electric energy and telephonic messages between ships or ships and land, also on land.
24,297. J. B. RELIN and C. A. ROSIER. London. Improvements in accumulators.
24,300. T. H. NASH. London. Improved means for surfacing commutators of dynamos, electric motors, and the like.
24,308. L. MEUNIER and I. GOUSSET. London. Incandescent electric cooking and warming apparatus.
24,323. I. LAIN. London. Improvements in machines for bending or curving electrotypes and the like.
24,325. J. A. FLEMING. London. Improvements in electric arc lamps.*

December 7, 1899.

24,359. G. H. CHARD. London. Improved system of electric wiring.
24,370. G. G. F. WHITE and J. SHAW. Improvements in electric switches.
24,337. C. VAN DEVENTER. London. Electric lamp.*

December 8, 1899.

24,431. J. HARRIS. London. Electric rate indicators.*
24,437. THE BRITISH THOMSON-HOUSTON CO. (LTD.). London. Improvements in coin-controlled mechanisms. (F. P. Cox, United States.)*
24,438. THE BRITISH THOMSON-HOUSTON CO. (LTD.). London. Improvements in coin-controlled electric meters. (Charles E. Holmes United States.)*

SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1898.

24,570. RAWSON. Electric batteries.
24,727. PRICE. Apparatus for measuring a supply of electricity.
24,859. SIMMS. Electric sparking plugs for explosion engines or motors.
24,887. MILLAR. Electric alarm clock specially applicable for use in public works and other institutions.
25,895. EBBUTT AND VERITYS LTD. Electric switch or key lamp holders or sockets.
25,896. EBBUTT AND VERITYS LTD. Electric lamp holders or sockets.
27,269. MORDEY and BEVIS. Alternate-current arc lamps and lanterns.

1899.

200. THOMAS DAVIES. Enclosed arc lamps.
1,044. SLOAN and BARNES. Switches for electromotors and the like.
1,087. SCHINDLER. Regulable electric resistances.
1,141. WAGNER. Method of and means for deriving two or more alternating currents of different phase from a source of single-phase electrical supply.
2,176. SIEMENS BROS. AND CO. (LTD.) (Siemens and Halske Aktien-Gesellschaft.) Safety appliances in connection with overhead or exposed conductors of electrical railways and tramways.
2,177. SIEMENS BROS. AND CO. (LTD.). (Siemens and Halske Aktien Gesellschaft.) Method of supplying electrical energy to motor vehicles from two overhead conductors.
15,541. ATKINSON. Dynamo electric generators and motors.
17,939. BARKER (Lesem). Electric rock drills.
18,962. LINCKE-GRAF and GMUER-BENZ. Telephone registering apparatus.
20,486. JARAY. Electrical distribution switch and fuse boards.
20,720. FEENY (Allgemeine Elektricitäts Gesellschaft). Electric lamps having illuminating bodies composed of second-class conductors.
20,983. WOOD. Trolleys used on overhead wires for electric traction.

NEW COMPANIES, STATUTORY RETURNS, &c.

KEYNSHAM ELECTRIC LIGHT AND POWER CO. (LTD.)—This company was registered on Dec. 29 with a capital of £5,000, in £1 shares, to enter into an agreement with the liquidator of the Western Counties Electric Light and Power Syndicate (Ltd.) (Mr. H. Dyer), and to carry on the business of electricians, electrical and mechanical engineers, and suppliers of electricity for the purposes of light, heat and motive power. The subscribers are H. A. H. Daniel, W. R. Wansbrough, F. B. Bond, C. E. W. Barry, E. T. Collins, J. E. Mills, and G. J. T. J. Parfitt, electrical engineer. The directors are H. A. H. Daniel, H. R. Wansbrough, and F. B. Bond.

MUTUAL TELEPHONE CO. (LTD.)—The annual return to Dec. 13, 1899, has been filed. The capital is £250,000, in 50,000 shares of £5 each, of which 16,466 have been taken up. 6d. has been called up on each share, and £1,102. 15s. has been received, including £691. 2s. paid in advance on 6,911 shares.

SOUTHERN ELECTRICAL INSTALLATION AND WIRING CO. (LTD).—The annual return to Dec. 9 has been filed. The capital is £10,000, in £1 shares, of which 2 500 are Preference. 1,853 Preference and 3,493 Ordinary have been taken up. 15s. per share has been called up on 422 Preference and 2,824 Ordinary, resulting in the receipt of £2,339. 12s. 6d., leaving £31. 17s. 6d. in arrears. 1,431 Preference and 669 Ordinary shares are considered as fully paid.

WIRELESS TELEGRAPH AND SIGNAL CO. (LTD.)—The third ordinary general meeting of this company was held on Friday last at the offices, 28, Mark-lane, London, E.C. The directors' report was set out in our last issue. Major Flood Page, managing director, proposed that the meeting be adjourned till some date in January or February, as the directors were of opinion that it was very much in the interest of the shareholders that the meeting should not take place till a later date. The motion was adopted.

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CITY NOTES.

MEMORANDA.—Bank rate 6 per cent. (since Nov. 30, 1899). Price of silver 27 1/8d. per oz. (Jan. 4). Consols (2¾ per cent.) 98⅝—98⅝ for money, 98⅝—98⅞ for account; 2½ per cent. 96¼—96¾ (Jan. 4). Stock Exchange Settling Days: Consols, Feb. 2; Stocks and Shares Continuation Days, Jan. 10 and 24; Ticket Days, Jan. 11 and 25; Pay Days, Jan. 12 and 26; Mining Share Carry-over Days, Jan. 9 and 23.

COSTA RICA ELECTRIC LIGHT AND TRACTION CO. (LTD.)—A private meeting of this company was held on Wednesday.

ELECTRIC CONSTRUCTION CO. (LTD.)—The transfer books of the Four per Cent. Perpetual First Mortgage Debentures are closed from 1st to 13th inst. inclusive.

PERTH AND DISTRICT TRAMWAYS CO. (LTD.)—At the annual meeting the chairman (Mr. W. S. Ferguson) said it would probably be to the advantage of the town, seeing it was to adopt electric lighting, for it to take over the tramways. Whether the latter event happened or no, they must get electricity to draw their cars. If they did not sell the system to the town, they must in the near future themselves establish works. If the town did not buy, and the company had to adopt electric traction, they would be able to pay a much larger dividend than they could do under the old system.

STOCK EXCHANGE NOTICES.—Application has been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to the further issue of 8,020 ordinary £5 fully-paid shares (Nos. 50,081 to 60,100) of the *St. James' and Pall Mall Electric Light Co. (Ltd.)*, and also to allow the further issue of 565 £10 fully-paid shares (Nos. 205,994 to 206,558) of the *Western Telegraph Co. (Ltd.)* to be quoted in a special list.

UNITED LIGHT AND POWER CO.—The reorganisation committee of this company notify that the interest due Jan. 1, upon the Five per Cent. First Mortgage Gold Bonds and the Six per Cent. Consolidated Mortgage Bonds (to be divided) is payable at the National Provincial Bank of England, 112, Bishopsgate-street, E.C.

UNITED RIVER PLATE TELEPHONE CO. (LTD.)—The directors announce that the business of the company having continued to make satisfactory progress during the six months ended Sept. 30 last, they are justified in distributing an interim dividend for that period on the ordinary share capital at the rate of 5 per cent. per annum.

WESTMINSTER ELECTRIC SUPPLY CORPORATION (LTD.)—Capt. E. Ironside Bax has resigned the position of general manager to this company, and has been elected a director. Mr. L. H. Hordern, who has been assistant manager for some years, will succeed Capt. Bax as manag r.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount	Aggregate. Inc. or Dec.
	1899	£	£		£	£
*Birmingham Tramways.	Dec. 30	3,709	− 114	26	106,482	+ 10,172
Blackpool Corporation...	„ 28	156	+ 12	39	20,693	+ 4,266
Blackpool and Fleetwood	„ 30	213	− 3	26	20,297	+ 5,821
Bradford Corporation ...	„ 31	353	+ 62	..	...	...
Brisbane Trams	Nov. 15	1,645	+ 498	7	18,150	+ 5,720
*Bristol Trams & Carriage	Dec. 29	3,049	− 146	26	80,235	+ 8,219
*Buenos Ayres & Belgrano	Nov. 15	2,368	+ 649	48	104,153	+ 45,915
City & South London Ry.	Dec. 31	965	− 70	26	26,961	− 41
Dover Corporation	„ 30	158	− 35	39	8,198	+ 1,000
Dublin United	„ 29	3,109	+ 132	...	...	...
Dublin Southern Dist....	„ 29	665	− 121	...	...	...
*Glasgow Corporation ...	„ 30	8,507	+ 13	...	...	...
*Liverpool Corporation...	„ 23	7,213	+ 542	51	351,154	+ 41,747
Liverpool Overhead Rly.	„ 31	1,305	+ 14	...	...	...
*Sheffield Tramways	„ 31	2,090	+ 567	...	...	...
*South Staffs. Trams.....	„ 29	†1,021	+ 67	52	34,823	+ 1,680

* Partly electrical. † Nine days against eight days last year.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Dec. 27.	Price Wednesday, Jan. 3.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Jan. 3. Highest	Lowest
			TELEGRAPHS.			£ s. d.			
£110,900	100	4¾	*African Direct Telegraph 4¾ Mort. Deb. (red.) ...xd	100 104	99 103	3 17 8	January and July.....	...	...
25,000	10	..	Amazon Telegraph	3 4	3 4	...	June and December ..	...	...
£125,000	100	5⅞	Do. 5 per Cent. Debentures ..	85 90	85 90	5 11 1	...	...	...
£875,520	Stock	15/0	Anglo-American	63 65	64 67	5 2 11	Feb., May, Aug., Nov.	67½	67½
£3,062,240	Stock	30/0	Do. Preferred	111 113	114 116	5 3 5	„ „	115½	112½
£3,062,240	Stock	18/0	Do. Deferred	15¼ 16¼	17⅛ 17⅞	5 1 5	... ...	17⅝	16⅜
207,950	10	3/0	Western Telegraph (late Brazilian Submarine)	14 14½	14 14½	4 16 7	Mar., June, Oct., Dec.	14 1/16	14⅜
£75,000	100	5⅞	* Do. 5 per Cent. Debs. (2nd Series, 1900) ...xd	107 111	106 109	4 11 9	June and December ..	...	...
$10,000,000	$100	$2½	Commercial Cable Capital Stock	198 202	...	...	Jan., Apr., July, Oct.	...	...
£1,332,823	Stock	4⅞	* Do. 4 per Cent. Debenture Stock.....xd	100 103	101 104	3 16 11	„ „ „ „	102⅜	...
16,000	10	8/0	Cuba Submarine Ordinary	8½ 9½	8½ 9½	8 8 5	February and August	8⅝	...
6,000	10	10/0	Do. Preference 10 per Cent.	19 20	19 20	5 0 0	„ „	...	...
12,831	5	2/0	Direct Spanish Ordinary	4 5	4 5	4 0 0	April and October.....	...	...
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference	9 10	9 10	5 0 0	„ „	...	...
£30,000	50	4½%	Do. 4½ per Cent. Debentures.....xd	103⅞ 107⅞	101⅞ 105⅞	4 5 9	January and July.....	...	...
60,710	20	3 0	Direct United States Cable	11½ 12	11½ 12	5 16 8	Jan., Apr., July, Oct.	11 13/16	...
£120,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red.) ...xd	101 104	99 102	4 8 3	June and December ..	...	...
£4,000,000	Stock	5%	Eastern Ordinary	143 148	145 150	4 15 7	Jan., Apr., July, Oct	148	145
£1,795,000	Stock	3½%	Do. 3½ per Cent. Preference Stock	97 100	93 93	3 11 3	„ „	...	...
£1,432,268	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.).....	115 120	115 120	3 6 11	May and November ..	115	...
250,000	10	2/6	Eastern Extension	14½ 14¾	14½ 15	4 13 4	Jan., Apr., July, Oct	14⅞	14 1/16
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	116 121	116 121	3 6 7	February and August	...	...
£16,200	100	5%	* Do. 5% (Austln. Gov. Sub.) Deb.,1900 (reg.)xd	99 103	99 103	4 17 1	January and July.....	...	...
£64,400	100	5%	Do. (Bearer) .....xd	100 103	100 103	4 17 1	„ „	...	...
£17,400	100	5%	*Eastern and S. African 5% Mort. Deb., 1900 (reg.)...	99 103	...	...	„ „	...	...
£24,500	100	5%	Do. (Bearer)	100 103	...	...	„ „	...	...
£300,000	100	4%	* Do. 4 per Cent. Mortgage Debentures, 1909 ...	101 104	101 104	3 16 11	February and August	103	...
£200,000	25	4%	Do. 4 per Cent. Mauritius Sub. Debs.(red.) ..	101⅞ 104⅞	101⅞ 104⅞	3 16 10	May and November	...	...
180,227	10	1/9	Globe Telegraph and Trust	10⅞ 11½	10⅞ 11½	4 13 4	Jan., Apr., July, Oct.	...	...
180,042	10	3/0	Do. 6 per Cent. Preference	14⅞ 15½	14¾ 15¾	3 18 8	„ „	15	14⅞
150,000	10	5/0	Great Northern of Copenhagen .....ex Coupon 47	31 33	31 33	3 15 9	January and July.....	...	...
£86,300	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb.(red.)xd	100 103	99 102	4 8 3	...	...	...
17,000	25	12/6	Indo-European	48 52	48 52	4 16 2	May and November ..	52	...
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904 ..	106 109	106 109	5 10 1	March and September	...	...
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.) .. xd	102 105	101 104	3 16 11	June and December ..	...	...
11,839	8	4/0	Reuter's	7 8	7 8	5 0 0	April and October.....	...	...
3,381	£100 Cert.	6%	Submarine Cables Trust	125 130	125 130	4 13 0	„ „	...	...
15,609	10	...	West African Telegraph	2½ 3½	2½ 3½	4 9 3	December and July ..	...	...
£200,000	100	5%	* Do. 5 per Cent. Debentures (red.)	99 102	99 102	4 18 0	March and September	...	...
30,008	2½	...	West Coast of America	¼ 1	¼ 1	...	...	...	...
£150,000	100	4%	* Do. 4 per Cent. Debentures .....xd	102 105	100 103	3 17 8	January and July.....	102	...
88,321	10	6d.	West India and Panama	¾ 1⅛	¾ 1⅛	...	May and November ..	...	...
34,563	10	6/0	Do. 6 per Cent. 1st Preference	9½ 9¾	9½ 9¾	6 3 1	„ „	...	...
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	7⅞ 8½	7 8	7 10 0	„ „	...	...
£80,000	100	5%	* Do. 5 per Cent. Debentures .. xd	106 109	104 107	4 13 6	January and July.....	...	...
£389,731	Stock	4%	Western & Brazilian 4 per Cent. Debenture Stock xd	104 107	102 105	3 16 2	June and December ...	...	...
£158,100	100	6%	*Western Union 6 per Cent. Sterling Bonds (red.) ..	98 103	98 103	5 16 6	March and September	...	...
			TELEPHONES.						
44,000	£5	3/0	Chill Telephone (fully paid)	2 3	2 3	6 13 4	August	...	...
224,850	10s.	0/1½	Consolidated Telephone Const. & Manufacturing ...	⅛ ¼	⅛ ¼	4 15 3	July	...	...
72,680	1	0/6	Monte Video Telephone Ordinary	⅛ ¼	⅛ ¼	5 0 0	October	...	...
86,492	1	1 0	Do. 5 per Cent. Preference	¼ 1	¼ 1	5 0 0	...	...	...
490,000	5	3/0	National	4⅝ 4⅞	5 5½	5 14 3	February and August	5	4 13/16
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Preference ...	14 15	14 15	4 0 0	„ „	...	...
15,000	10	6 0	Do. 6 per Cent. Cumulative 2nd Preference ...	14 15	14 15	4 0 0	„ „	...	...
250,000	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref. ...	5⅛ 5⅜	5⅛ 5⅜	4 13 0	„ „	...	...
1,329,471	Stock	3½%	* Do. Debenture Stock 3½ per Cent. (red.) ...xd	100 102	98 100	3 10 0	June and December ..	99⅞	99
171,504	1	0/4	Oriental	¾ 1	¾ 1	5 0 0	April and October.....	...	...
58,000	5	2/6	United River Plate	4½ 5½	4½ 5	7 10 0	July	4¾	...
16,639	5	1/4	Do. 5% Cumulative Preference .....xd	3½ 3¾	4½ 5	5 0 0	...	...	...
£179,947	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)..... xd	105 108	102 105	4 15 3	June and December ..	...	...

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Dec. 27.		Price Wednesday, Jan. 3.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Jan. 3.	
								£ s. d.		Highest	Lowest
			ELECTRICITY SUPPLY COMPANIES.								
100,000	1	...	Bl'ckh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.)	¾	1	¾	1	...	...	...	...
6,000	10	7/9½	Bournemouth and Poole Elec. Supply Ord.	12	13	12	13	3 0 0	...	...	...
6,000	10	4/6	Do. 4½ per Cent. Cumulative Pref.	10	11	10	11	4 1 10	...	...	...
19,661	5	2/6	Brompton & Kensington Electricity Supply Ord.	7⅛	8⅛	7⅛	8⅛	3 15 0	...	...	...
12,000	5	3/6	Do. 7 per Cent. Preference	9	10	9	10	3 10 0	March and September	...	...
20,000	5	...	Calcutta Elec. Supply Ordinary (fully paid)	6½	7	6½	7	...	...	6⅞	...
30,000	5	4/0	Charing Cross & Strand Electricity Supply Corp.	9⅝	10⅛	9⅝	10⅛	4 5 9	February and August	...	...
20,000	5	...	Do. (Nos. 3,001 to 50,000)	9⅝	10⅛	9⅝	10⅛	...	...	...	...
20,000	5	2/3	Do. 4½ per Cent. Preference	5½	6	5½	6	3 15 0	" "	...	...
34,000	5	2/6	Chelsea Electricity Supply Ordinary	7⅛	8⅛	7⅛	8⅛	3 10 7	March	...	...
£100,000	Stock	4½%	* Do. 4½ per Cent. Debenture Stock (red.)	109	111	109	111	4 1 1	June and December	...	...
$1,200,000	$1,000	5%	Chicago Edison 1st Mort. 5% 30 year Gold Bonds (red.)	100	110	100	110	4 10 11	April and October	...	...
60,000	10	7/0	City of London Electric Lighting Ordinary	10	11	10	11	5 9 1	February and August	10⅜	10½
40,000	10	6%	Do. 6 per Cent. Cumulative Preference	13	14	13	14	4 5 9	January and July	...	...
£100,000	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	125	130	123	127	3 18 9	June and December	...	...
40,000	10	...	County of London and Brush Prov. Ordinary	10	11	10	11	...	...	10½	...
20,000	10	6/0	Do. 6 per Cent. Cumulative Preference	13	14	13	14	4 5 9	March and September	13⅛	...
£200,000	Stock	4½%	Do. 4½% Deb. Stock Certs. (all pd.) (red.)	110	113	107	110	4 1 10	...	...	...
15,000	5	10/	Kensington and Knightsbridge Ordinary	12	13	12	13	4 1 6	...	...	...
10,000	5	6%	Do. 6 per Cent. 1st Preference	7½	7¾	7½	7¾	3 17 5	January and July	...	...
110,000	3	...	London Electric Supply Ordinary	2½	2¾	2½	2¾	...	...	...	...
48,050	5	3/0	Do. 6 per Cent. Preference	5½	6	5½	6	5 0 0	...	...	...
£100,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures	102	104	102	104	3 16 11	Mar., June, Sept., Dec.	102	...
62,500	10	5/0	Metropolitan Elec. Supply Ord. (Nos. 1 to 62,500)	13	14	13	14	3 11 5	April and October	14	13¾
22,500	10	3/7½	Do. (Nos. 62,501 to 85,000)	13	14	13	14	3 10 0	...	...	...
£220,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage	117	119	116	118	3 16 3	June and December	...	...
£125,000	Stock	2¾/3	Do. 3½ per Cent. Mort. Deb. Stock (red.)	97	99	95	97	3 12 3	...	...	...
6,452	10	6/0	Notting Hill Electric Ordinary	15½	16½	15½	16½	3 15 0	March	...	...
10,000	5	5/0	Oxford Electric Ordinary	6¾	7¼	6¾	7¼	3 9 0	"	...	...
300,000	1	8/	Rand Electric	¾	¾	¾	¾	10 13 4	...	...	...
£130,070	Stock	5%	River Plate El. Lt. & Tr'ct'n, Ltd., 6% 1st Mor. Deb.	80	90	80	90	5 11 1	...	...	...
150,000	$100	$2	Royal Electric Company of Montreal Shares	160	180	150	170	4 14 2	...	...	...
£123,200	100	4½%	* Do. 4½ per Cent. 1st Mortgage Debentures	104	106	104	106	4 5 6	April and October	...	...
31,980	5	5/0	St. James's and Pall Mall Electric Ordinary	15	16	15	16	4 10 8	February and August	...	...
20,000	5	3/6	Do. 7 per Cent. Preference	9	9½	9	9½	3 13 8	" "	...	...
65,000	5	...	South London Electric Supply Ordinary (fully paid)	4½	4¾	4½	4¾	...	...	...	...
79,900	5	5/0	Westminster Electric Supply Ordinary	13½	14½	13½	14½	4 2 9	March and September	...	...
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
125,000	1	7½d.	Aron Electricity Meter 6 per Cent. Cum. Pref.	¾	¾	¾	¾	6 17 2	...	...	...
45,000	1	...	British Electric Works Co. Ordinary	14/6	15/6	14/3	15/6	...	...	...	...
50,000	1	...	Do. 5 per Cent. Cumulative Preference	17/0	18/0	17/0	18/0	...	...	...	...
£10,000	100	...	Do. First Mortgage Debentures	...	...	90	100	...	...	...	...
40,000	5	5/0	British Insulated Wire Ordinary	11½	12½	11½	12½	4 0 0	...	...	...
27,500	5	3/0	Do. Preference	6½	6¾	6½	6¾	4 8 11	...	...	...
90,000	2	2/0	Brush Electrical Engineering	1⅞	2⅛	1⅞	2	5 0 0	September	1⅞	...
90,000	2	1/2½	Do. 6 per Cent. Pref. Non-Cumulative	2⅛	2⅜	2⅛	2⅜	5 1 1	...	...	...
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Deb. Stock	110	115	110	115	3 18 5	February and August	...	...
£50,000	Stock	4½%	* Do. 2nd Debenture Stock (red.)	104	107	102	105	4 5 9	June and December	...	...
20,000	5	5/0	Callender's Cable Construction Ordinary	12½	13½	1	13½	5 11 1	...	...	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5½	6	5½	5¾	4 6 11	" "	...	...
£90,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb. (red.)	113	116	110	115	3 18 3	November and May	...	...
300,000	1	0/9⅜	Castner-Kellner Alkali Co. (fully paid)	1⅛	1⅜	1⅛	1⅜	5 16 5	...	...	...
60,000	1	0/7½	Chadburn's Ship Telegraph Ordinary	¾	1⅛	¾	1⅛	5 6 8	...	...	...
60,000	1	0/7½	Do. 6 per Cent. Cumulative Preference	¾	1⅛	¾	1⅛	5 6 8	...	...	...
32,098	3	2/1½	Crompton and Co. (Nos. 1 to 32,098)	3⅜	4	3⅜	4	4 10 9	January and July	3½	...
£100,000	100	5%	* Do. 5 per Cent. First Mortgage Deb. (red.)	100	103	95	101	4 19 0	" "	...	...
60,000	1	0/3	Davis and Timmins 6 per Cent. Cum. Pref.	¾	1	¾	1	...	...	...	...
99,261	5	1/9⅜	Edison and Swan United ("A" Shares) (£3 paid)	2	2⅛	2	2⅛	7 4 0	February and August	...	...
17,139	5	2/9⅜	Do. (£5 paid)	3⅛	4⅛	3⅛	4⅛	6 13 4	" "	...	...
£314,023	Stock	4%	Do. 4 per Cent. Mortgage Deb. Stock (red.)	95	97	93	95	4 4 3	June and December	...	...
26,100	5	5/11½	Edmundson's Electric Corporation Ord. (fully pd.)	4½	5½	4½	5½	5 14 3	Half-yearly	...	...
112,100	2	1/2½	Electric Construction Co. (Limited)	2	2½	1½	2½	5 8 3	January and July	...	...
25,000	2	2/9⅜	Do. 7 per Cent. Cumulative Preference	2⅜	3⅛	2⅛	3⅛	4 6 2	July	...	...
182,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	104	107	104	107	3 15 8	January and July	...	...
91,195	1	...	Elmore's Patent Copper Depositing	¾	¾	¾	¾	...	...	...	...
30,900	5	...	Henley's Telegraph Works Ordinary	12	13	12	13	...	February and August	12½	...
15,000	5	...	Do. 4½ per Cent. Preference	5	5½	5	5½	4 1 10	" "	5⅜	5
£50,000	Stock	4½%	Do. 4½ per Cent. Mortgage Deb. Stock (red.)	111	114	111	114	4 0 0	" "	...	...
50,000	10	10/0	India Rubber, Gutta Percha, &c., Works	21	22	20½	21½	4 13 0	" "	...	...
£300,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	103	104	100	104	3 16 11	March and September	...	...
37,350	12	12/0	Telegraph Construction and Maintenance	33	37	34	38	4 14 9	March and July	37	36
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909	103	106	103	105	3 16 2	...	...	...
20,000	5	3/0	Do. Manufacturing Ordinary	9	10	9	10	3 10 0	...	...	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5½	6	5½	6	4 3 4	...	...	...
30,000	5	5/0	Willans and Robinson Ordinary	10	11	10	11	4 1 10	April and October	...	...
30,000	5	3/0	Do. 6 per Cent. Cumulative Preference	7	7½	7	7½	4 0 0	" "	...	...
£100,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Debentures	104	106	104	103	4 0 2	May and November	...	...
			ELECTRIC RAILWAYS, TRAMWAYS, &c.								
12,000	10	6/0	Blackpool and Fleetwood Tramways	17	19	17	19	3 13 8	...	...	...
£167,900	100	5%	Brisbane Tramway 5 per Cent. Debentures	104	106	104	106	4 14 4	...	...	...
50,000	10	7%	Bristol Tramways and Carriage Ordinary	23	24	23	24	2 17 2	February and August	...	...
25,000	10	...	Do. Cumulative Preference (£6 paid)	4⅝	4⅞	6½	6¾	...	...	6⅞	6¼
£100,000	Stock	4%	Do. 4 per Cent. Debentures	118	119	117	118	3 7 3	...	118	117
30,000	10	9/0	British Electric Traction Ordinary	15	16	15	16	1 11 3	...	16	...
30,000	10	6/0	Do. 6% Cum. Pref. (Nos. 30,001 to 60,000)	12⅞	13⅛	12⅛	13	4 12 4	...	12⅞	12⅝
£200,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures	125	128	125	128	3 18 6	...	...	...
40,000	5	1/9	Buenos Ayres & Belgrano 6% "A" Cum. Pref.	5	5⅛	4⅞	5⅛	5 17 1	...	...	...
27,500	5	...	Do. "B"	4⅞	5⅛	4⅞	5⅛	...	...	...	...
265,585	Stock	5%	Do. 5 per Cent. Debentures	108	111	106	109	4 11 9	...	...	...
213,533	10	3/0	Central London Ordinary	9⅛	10	9⅛	10	3 0 0	June and December	9⅝	9⅜
$365,000	Stock	2½%	City and South London Railway Con. Ordinary	59	62	59	62	3 8 6	January and July	...	...
37,000	10	...	Do. (Nos. 22,501 to 60,000) (£4. 10s. paid)	3⅛	4⅛	4⅛	5⅛	...	...	...	...
£150,000	Stock	5%	Do. 5 per Cent. Perpetual Preference (1891)	143	149	143	148	3 8 0	January and July	...	...
£200,000	Stock	5%	Do. (1896)	135	140	135	140	3 11 11	...	...	...
£187,701	Stock	4%	Do. 4 per Cent. Perpetual Debenture	127	133	127	133	3 3 0	May and November	...	...
20,000	10	7½%	†Imperial Tramways Ordinary	23	24	23	24	...	March and September	...	...
10,000	10	6%	† Do. 6 per Cent. Preference	15½	15¾	15½	15¾	3 13 10	" "	...	...
£200,000	Stock	4½%	† Do. 4½ per Cent. Debenture xd x new	115½	116½	115½	116½	3 17 6	January and July	115	113
30,000	10	1/3	Kidd'rm'nst'r & Dist. E.L. & Tr'ct'n 5% Pref. (£8 pd.)	6	6½	8	8½	4 14 1	May and November	...	...
37,500	10	2½%	Liverpool Overhead Railway Ordinary	8⅜	8⅝	8⅜	8⅝	3 15 4	February and August	...	...
10,000	10	5%	Do. 5 per Cent. Preference	13	13½	13	13½	3 15 6	" "	...	...
125,000	Stock	4%	Do. 4 per Cent. Debenture xd	104	106	102	104	3 16 11	January and July	...	...
24,000	5	...	New General Traction Ordinary	3½	4	3½	4	...	...	...	...
30,000	5	6/0	Do. 6 per Cent. Cumulative Preference	5	5½	5	5½	5 9 1	May	...	...
4,000	10	...	Oldham, Ashton and Hyde Elec. Tramway Ord.	19	19½	18	19	...	February and August	...	...
4,000	10	5/0	Do. per Cent. Preference	10⅜	10⅝	10⅜	10⅝	4 11 11	" "	...	...
13,334	10	...	Potteries Electric Traction Ordinary	11½	12⅛	11½	12⅛	...	...	...	...
20,000	10	5/10	Do. 5 per Cent. Cumulative Preference	10	11	10	11	4 10 11	...	...	...
£510,000	Stock	3%	Waterloo and City Ordinary	103	103	101	104	2 18 4	June and December	100	...

* In calculating the yield on this security, allowance has been made for accrued interes but *not* for rede uption.

† The London Stock Exchange Committee refuses to quote these.

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THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,130. [No. 12. Vol. XLIV.] FRIDAY, JANUARY 12, 1900. PRICE SIXPENCE (by post, 6½d.), Abroad, 9d., or 15 cents. or 30fr., or 70nf.

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NOTES.

Prof. J. A. Fleming brings to a conclusion in our issue this week his remarkable critique on the established system of electrical units. He has asked the question: What shall we do with them? Whether to leave them alone, as being practically convenient though scientifically unsound; or to recast them entirely on the solid basis of Heavisidian theory; or to adopt a middle course, and, while retaining the fabric of their present construction, to alter their scale in accordance with a convenient modification of the permeability of pure ether: these are the three possible courses from which to decide as to the future. Prof. Fleming expressly refrains from definitely advocating either of these courses; he brings his able essay to a conclusion, in fact, with an explicit assertion that it is "not intended to be a dogmatic or self-assertive expression of the direction such reform should take, but merely a contribution to a discussion of the subject." Nevertheless, he has developed with much elaboration a system of units suggested by an idea of Prof. Fessenden's—viz., that the permeability of ether should be regarded as 4π instead of as unity.

We await with considerable curiosity the reception this new system will receive from theorists and practical men. It is to be hoped that both classes will discuss it on its merits, fairly and impartially. On the one hand, will the advocates of a sound theoretical foundation for our units be satisfied with a conventional alteration of the constant for the permeability of ether; or will they not rather insist that, if change there is to be, it must be radical and rational? On the other hand, will the army of practicians have their fears of revolution assuaged by the assurance that it is to be merely a matter of centre punches and decimal points? Probably, if the extreme theorists can be persuaded that their extremely theoretical systems stand an infinitesimal chance of commercial adoption, they would accept Prof. Fleming's suggested changes with good grace; and the practicians, taking heart from this encouragement, might be disposed to adopt the barely more than decimal alterations it would involve. Then there is the question of nomenclature. Prof. Fleming's system may be most acceptable and timely, but are we bound to accept his terminology along with it? Not necessarily, of course; and we apprehend vigorous discussion on this head. It is to be hoped, however, that those who contribute to any discussion on the subject will not be led away from the main proposals by incidental questions of nomenclature. These can easily be settled later.

Patent Office procedure and the general matter of encouragement to inventors have long called for investigation and reform. We learn with profound satisfaction that the President of the Board of Trade has at last appointed a strong departmental committee, "to consider"—as the reference specifies—"various suggestions which have been made for developing the benefits afforded by the Patent Office to inventors, and report." The chairman of this committee is Mr. F. G. S. Hopwood; the secretary is Mr. Arthur Neeves, of the Board of Trade; and the other members are Mr. E. Carpmael, President of the Chartered Institute of Patent Agents; Mr. C. N. Dalton, C.B., Comptroller-General of Patents, and Mr. J. A. Kempe, Deputy-Chairman of the Board of Customs. The report will be awaited with something akin to impatience by a wide circle of those interested in the privileges afforded by letters patent for inventions, and it is to be hoped it will embody specific recommendations for immediate reform.

During the past week we have had the privilege of discussing with Mr. Arthur J. Arnot, the electrical engineer to the Corporation of Melbourne, the new scheme which he has drawn up for a more complete and effective electric supply in the Victorian capital. Mr. Arnot has personally developed the municipal electric lighting works in Melbourne, and he has brought them already to a very high standard. It

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would probably be no exaggeration to say that the street lighting, which comprises some 800 arcs and 1,200 glow lamps on the series system, is unsurpassed by that of any other city in the world. Indeed, although Mr. ARNOT admits that our own best example of street lighting—viz., at Edinburgh—offers greater artistic beauties, he will not concede that anywhere the lighting itself is more abundant or better done than in Melbourne. Our readers may recall the fact that the public lighting is entirely carried out on the series system, the lamps being run on circuits fed from Thomson-Houston continuous current machines. Where glow lamps are used, these are placed in series with the arcs, a simple form of paper cut-out being employed to safeguard the lighting in the event of a filament breaking.

ENTRUSTED by the Corporation with the difficult task of advising as to which would be the best system to adopt for a general supply of light and power in Melbourne, Mr. ARNOT wisely decided upon a careful personal inspection of the best examples of work to be found in this country and on the Continent. After several months' absence from home, he has brought this tour to a successful conclusion; and he sailed yesterday for Melbourne, taking with him complete plans and specifications for the elaborate extensions which are to be put in hand as soon as he returns. Prior to his departure from Melbourne, by the way, Mr. ARNOT advised the Corporation to buy out the three competing electric supply companies, in so far as their supply affected the municipal area; and this step was decided upon, the sum of about £52,000 having been arranged for the purchase of the rights, &c., of the three concerns.

THE area to be supplied by the Corporation, and already lighted by the public lamps, comprises a comparatively small central area in the principal part of the city, together with a much larger and straggling area, including the environs and outlying suburbs. It is intended to supply the central area on the continuous-current low-pressure three-wire system, at 2 × 230 volts. The surrounding area is to be supplied on the alternate current transformer system, using sub-stations wherever the load is sufficiently dense to allow of them. This project will necessitate the employment of a large quantity of additional mains, and these are to be placed underground in the central area and carried overhead in the suburbs. The new cables will comprise some 24 miles of distributers, 9 miles of feeders, and 17 miles of series arc cable.

To meet the increased load these extensions will produce it is intended to erect new generating plant aggregating 2,400 H.P. This will comprise four sets of 350 kw. capacity and one set of 200 kw. capacity. Contractors tendering are to be allowed considerable latitude with regard to details of the plant, but it has been decided to have direct-driven engines and dynamos; and the latter are all to be drum-wound shunt machines, with preferably slotted windings for the four larger armatures. The engines are allowed 5 per cent. variation in speed between zero and full load, and the steam consumption on trial is not to exceed 19lb. for the large engines and 21lb. for the small engine at the most economical load, per H.P. working condensing. The plant also comprises an equaliser of 150 amperes capacity, and a three-armature booster and motor.

OUR readers will be glad to learn that Mr. ARNOT returns to Australia greatly impressed with the progress of electrical engineering in the mother country, and with the excellence of our manufactures. Especially in regard to cable making does he think that we hold a pre-eminent position. If there be any sign of weakness at home, it is to be found in the comparatively scanty attention we are paying to the development of large multipolar continuous current generators. Doubtless, however, the growing demand for this class of machinery will encourage a greater number of British dynamo builders to turn their attention to it. But it must not be overlooked that for some time past two or three of our leading firms—*e.g.*, the Electric Construction Co.—have built large generators of this type with marked success. We are sure that our readers will follow with great interest the progress of electric supply in Melbourne, and we hope to give them further particulars of Mr. ARNOT'S scheme when it is nearer completion.

MR. C. VERNON BOYS is heartily to be congratulated on the profoundly interesting series of lectures which he has delivered at the Royal Institution. Though intended for a nominally juvenile audience, the fairly complete account of these lectures which we have published in our issues of last week and this, explain and justify the presence of a considerable majority of "children of an older growth," of grey-haired and middle-aged ladies and gentlemen, in addition to the juveniles at whom the lectures were assumed to be directed. If these lectures were really and truly "juvenile lectures," it would be of great interest to have the Royal Institution's specification of a "juvenile." To our mind the term "popular" would be the more correct and universally used term, having a signification corresponding to the obvious aim, standard, and method of treatment of these lectures. A society like the Royal Institution, with a history which is so closely bound up with the history of science in the nineteenth century, must needs be conservative in its administration, and it will properly hesitate before adopting any change in the nomenclature of its lectures. But we do not doubt that a scientific society of such universal repute, which can boast of a long, intimate, and honourable connection with DAVY, FARADAY, and MAXWELL will value accuracy before all things.

THE course of juvenile lectures in the present instance covered an immense ground, and the illustrations, of which there was a magnificent crop, were drawn from many sources, apparently most remote and unconnected. Little domestic devices like the spray producer, the testing of eggs to see if they are boiled or not, the cream separator, the behaviour of water in water taps, the separation of tea dust from the tea in a saucer, and others, might be taken as appealing more directly to the feminine section of Mr. BOYS' audience. The large number of scientific toys shown would appeal to the younger children, while those of

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a more speculative turn of mind, possessing some extended knowledge of physical phenomena, would have watched with absorbing interest the experiments on vortex rings,—liquid and gas—Prof. Hele-Shaw's demonstration of the stream lines in a perfect liquid, the various types of turbines, the principle of action of ejectors, injectors, centrifugal pumps and fans, and a host of other interesting matters for which we must refer our readers to the account we give elsewhere. We sincerely hope that Mr. Boys will be persuaded to publish these lectures in book form. We know of no source where so many interesting experiments in connection with liquids and gases are to be found, and there are many who would not fail to find such a book of great utility.

Personal.—Mr. R. A. Dawbarn has resigned the position of superintending engineer to the Brush Electrical Engineering Co., in order to take up consulting practice.

Appointment.—Dr. F. Kohlrausch, president of the Physikalisch-technischen Reichsanstalt, at Charlottenburg, has been appointed honorary professor of physics at Berlin.

Association of Technical Institutions.—The annual general meeting of this association will be held on Wednesday, January 24, at the Mercers' Hall, London. The president (Earl Spencer, K.G) will preside, and an address will be given by the president elect, Sir Swire Smith.

"Doctor Engineer."—At a meeting of the Charlottenburg Polytechnic Academy, held on Tuesday last to celebrate the beginning of the new century as reckoned in Germany, it was announced that the first recipient of the new degree, "Doctor Engineer," would be Prince Henry of Prussia.

Tramway Accident in Glasgow.—Another accident on the Glasgow electric tramways occurred on the 9th inst., owing to the collision of an electric car with the rear of a horse car. The horse car was derailed, and the two horses were hurled into a deep trench which had been dug in order to carry out the extensions of the electric tramway system to Dennistoun. It is stated that both cars were travelling very slowly, and that the electric car was little the worse for the accident.

Cable Interruptions and Repairs:—

	Date of Interruption.		Date of Repair.
Latakia—Cyprus	June 21, 1899	—	...
Cayenne—Pinhieros	Oct. 11, 1899	—	...
Zanzibar—Mombassa	Oct. 27, 1899	—	...
Mozambique—Lourenco-Marquez	Dec. 17, 1899	—	...
Gibraltar—Tangier	Dec. 31, 1899	—	Jan. 3, 1900
Tangier—Tarifa	Jan. 3, 1900	—	...
Iquique—Valparaiso	Jan. 9, 1900	—	...
Serena—Valparaiso	Jan. 9, 1900	—	...

Water Power Utilisation on the Isle of Man Electric Tramways.—An interesting hydraulic plant has just been completed at Laxey for working the electric railway between Douglas and Ramsey during the winter months. The plant has been in operation for about a fortnight, and thus far has given very satisfactory results. The principal advantage in the use of hydraulic power at Laxey is that it enables the entire steam plant to be shut down for about seven months in the year, during which time the pressure of traffic is at a minimum.

Electric Tramway Extension in Leeds.—Electric tramway traction is making excellent progress in Leeds, as indeed it has done from the inauguration of the first section of the lines. The traffic has grown to such an extent that an order has been placed for 50 new motor cars; and besides this the lines have been considerably extended, a new section of line between Headingley and Chapeltown being inaugurated on the 3rd inst. Some 19 cars are appropriated to this section, upon which a ten-minute headway is in operation. The Headingley-Chapeltown section has hitherto been worked by steam locomotives.

Wireless Telegraphy on Channel Steamers.—We are informed that the Wireless Telegraph and Signal Co. are now equipping the cross-Channel fleet of the South Eastern and Chatham Railway with the Marconi apparatus. All the vessels of the fleet are ultimately to be thus equipped, but it is intended to erect only one land mast for this service—viz., at Dover. The height of this mast will be such as to command the steamers the whole distance to the Calais and Boulogne harbours for the steamers running from Dover and Folkestone respectively. We understand that for the present it is not intended to use the Marconi system on the Ostend boats, the rumour to this effect being incorrect.

Electrical Equipment of the ss. "Oceanic."—In our description of the electric lighting and telephone installations on board the liner "Oceanic" last week we omitted to note that the telephone deck and engine room service had been carried out by Messrs. Alfred Graham and Co., who have fitted the vessel with their patent loud-speaking instruments. The first illustration on p. 353 of our issue of Jan. 5 shows the type of telephone instrument which is largely and exclusively used for similar installations on board a number of Her Majesty's battleships and cruisers, and the installation on the "Oceanic" is similar in design to that with which the "Kinfauns Castle" and "Kildonan Castle" (of the Castle line of steamers) are equipped.

The Institution Visit to Switzerland.—The Swiss Visit Committee have selected 72 photographs from the large number exhibited, and by kindness of Mr. W. C. Mountain have arranged for these to be enlarged and mounted in an album at cost price. The album will contain 12 prints 12 × 10, 24 prints 6 × 5, and 36 prints 4 × 3. Several of the subjects will be technical, but the greater part will be interesting views both of scenery and members. The price, bound in half-basil, will be 27s. post free in England. Members who, though unable to take part in the visit, wish to obtain a copy are requested to apply to Mr. R. S. Erskine, 22, Stanford-road, Kensington, not later than Monday, 22nd inst.

Telegraphists and First Aid to Wounded.—It has been arranged that a series of lectures on "First Aid to the Injured," in connection with the St. John Ambulance Association, by S. Osborn, Esq., F.R.C.S., chief surgeon of the metropolitan corps of the St. John Ambulance Brigade, shall be given on Monday, January 22nd next and the four following Mondays, at 5 p.m., at Winchester House, Old Broad street, E.C. The fee for the course is 5s. This class for men, (not exclusively for telegraphists), has been arranged by some of the staff of the Eastern Telegraph and associated companies, and gentlemen wishing to attend are invited to send their names as early as possible to Mr. G. R. Neilson, 188, Winchester House, E.C., from whom all particulars, together with books and bandages to be used during the course, can be obtained.

The Telephone System in Guernsey.—We give below some particulars of the present condition and progress of the telephone industry in the island of Guernsey. The exchange, which is the only one operating in Guernsey, and has no connection with either the Post Office or National Co.'s system, is situated at St. Peter-Port, Guernsey, the engineer being Mr. A. R. Bennett, of London. At the present time the total number of lines of all descriptions connected with the exchange is 499, and, considering that the population of the island is only 35,000, this shows the excellent proportion of one telephone to 70 inhabitants. Of this total there are 431 subscribers connected on direct lines, 21 on extension lines, 20 on public telephones, 15 on junction lines, 6 on private lines, 3 on firemen's alarms, and 3 on service lines.

Explosion in Manchester Electric Conduits.—We are authoritatively informed that on Friday the 5th inst., about 2 p.m., some workmen in Princess-street, Manchester, who were employed by the waterworks department, drove a steel crowbar into a culvert, causing a short-circuit on the electric supply mains, which was quickly cleared. Within a few minutes of this short-circuit, however, another one occurred, apparently in consequence of it, in a different part of the town—namely, in Bank-street, near the Royal Exchange, on five $\frac{1}{8}$ sq. in. rubber cables in a pipe. The heat of the short-circuit distilled the rubber and tarry compound in the braiding surrounding the conductors, thus forming an explosive mixture, which passed into a junction box and culvert, and, becoming ignited, exploded. The lid of the junction box was blown off and the flagstones immediately over the culvert were disturbed for a few yards. No one was hurt, nor was any damage done

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to property beyond the breaking of one pane of glass. The supply was not interrupted, the pressure merely being unsteady for a few minutes. The consumers on the actual length of main affected, about 40 yards, were without light until the following day; while in consequence of the short-circuit a few consumers were without light for about an hour—namely, those connected to the length of main, about 200 yards, affected by the crowbar accident.

A Curious Electric Locomotive.—*Cassier's Magazine* describes a rather remarkable locomotive designed by MM. Baudry and Auvert, of the Paris, Lyons and Mediterranean Railway in France. It is an electric storage battery locomotive, and has been on trial service on one of the branch lines running out of Paris. The main driving current is supplied from batteries carried on a separate tender. The engine has three axles, two being driving axles, and these have armatures mounted directly upon them. The housing of the locomotive is built in five distinct compartments. The one in the rear, directly over the motors, is the cab for the motorman and his assistant. A central forward compartment, of moderate height so as not to obstruct the view of the motorman, contains an air compressor run by a small electric motor. The apparatus furnishes the compressed air necessary for the operation of the air brakes and whistle. Of the three other compartments, two are situated on the right and one on the left hand side of the engine. Each of the former contains nine accumulator cells, connected in series, and used to excite the fields of the motors and to furnish the current necessary for the compressed air and the lighting. The locomotive can also run at a very slow speed. The fifth compartment contains a large water rheostat, which opens and closes the circuits of the motor fields and also regulates their intensity. The current for the locomotive is furnished by two batteries of accumulators of 96 cells each, which are carried upon the previously-mentioned tender. No particulars are given of the results of trials, or of advantages claimed for this engine.

Phosphorescence.—The first of a course of lectures on "The Phenomena of Phosphorescence," intended for a juvenile audience, was given by Mr. Herbert Jackson, on January 3, at the Society of Arts. The lecturer first referred to the natural sources of phosphorescence in the sea and in some cases of animal decay, &c. Phosphorescence and fluorescence might be treated as identical terms. They were illustrated by a phosphorescent jet of steam issuing from a vessel containing water and phosphorus, and by the effect of sprinkling fluor spar on a heated plate. The lecturer then showed that there are certain substances which show light, generally of a yellowish or greenish colour, when exposed to the more refrangible rays, and that the visible spectrum is apparently extended in length when the violet and ultra-violet rays fall on a surface prepared with such materials as sulphate of quinine or thallene. On passing a slab of uranium glass along the spectrum, it was seen that no effect was produced on the glass by the red end, whereas as soon as it was placed in the violet rays it glowed with its characteristic greenish-yellow colour. The phosphorescence of quinine and of fluorescein when the solution was dropped into a tall jar of water was also shown, and by burning sulphur in oxygen in a jar immersed within a larger jar filled with the phosphorescent solution. The phosphorescence of these materials only lasted while the exciting cause was present; but there were other materials which continued to emit light after the exciting source had been withdrawn: of these possibly the best known was Balmain's luminous paint. Mr. Jackson exhibited a fine series of phosphorescent bodies, principally lime salts, which, when excited by the brilliant discharge from a large induction coil, glowed for a certain time with various tints—blue, yellowish-green, and pinkish-red. Even purely phosphorescent phenomena lasted, and were shown to last, during a finite time after the withdrawal of the exciting light. After this the lecturer passed to the phosphorescent effects produced by the electrical discharge in vacuous tubes, and showed the very beautiful results in a long tube, in which a spark from an induction coil was passed, as the air and the various gases with which the tube was filled were gradually exhausted.

Experiments on Some Mechanical Properties of Iron.—The last number of the *Comptes Rendus* contains an interesting note of some experiments made by M. Galy-Aché in support of the hypothesis of MM. Osmond and Werth that iron exists in two allotropic states, in the first of which it is stable at ordinary, in the second at high, temperatures. The iron experimented on was found to be *absolutely free from carbon*, the only impurity being slight traces of phosphorus. This was heated to a temperature of 1,000°C. and then carefully annealed, the cooling being extended over about 12 hours. By subjecting pieces of this iron to repeated loads, applied hydrostatically, of varying magnitude, it was found to be quite homogeneous. Permanent deformations were observable only when the load exceeded the elastic limit for the iron—18 kgm. per sq. mm. Each little cylinder of 13mm. length was crushed to the extent of 0·1mm. under a load of 900 kgm. per sq. mm., causing the ends to perceptibly bulge out. If the load were suddenly removed and then gradually reapplied, no further diminution in size was observable till the former maximum load was reached, and no outside bulging was observed. If, however, the pressure were gradually reapplied after some hours, even a greater load than the previous maximum load could be safely applied. If the reapplication of the load were made in six months, the maximum pressure which could be applied without producing further distortion was always much greater than the original maximum load. The rise of this elastic limit with time gradually attained a maximum, which in one case amounted to a stress of 50 kgm. per sq. mm., the initial maximum stress being 43 kgm. per sq mm. When a cylinder of this same iron was heated to a temperature above 850°C., the temperature of reca-lescence, and then slowly cooled, distortion effects could be obtained by subjecting it to compression. If, however, it were suddenly cooled, this distortion disappeared and subsequently gradually reappeared. Slight heating considerably hastened this reappearance. If the iron were heated to a temperature less than 850°C., the distortions produced by compression were independent of the rate of cooling. These experiments are held to support the hypothesis of two allotropes of iron, the first existing at ordinary temperatures, the second at high temperatures. The second variety may also be obtained at ordinary temperatures either by sudden cooling or by excessive straining, but iron of this type returns slowly at ordinary temperatures, more quickly at higher temperatures, to that of the other kind.

MEETINGS OF SCIENTIFIC AND ENGINEERING SOCIETIES, &c.

(TO-DAY) FRIDAY, January 12th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Students' Meeting, when an Address will be delivered by Prof. T. Claxton Fidler on "The Theory of Structures and Strength of Materials."

TUESDAY, January 16th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. The following Paper is down for reading, should time permit: "Swing Bridges over the River Weaver at Northwich," by J. A. Saner.

WEDNESDAY, January 17th.

ROYAL METEOROLOGICAL SOCIETY.

7.45 p.m. Annual General Meeting, at the Institution of Civil Engineers, 25, Great George-street, Westminster.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. Paper to be read, "Ventilation without Draughts," by Arthur Rigg.

ROYAL MICROSCOPICAL SOCIETY.

8 p.m. Ordinary meeting at 20, Hanover-square, W.

THURSDAY, January 18th.

INSTITUTION OF JUNIOR ENGINEERS.

8 p.m. Lecture at the Finsbury Technical College, Leonard-street, City-road, illustrated by experiments, on "The Balancing of Engines," by Prof. W. E. Dalby.

FRIDAY, January 19th.

ROYAL INSTITUTION.

9 p.m. Evening Discourse on "Flight," by the Right Hon. Lord Rayleigh, F.R.S.

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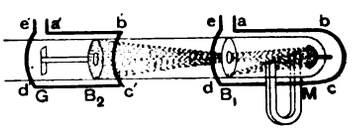
CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

Nature of Cathode Radiation.—A first-class piece of work on the velocity and magnetic deflection of cathode rays has been carried out by E. Wiechert. Contrary to the usual practice, he used Tesla currents for generating the rays and a Lecher wire system bent into loops for deflecting them. The general principle adopted is indicated in the diagram, where *a b c d e* and *a' b' c' d' e'* are loops connected to the two secondary armatures of the Lecher condenser system. The rays are permanently deflected by the small magnet M, and periodically raised to the axis of the tube by the loops. The portion B_1 B_2 is traversed by the rays without deflection. If the rays arrive at B_2 before the Lecher current has changed in direction, they will be again deflected in the same sense as before. But if the Lecher vibrations are rapid enough, the second deflection will exhibit some change, and that change will vary as the distance B_1 B_2 is increased or diminished. The results obtained indicate a velocity about one-seventh that of light. Since

$$\frac{e}{m} = \frac{v}{S},$$

where v is the velocity of the rays and S their "magnetic stiffness," the result gives another value for the important ratio e/m. It comes out as $1{\cdot}26 \times 10^7$, or considerably lower than Simon's standard value. The author utilises his results further by inquiring what amount of matter is transported with each electron, or, if one may so express it, what is the mass of an electron, and he puts it down as 1/1,800th part of the atomic weight of oxygen. The author endorses the corpuscular theory of electric conduction, believing that electricity is a form of matter which links the atom to the



surrounding ether but can be transferred from one atom to another. He favours the idea that there is only one type of electron, and that the negative one. This would seem to be a modern variation of the old one-fluid theory.

[E. Wiechert, *Wied. Ann.*, No. 12, 1899.]

An Electromagnetic Fallacy.—E. Lecher, writing about König's electromagnetic rotation, again protests against the allegation that a magnet pole will rotate along the lines of force due to an electric current. He suspends two vertical bar magnets by two wires joined at the top and communicating there with a mercury cup forming an electrode. The magnets are joined in the middle by a bar, from the centre of which another wire descends to the other electrode. There is then no trace of rotation, though all the usual conditions are fulfilled and similar poles are in juxtaposition. Rotation only takes place when the magnetic lines of force cut across a conductor in operation. This they do in König's arrangement, where a U-shaped magnet is suspended with one pole in the centre and the other outside a cylinder conveying a current along its surface. The rotation has nothing to do with the motion of a magnet pole along the lines of force; it is simply another case of Barlow's wheel. Ebert's diagram of a current and a magnet pole, showing the lines of force due to the latter converted into an infinite spiral, is incomplete, as the spiral must eventually be closed up about the opposite pole. The author also shows that Faraday did not adhere to the usual definition of a magnetic line of force.

[E. Lecher, *Wied. Ann.*, No. 12, 1899.]

Surface Electrification of Vacuum Tubes.—E. Riecke has effectively employed Lichtenberg's figures to demonstrate and investigate the distribution of electric charges on the outer surface of vacuum tubes. If a point on the surface is electfied, say negatively, it will attract the red lead powder, and a zone will be formed on the outside of which the weight of the powder, its electric attraction, and its friction against the glass form a system of forces in equilibrium. The most pronounced feature disclosed is the wide ring formed round the fluorescent patch produced by the impact of the cathode rays upon the glass wall The ring is bordered by yellow powder. Inside the ring are irregular patches of red powder. When a metallic object intervenes in the path of the rays, it casts a sharp shadow free from red powder. The sulphur covers the rest of the tube, with the exception of the neighbourhood of the cathode, where a red ring is formed at the intersection of the cathode plane with the glass, and a red cap, produced by rays from the stem, surrounds the point of entry of the cathode wire. A remarkable observation is that a metallic mirror placed in the path of the cathode rays produces a yellow ring and red patches on the opposite glass wall. This indicates a regular reflection of the rays.

[E. Riecke, *Wied. Ann.* No. 12, 1899.]

Photographic Current Curves.—Another improvement in Braun's cathode-tube method of obtaining current curves has been devised by J. Zenneck. Instead of photographing the curves on a sliding plate, like Wehnelt and Donath, or using a revolving mirror, the author produces the curves upon the fluorescent screen in the tube itself, where they appear absolutely steady and immovable as long as the current does not change. This is accomplished by using two deflecting magnets, one for producing the vibration of the spot of light in the ordinary way, and the other for imparting to it an additional lateral movement strictly proportional to the time. The latter is excited by a current taken off the circumference of a wheel carrying a thin wire and coupled to the alternator, The deflecting current is inversely proportional to length of the wire in circuit at any instant. The method admits of the most varied applications, the only limit imposed being that of the speed of alternation, which may be too great for effective photography. The author puts the limit at about 1,000 reversals per second. But that may be exceeded by special contrivances. Several improvements are also made in the construction of the Braun tube.

[J. Zenneck, *Wied. Ann.*, No. 12, 1899.]

Influence of Pressure upon Resistance.—The influence of exhaustion upon the conductivity of a gas is marked and well known. Exhaustion in all probability increases the dissociation of a gas, and a maximum of conductivity occurs where there is maximum dissociation and before the number of molecules falls below a certain figure required for effective conduction. In solutions the case is very different. There the dissociation increases directly with the pressure, and hence an increase of conductivity may be expected to occur in a compressed electrolyte. Such an increase has been demonstrated by G. Tammann in the case of a decinormal solution of acetic acid, which, as we know, is far from being completely dissociated. Exposed at the ordinary temperature to a pressure of some 2,500 atmospheres, the resistance falls to half its original value. The behaviour of a decinormal solution of sodium chloride is different. Pressures up to 2,500 atmospheres complete what little dissociation remains to be accomplished, and the resistance shows a fall of some 9 per cent. After that the increase of the ionic friction, which goes hand-in-hand with the increase of viscosity, leads to an increase of resistance with further pressure. This increase may be utilised for determining the ionic friction itself.

[G. Tammann, *Wied. Ann.*, No. 12, 1899.]

A Large Electric Crane Equipment for Middlesborough Docks.—The North Eastern Railway Co. has decided to adopt electric power for a large number of cranes and capstans at their new docks at Middlesboro', and the contract for the electrical part of this work, including a 1,000 H.P. generating station, has been placed with Messrs. Siemens Bros. and Co., the mechanical equipment being in the hands of Messrs. Cowans, Sheldon and Co. This large electrical plant will include three 10 ton cranes, seventeen 3 ton cranes, and 24 capstans, all of which will be driven electrically.

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PROGRESS OF ELECTRICAL SUPPLY AT CAMBRIDGE.

Electrical supply was first started in Cambridge by the Cambridge Electric Supply Co. in November, 1892, the company having obtained a provisional order in 1890. The system of supply is the three-wire alternate-current transformer sub-station system at 2,000 volts, the consumers being in recent times supplied at both 100 and 200 volts. During the past year the total lamp connections of this station have increased from 25,000 to nearly 28,000, necessitating a considerable increase in the plant capacity of the power station.

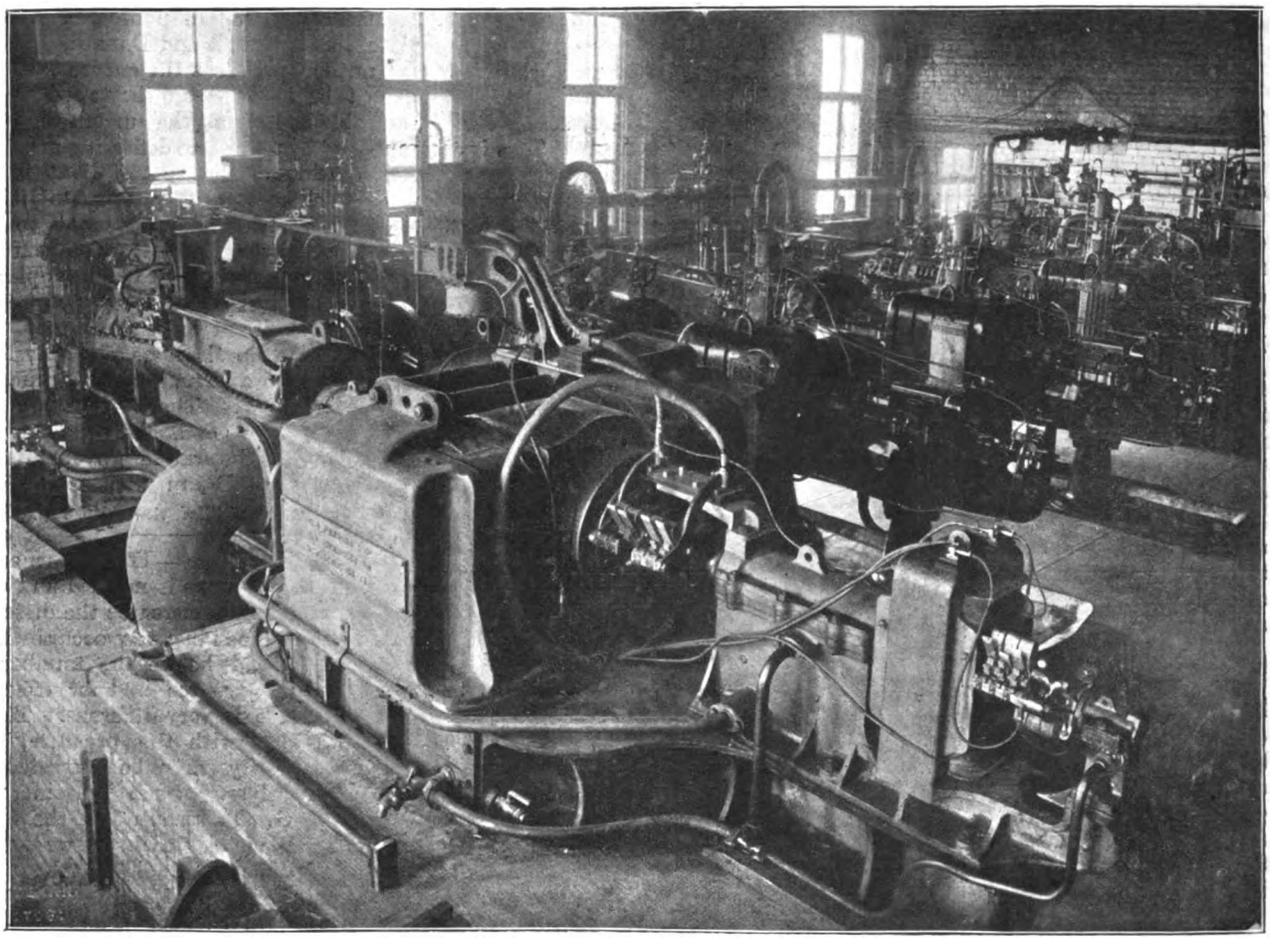
Through the courtesy of Mr. John H. Barker, the general manager and engineer of the Cambridge Electric Supply Co., we are enabled to publish the accompanying illustrations and the following description of the new plant recently erected at the station.

Having decided on this extension, the directors invited tenders from five leading English firms for a direct-coupled high-speed engine and a 500 kw. alternator. Tenders were received from four of these firms, ranging from £4,100 to £5,010, for plant without condenser or pumps, and from Messrs. C. A. Parsons and Co. at £4,824 for the specified plant, together with condenser and pumps. In accepting the tender of Messrs. C. A. Parsons and Co. the directors were guided by the consideration that the cost of a condenser and pumps, with an independent engine to drive them, would be about £1,025, thus reducing the net tender of Messrs. Parsons to £3,799 for the specified plant alone. Another consideration, even more important, was that the very limited space available for the extension plant would not accommodate a single set offered by the first four contractors, while it would have been possible to install no less than two 500 kw. sets of the steam turbine type, of which Messrs. Parsons and Co. are the well-known manufacturers; and, as a matter of fact, a second set has since been ordered for delivery during the present year. Moreover, the guaranteed consumption of steam per kilowatt-hour for the Parsons plant was lower than that of the other makers, the figures for the various tenders being as given below:—

—	25% over load.	Full load.	Half load.
A.	.....	28lb.	34lb.
B.	.....	28lb.	34lb.
C.	25·5lb.	27lb.	32lb.
D.	.....	26·6lb.	31·2lb.
E. (Parsons and Co.) ...	.....	27lb. (superheated)	30lb. (superheated)

The figures are for 140lb. steam pressure, the engines working condensing. The last row of figures include the power absorbed by the air and circulating pumps, and are for superheated steam, the other engines working saturated.

Tests of this set were carried out by Mr. Barker at the makers' works, Newcastle-on-Tyne, last October. As it was impossible to attach the condenser made for the set, this already having been delivered and put into position at Cambridge, the condenser and pumps attached to the test house were used. These tests extended over a period of four hours, and gave the results tabulated below:—



MACHINERY ROOM: CAMBRIDGE ELECTRIC SUPPLY STATION.

Tests of a 500 kw. Parsons Steam Turbo-Generator for Cambridge Electric Supply Works.

Boiler pressure	127	139	145	140
Vacuum	24·75	24·5	26·5	27·5
Barometer	29·6	...	...	...
Water per hour, pounds...	13,400	12,675	7,029	4,180
Output in kw.	598·0	526·4	256·1	124·0
Water per kw. hour	22·4	24·1	27·5	33·7
Exciting current, kw.	3·5	3·3	3·1	3·0

When in position with its own condenser it is hoped to get even better results, as a higher vacuum will be maintained than is possible with a condenser so far away from the engine as is necessary in a test house, and without the many branches on a trunk pipe. So far as is known, the figure of 22·4lb. of steam per kilowatt-hour at only 127lb. pressure has not been previously attained with a high-speed engine of this size, and

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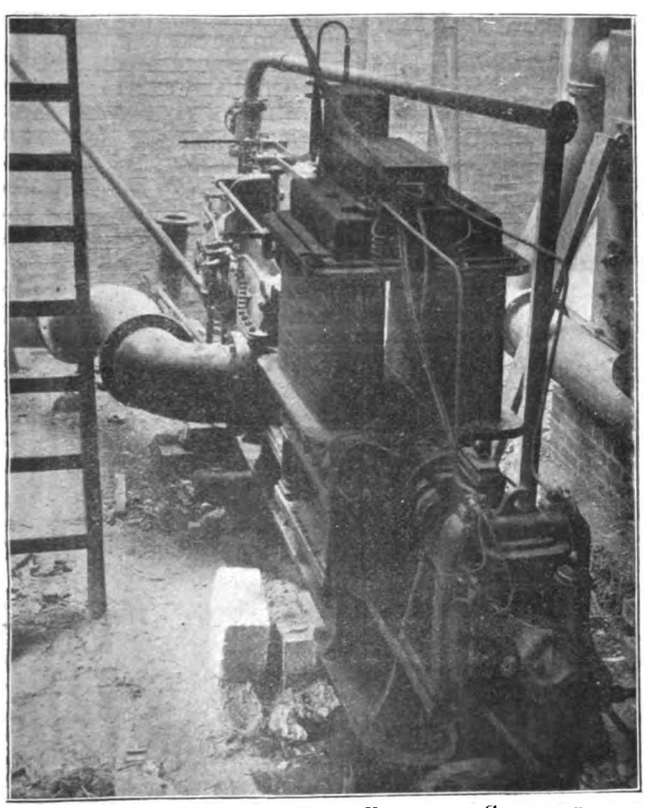
a maintained efficiency down to one-quarter full load of only 33·7lb. is a remarkably good performance.

One of the illustrations shows the set erected in position at Cambridge. The engine is of the usual parallel-flow turbine type, and runs at a speed of 2,700 revs. per min. It is electrically governed, and can run in parallel with other alternators. Below the floor, in a tunnel, is a surface condenser, which is connected by a pipe on either side. The air and circulating pumps are on the same level as the condenser, and are driven from a worm and wheel, which worm has three threads and is connected to an extension of the engine shaft at the high-pressure end. This arrangement of driving air pumps has been found satisfactory during the last four years, an engine with this attachment having run almost daily with the same worm-wheel, which is still in excellent condition. The alternator is coupled direct to the engine: it has four poles, with rotating armature, and delivers current at 2,000 volts of 90 periods per second. To the same shaft is coupled the exciter dynamo, having a capacity of 5 kw., though only 3 5 k.w. are required at full load, or about 0·7 per cent. of the output.



Temporary Emergency Plant Erected at Cambridge.

It was found to be impossible to deliver the engine in time for the winter of 1899, and the plant at the disposal of the company was not powerful enough to carry through without dangerously overloading. Messrs. Parsons and Co. therefore lent a 100 kw. set non-condensing to run until delivery of the larger machine. The second illustration shows this temporary engine and dynamo as it stood working in the basement of the engine room. It rests only on four blocks of timber laid on the bare earth, three connections only being required—viz., a 3in. steam pipe, a 10in. exhaust, and a pair of cables to the switchboard. The total cost of erection was something under £5. It is safe to say that no other class of plant can be so readily adapted in urgent cases, nor could a 200 I.H.P. engine of other build run under such simple conditions of foundations. In actual running the engine was the most silent in the place, and was quite as good in all other respects. It may be of interest to add that in 1896 the directors let one of their Parsons engines and alternators to a town where the heavy season was in the summer, to help at the electric supply works until they could obtain other plant; and the engine, in a few days after its return to Cambridge, was at work and ready for the winter season.

ELECTRIC TRACTION IN PARIS.

Many of our readers are aware of the rapid strides which the trolley system of electric traction has made in France. Since 1889, when the first line of this kind was laid,

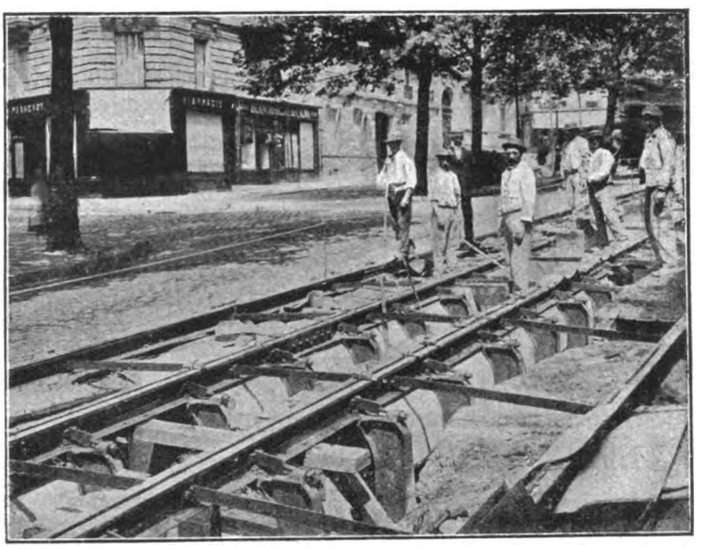


Fig. 1.—View showing Conduit Line in Course of Construction.

nearly every large town has adopted it, and there are now about 1,500 miles of trolley line in France, not less than 1,100 miles of which the French Thomson-Houston Co. claim

Fig. 2.—View of Etoile-Montparnasse Terminus, showing Special Deflecting Device.

to have put down. Despite the very many, and admitted, advantages of this system, a number of large towns, including Lyons, Nice, and Bordeaux, have changed over, or are doing so, from the trolley to the conduit system, and in each case

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the same company has been given the contracts for the carrying out of these changes. The length of the line in Lyons is 8,600 metres (2·24 miles), and is in actual operation; whilst in Nice and Bordeaux the new lines are in construction, the lengths of line in these towns being 6,000 metres (3·73 miles) and 4,000 metres (2·49 miles) respectively.

In Paris some faddists thought, and these are the ones which prevailed, that the overhead trolley system disfigured the beautiful appearance of their public streets. Their objections have not carried permanent conviction, for new lines recently opened and other lines now in construction are adopting the trolley system. The new line between the Bastille and Charenton opened up by the General Tramways Co. of Paris is worked over nearly its entire length by trolley lines. In fact, of the 6,200 metres total length of line, 5,300 metres are trolley, and of this 3,500 metres are in Paris itself. The remaining 870 metres, divided up into two sections, one near Dumesnil, the other near the Place de la Bastille, are conduit lines.

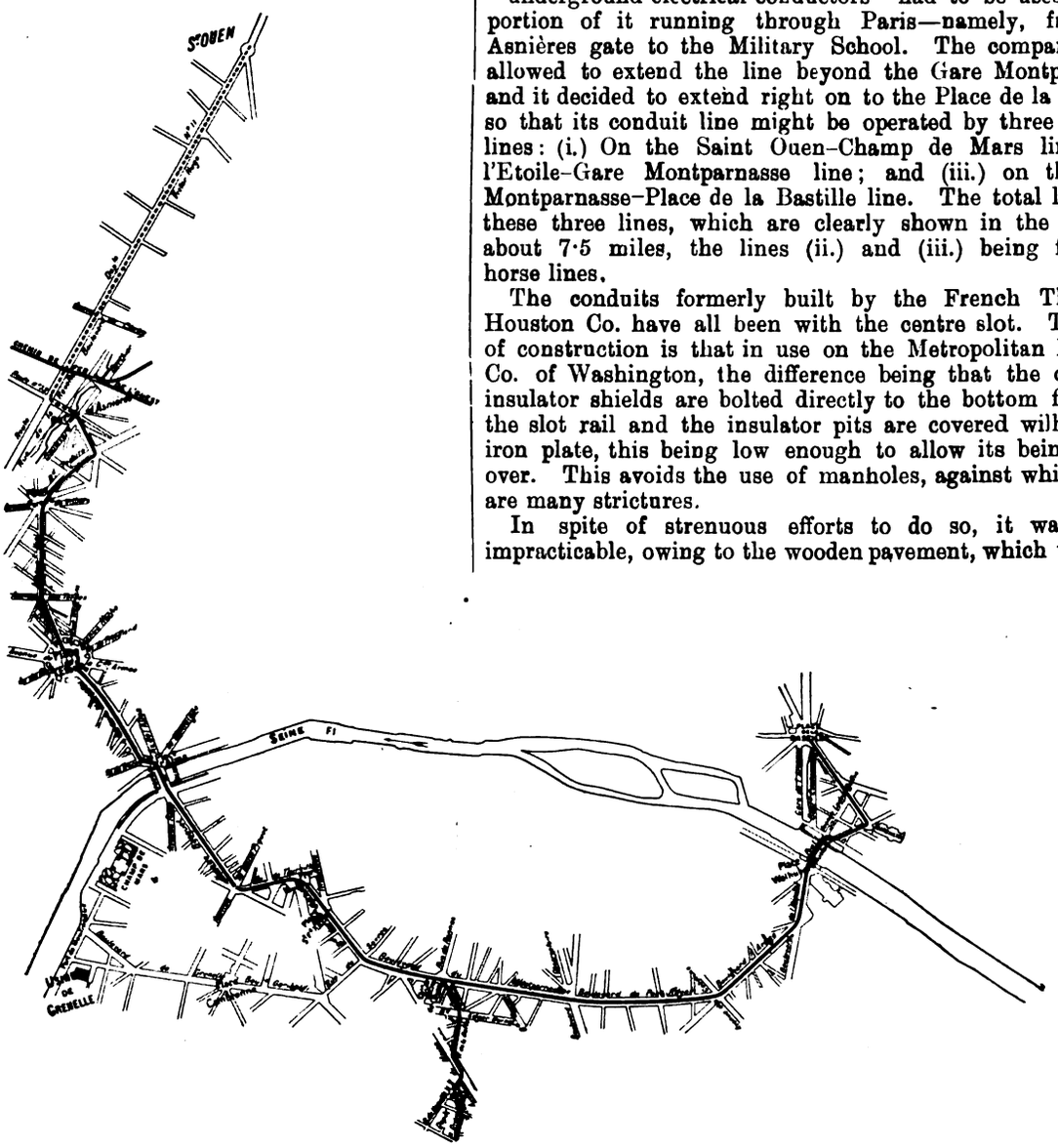

FIG. 3.—MAP OF PARIS, SHOWING LOCATION OF NEW ELECTRIC CONDUIT LINE

The favour in which the new lines are held appears to be very high indeed. The suburbs have been made specially accessible, a fact whose appreciation is shown in the extraordinary increase in the number of daily passengers carried by this line before the transformation and now—from 6,000 to 30,000.

There are no fewer than *ten* different systems of mechanical traction in actual operation in Paris, but no one of them combines the conditions for rapid and frequent service with economical working and a tolerable remuneration to the shareholders. The experience of conduit construction in Washington, Budapest, New York, and Brussels is not unknown to French engineers, but its close study has been hindered by the large number of trolley lines already in existence in different parts of France. The main object of the present article is to explain a new system of conduit traction which has just been put in operation in Paris.

The General Parisian Tramways Co. obtained a concession in December, 1897, for a line between Saint-Ouen and the Champ de Mars. By the conditions of the specifications, "underground electrical conductors" had to be used in that portion of it running through Paris—namely, from the Asnières gate to the Military School. The company were allowed to extend the line beyond the Gare Montparnasse, and it decided to extend right on to the Place de la Bastille, so that its conduit line might be operated by three distinct lines: (i.) On the Saint Ouen–Champ de Mars line; (ii.) l'Etoile–Gare Montparnasse line; and (iii.) on the Gare Montparnasse–Place de la Bastille line. The total length of these three lines, which are clearly shown in the map, is about 7·5 miles, the lines (ii.) and (iii.) being formerly horse lines.

The conduits formerly built by the French Thomson-Houston Co. have all been with the centre slot. The type of construction is that in use on the Metropolitan Railroad Co. of Washington, the difference being that the cast-iron insulator shields are bolted directly to the bottom flange of the slot rail and the insulator pits are covered with a cast-iron plate, this being low enough to allow its being paved over. This avoids the use of manholes, against which there are many strictures.

In spite of strenuous efforts to do so, it was found impracticable, owing to the wooden pavement, which wears so rapidly, to continue this central-slot construction in Paris. The proposition to add still another rail in the centre of the track was therefore looked on decidedly askance, and finally the side-slot conduit was settled on. The chief objections to this system are: (i.) The increased importance of slot closure, since the wheel flanges and plough must pass into the slot; (ii.) the whole weight of the car traffic is borne by the conduits, necessitating much stronger construction; (iii.) the splash of mud and water from wheels renders insulation of plough more difficult; and (iv.) it is absolutely impossible to make a really satisfactory slot-switch.

The last objection is very serious. A wide slot is necessary for the wheel flanges, and the upper face of the switch must be flush with the rail head, because the wheels roll upon it. It must also be strong, and have considerable width at the point where it must be supported; with these conditions a mechanically satisfactory switch will give a slot of $1\frac{3}{4}$in. to

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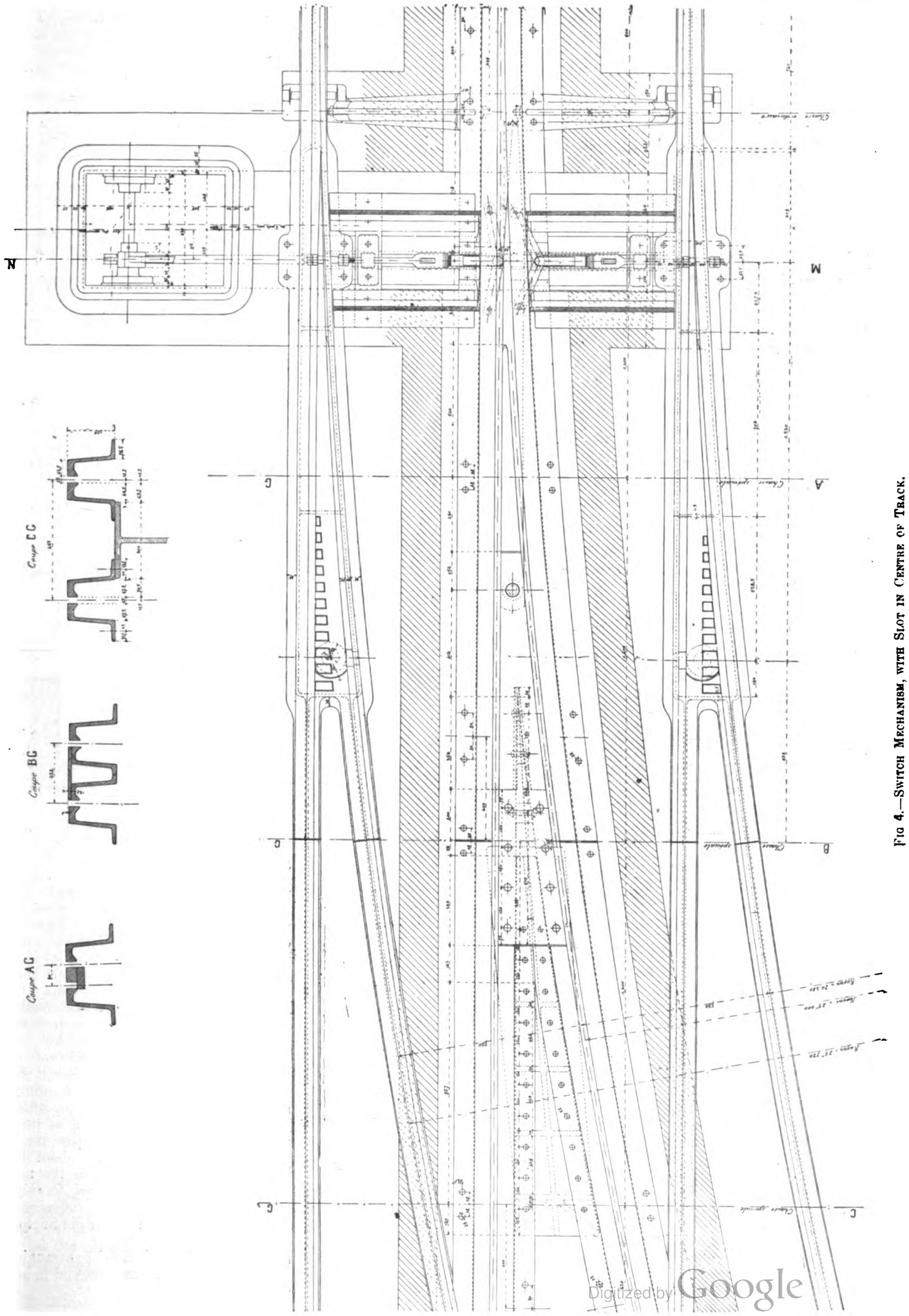

FIG 4.—SWITCH MECHANISM, WITH SLOT IN CENTRE OF TRACK.

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2in. at the point. The difficulty has been overcome in the Paris construction in a manner which will be described.

In the actual construction the two conduits are interiorly placed. The rails are held to gauge by tie-rods spaced every 2·10 metres, and the interior slot rails are similarly tied together. The details are very much the same as in other conduit systems. The laying of ordinary track is clearly

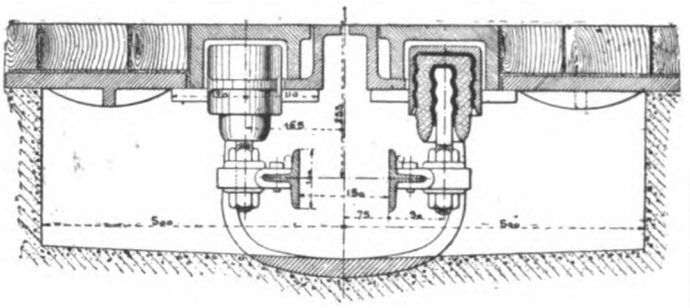


Fig. 5.—Shallow Conduit on the Pont d'Alma.

shown in the engraving (Fig. 1). The metalwork is tied together and accurately gauged. The forms are then put into position and the conduit walls built up with concrete. The wooden road bed is then laid down, and the track is completed. Despite many extraneous difficulties which arose during construction, 100 metres of double track could be laid per day.

the traction engineer; one never knows what *bizarre* effects may be produced. The inherent difficulties of the side-slot switch are avoided by the device of deflecting the slot to the centre at such points. This construction is clearly indicated

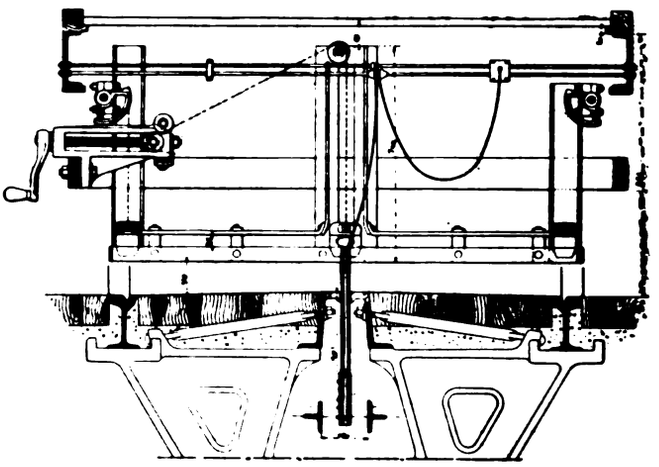
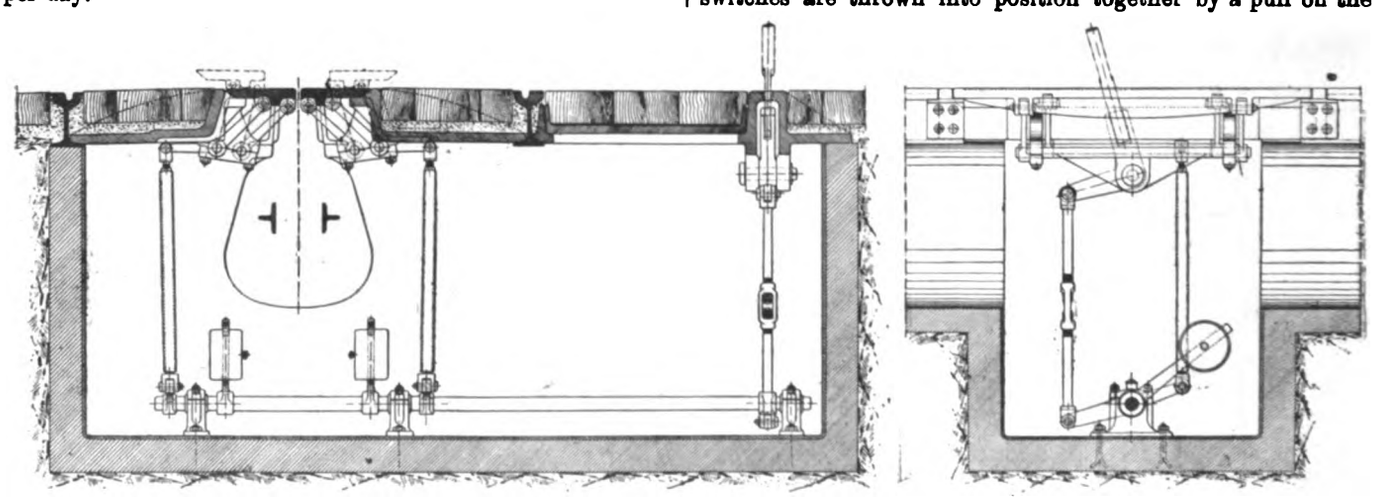


Fig. 7.—Showing Position of Plough in Central Conduit.

at the Etoile-Montparnasse terminus (Fig. 2), and represents a design which has been in use with success on the lines of the Lyons Omnibus and Tramways Co. The slot and track switches are thrown into position together by a pull on the



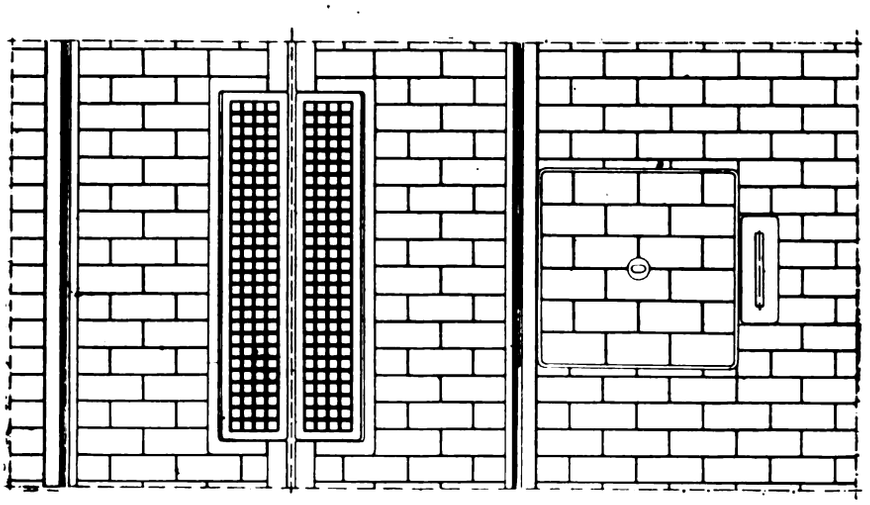


Fig. 6.—Views showing Arrangements for Widening Slot to Permit Removal of Plough.

The above method of construction ensures great solidity. The swelling of the wood blocks will not affect the width of the slot, and the conduit is able to resist very great pressures; but not so for the rails. These, not being supported on a concrete bed, have experienced slight tilting. The use of wood pavement introduces the most complicated problems to

detachable switch lever placed outside of the track. The arms which push the slot tongue are inclined to the slot. The plough in passing pushes them back under the slot-rail, the force required to do this being so very slight that there is no danger of damage to the plough or the carrier. The whole arrangement is clearly indicated in the drawing (Fig. 4).

Across the Pont d'Alma, where the line crosses the Seine, the height of the masonry necessitated the construction of a special form of conduit represented in Fig. 5. It consists of cast-iron tubes, strengthened by an exterior web every metre length. A special Z-bar is bolted to steel plates on the tube forming the slot rail. The rods are held in position by special steel castings acting as tie-rods. This construction necessitates the conductor bars being raised about 12cm. (4¾in.) above their level in the normal conduit. Special means are therefore required to raise or lower the plough for passage over this bridge, independently of the arrangements for passage from the conduit to the trolley line.

The solution to the latter problem, obtained by arranging to attach or detach the plough, as the case may be, and in actual

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employ on two lines in the United States, is far too primitive to be satisfactory in cases where there is a frequent service. At Berlin, Brussels, and, more satisfactorily still, at Budapest, the most practical method was found to consist in providing means on the car for raising or lowering the plough when necessary. The width of the slot required for this purpose

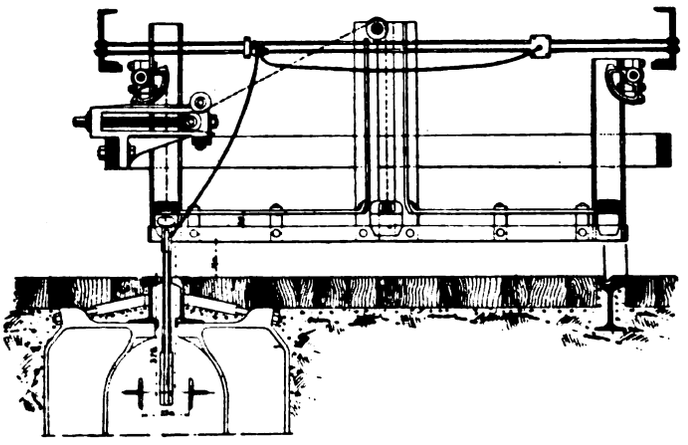

FIG. 8.—SHOWING POSITION OF PLOUGH IN STANDARD SIDE CONDUIT.

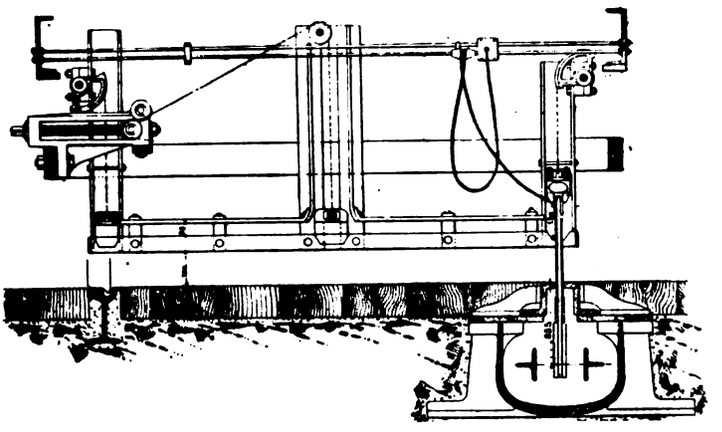

FIG. 9.—SHOWING POSITION OF PLOUGH IN SHALLOW SIDE CONDUIT.

becomes a very important consideration, and the design of the plough itself becomes serious. After careful consideration, it was decided to adopt the method now in use in Washington. This consists in making the plough in the shape of cast-iron shoes, which are pressed sideways by light semi-elliptic springs and supported on horizontal links which limited their outward play. These links absorb all the joltings and rough treatment of the rails, the mechanical strength of the springs being then unimportant, their function being simply to press the slots lightly against the conductor rail. The advantage of being able to raise or lower the plough at any point on the line had, in this design, to be sacrificed, though this advantage is probably exaggerated, for all that is really required is to be able to make these changes at the junction of trolley and conduit sections.

The necessity for making a slot opening wide enough to permit of the free passage of the plough, and which could be rapidly opened or closed, was met in the manner shown (Fig. 6). In the slot are placed two cast-steel covers supported on the one side by a cast-iron frame and the ends by angle irons bolted to the slot rails. These covers are raised to the dotted position shown by a single motion of a removable lever outside of the track. The use of counterweights simplifies this operation. Sheet-iron guides (not shown) are fastened to the conductor rails, and direct the shoes when the plough is lowered. The covers are opened by the conductor, who also raises or lowers the plough from the side of the car in the manner to be explained.

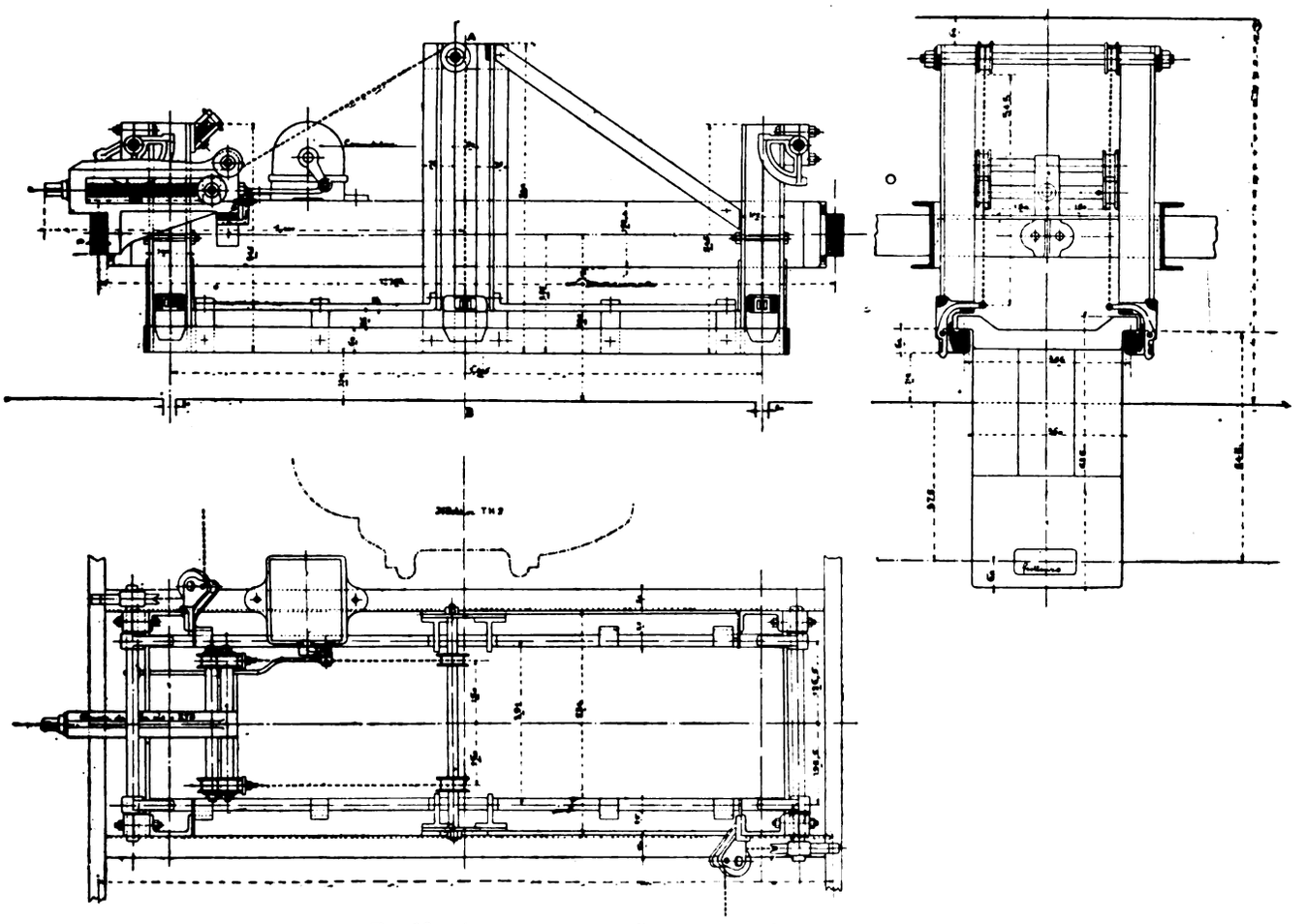

FIG. 10.—ARRANGEMENT FOR CARRYING AND RAISING PLOUGH.

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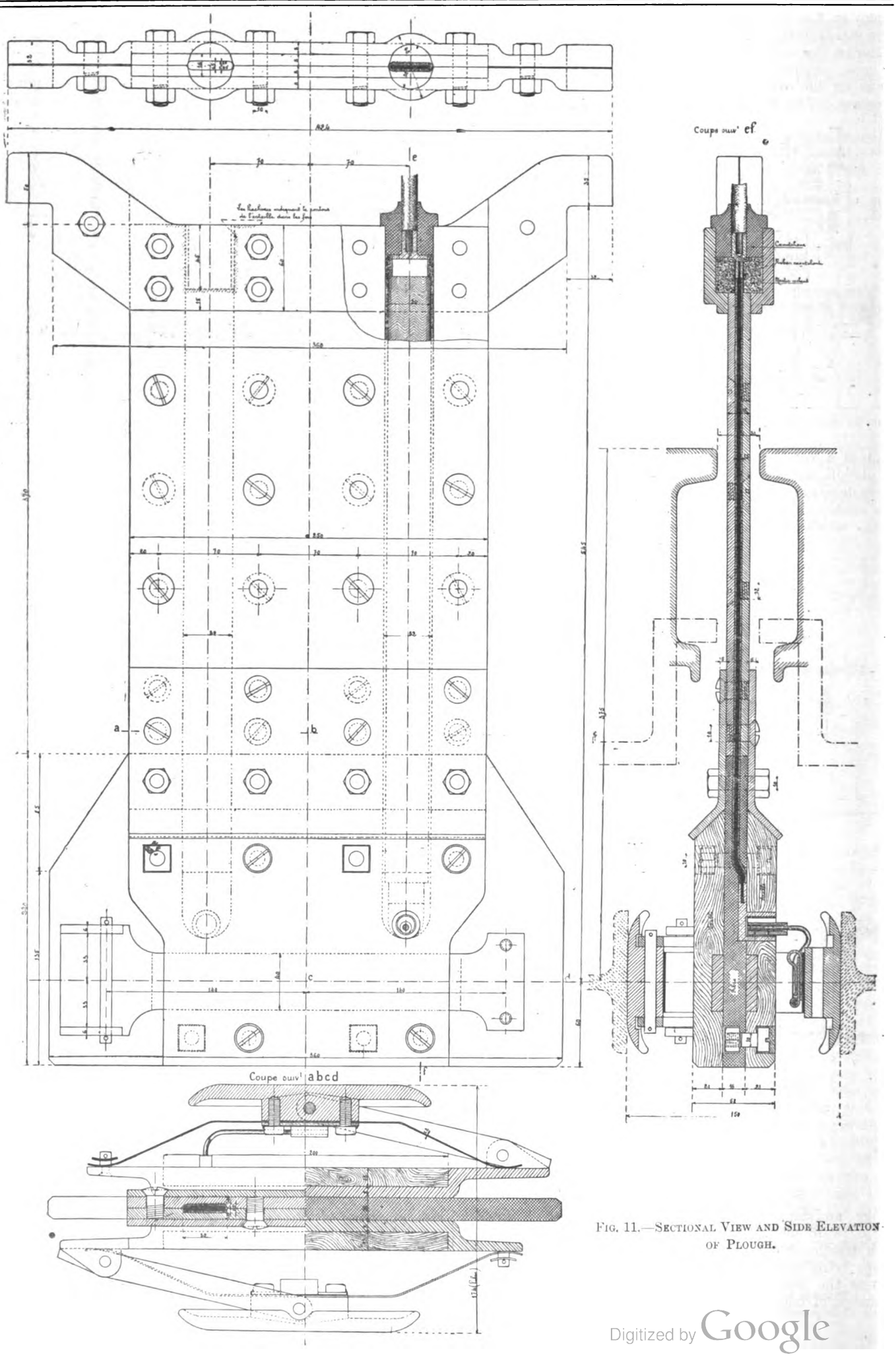

FIG. 11.—SECTIONAL VIEW AND SIDE ELEVATION OF PLOUGH.

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The most difficult problem consisted in the design of the carrier. The conditions which this had to fulfil were: (i.) The plough should be able to slide laterally right across the track; (ii.) it should be capable, when in its central position, of being withdrawn or introduced, as the case may be; (iii.) it should be raised or lowered from each of its side positions the necessary distance between the height of the conductor rails and the shallow conduit of the Pont d'Alma; and (iv.) at the contact points of trolley and conduit lines the same operation of raising or lowering the plough should also automatically change the circuits. The necessity for this change arises because the conduit circuit is a completely insulated one, while on the trolley the return is by the rails.

The views (Figs. 7, 8, 9) show the action of the plough in three different conduits, and give some idea of the operating mechanism. The plough is deflected to the centre, and is raised or lowered by means of the trap already described (Fig. 4). The plough-carrier is shown in greater detail (Fig. 10). This plough is raised from its central position by the screw bolted to the side-bar of the track, and turned by the controller handle which simultaneously switches on the circuits, by means of the bar attached to the commutators.

The "commutator" is in construction based on a car controller, with finger-tips, cylinder, and spring to make a sharp break, so as to avoid destructive arcs. The entire lifting device, here explained, differs from the type used on the Bastille-Charenton, Nice, and Lyons lines, in that on these lines the lifting chains are attached directly to the plough. This cannot be used where the plough can shift the whole width of track, and the chains are therefore attached to a "cape," in which the plough slides. The design of the plough needed a special study. The form finally selected is shown in Fig. 11.

There are numerous other points of interest connected with this line, but enough has been said to show that the line posseses many novel features.

VARIATION OF RESISTANCE UNDER MECHANICAL PRESSURE.

BY LAWRENCE BIRKS, B.SC., A.M.I.E.E.

An interesting article appeared in *Nuovo Cimento* of August last, describing a series of experiments by Prof. S. Lussana, which throws open a new question in the relationship between molecular condition and electric conductivity. Wires of various metals and alloys were wound on ebonite cylinders immersed in oil and subjected to pressures ranging up to 1,000 atmospheres. Their resistance was determined at various pressures, with the results plotted in Fig. 1. As shown by these curves, the resistance falls off as the pressure increases, tending toward a minimum value. For lead the fall is so rapid that the curve (shown dotted) had to be reduced to one-tenth the scale employed for the other metals in order to bring it into the same diagram. The variation of temperature accompanying the increase in pressure was determined thermo-electrically, and its effect on the resistance eliminated in the calculations. As in the case of the temperature variation, it will be noticed that the coefficient is much smaller for alloys than for the pure metals, the actual values per atmosphere being:—

Lead	194×10^{-7}	"Argentana"	$9\cdot7 \times 10^{-7}$
Iron	38×10^{-7}	"Nickelina"	$7\cdot4 \times 10^{-7}$
Silver	32×10^{-7}	"Constantea"	$7\cdot9 \times 10^{-7}$
Copper	31×10^{-7}	Manganin	$5\cdot6 \times 10^{-7}$
Platinum	24×10^{-7}	Brass	$4\cdot3 \times 10^{-7}$
Nickel	19×10^{-7}		

Comparing these with the coefficients of volume and temperature, the author concludes that the specific resistance of a metal depends not only on its state of molecular aggregation, but also on the velocity of its molecular vibration. In the above series of observations a period of an hour elapsed between the alteration of pressure and the measurement of resistance, allowing the quantities to settle down to a steady value. Under these conditions the curves taken with increasing and with diminishing pressures are practically the same.

But a phenomenon of much greater interest was discovered when observations of the resistance were taken at frequent

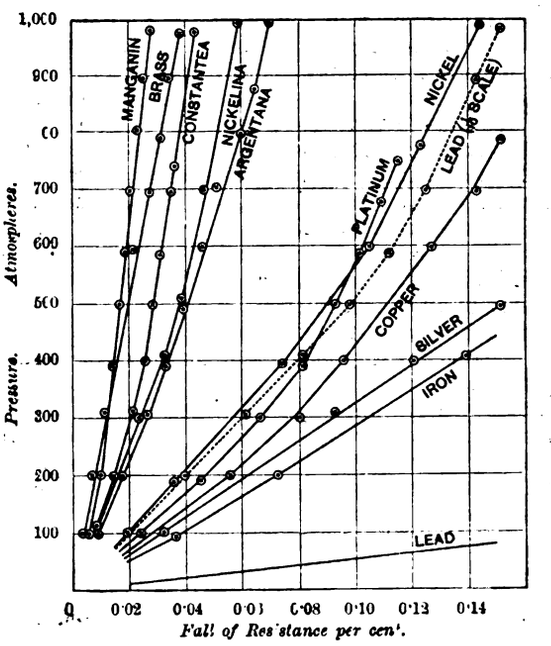

FIG. 1.

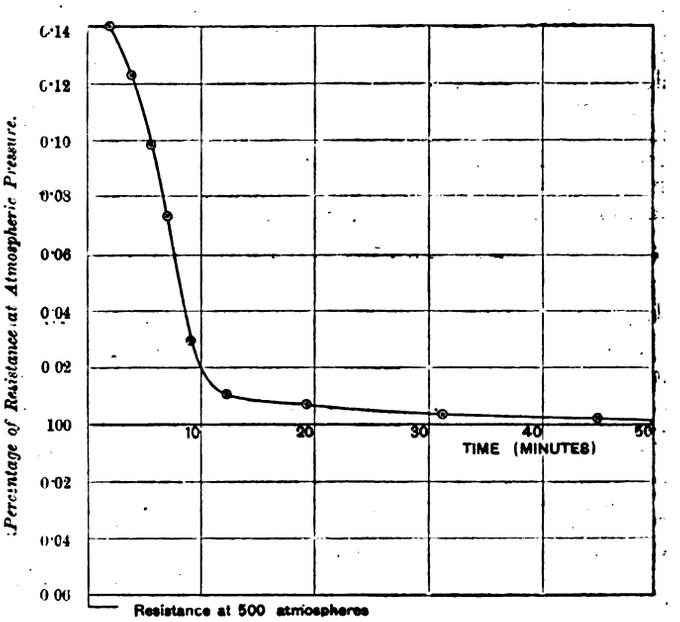

FIG. 2.

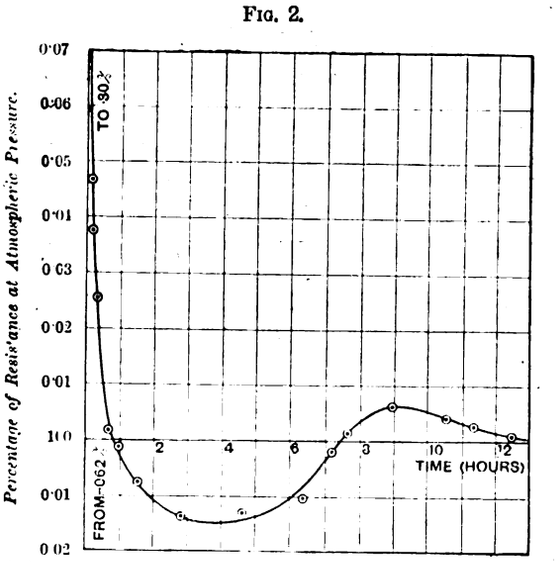

FIG. 3.

intervals, commencing immediately after the alteration of pressure. In addition to the permanent change in resistance

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corresponding to the altered pressure, a much larger temporary change takes place, the duration of which depends, curiously enough, on the duration of the previous condition; in other words, on the former history of the wire. The variation of resistance appears to correspond to the motion of an imperfectly elastic spring immersed in a viscous fluid, and which, when displaced, springs beyond its normal position and returns gradually to that position under the influence of its elasticity; this elasticity depending on the duration of the former state of strain: the longer this duration, the smaller the elasticity and the slower the return. The time of return in the case of the resistance of a wire is relatively long. This is clearly shown in Fig. 2, which refers to a wire of platinum subjected to a pressure of 500 atmospheres for an hour, measurements of the resistances being measured at intervals after the pressure was released showing that it took another hour to assume a steady value.

The analogy with imperfect mechanical elasticity breaks down in an unexpected way if the previous condition of the wire be of much longer duration. For the variation in resistance assumes under this condition the form of an oscillation about the normal value—a strongly damped oscillation of very long periodic time. The elasticity is increased instead of being reduced. This is illustrated in Fig. 3, which represents the temporary variation in the resistance of the same platinum wire as in Fig. 2, but when released after having been subjected to a pressure of 500 atmospheres for 24 hours. In this case the resistance took 14 hours to assume a steady value, executing in that time three irregular semi-oscillations about its steady value with amplitudes of 0·3, 0·014, and 0·006 per cent.

The very long periodic time of several hours makes it very improbable that this oscillation is the result ef any mechanical reaction. It is most likely connected in some way with the molecular vibration of the mass of metal, but its real nature remains to be solved by a future investigator.

BOOKS RECEIVED.

(Copies of any of the undermentioned works can be had from *The Electrician* office post free, on receipt of published price.)

"Signalling Through Space Without Wires," being a description of the work of Hertz and his successors. By Prof. O. J. Lodge, F.R.S. Third Edition. (London: *The Electrician* Printing and Publishing Co.) 5s.

"Lubrication and Lubricants." By Leonard Archbutt and R. Mountford Deeley. (London: Charles Griffin and Co.) 21s.

"Lockwood's Builders', Architects', Contractors', and Engineers' Price Book for 1900." Edited by Francis T. W. Miller. (London: Crosby, Lockwood and Son.) 4s.

"Bent Iron or Strip-Work. By G. Day and C. G. Leland (London: Dawbarn and Ward.) 6d.

"Telephones and Microphones: How to Make and Use Them." Edited by Percival Marshall. No. 4 of "The Model Engineer" Series. (London: Dawbarn and Ward.) 6d.

"The Official Gazette of the United States Patent Office." No. 13. Vol. LXXXIX. Published by authority of Congress (Washington: Government Printing Office.)

"Annual Report of the United States Commissioner of Patents for the Year 1898." (Washington: Government Printing Office.)

ELECTRICITY WORKS ACCOUNTS.

Dundee Municipal Electric Supply Works.

Very satisfactory indeed are the results of the working during 1898 of the Dundee municipal electric supply undertaking. In the matter of output we are able to chronicle an advance of nearly 40 per cent., the units sold during the year having exceeded those of 1897 by 128,755, thus reaching 451,942. The lamp connections have gone up by 32 6 per cent., the equivalent of 6,967 8 c.p. lamps having been connected during the year.

In spite of a reduction in the total average revenue from 4·47d. to 3·86d. per unit, the working profit has been more than maintained by the very material reduction in the costs, which in the aggregate are now quite 0·5d. below the average at the output. All the items of generating costs, except perhaps repairs and maintenance at the station, are also well below the average of municipal stations in 1898 irrespective of output. The repairs item, however, at 0·226 is by no means abnormal.

The year's working profit of £3,459, or 8 12 per cent. of the mean capital, compares well with the 1897 result. Interest charges have absorbed £818 and the sinking fund £700, resulting in a net profit of £1,941 for the year.

Aberdeen Municipal Electric Supply Works.

The accounts of the Aberdeen municipal electric supply undertaking for 1898 indicate a more than maintenance of the good progress and position which, from the commencement of supply, has characterised the concern. The output of 1898 exceeded that of the preceding year by 125,331 units sold—being an increase of no less than 43·7 per cent. Excellent indications for 1899 are contained in the large number of new consumers and lamps connected—the latter raising the total equivalent lamp connection from 29,635 8 c.p. lamps to 35,794, or nearly 21 per cent.

As at Dundee, so here the working profit has been well maintained by economies in the working expenditure in spite of a reduced average revenue. Unfortunately, the fuel item is still increasing, as it did last year, though it cannot be said that 0·45d. per unit on this score is anything but low at the output.

The other items of works costs, and also the management and property charges, have fallen, and the aggregate costs, like those at Dundee, are exceedingly satisfactory. The provision for reserve funds has been well kept up at Aberdeen. In 1898, after satisfying the interest charges, amounting to £1,405, £1,463 was set aside to the depreciation fund and £905 for the redemption of debt. With a working profit of £4,242, the net profit for the year was £469.

It was found necessary to take steps to lessen the leakage arising from the change-over to a higher electrical pressure on the mains. This involved inserting new insulators in place of the original ones in connection with the copper strip conductors. A proportion of the cost of this charge, amounting to £595, was charged to the revenue and expenditure account, but for comparative purposes this sum would have appeared unfairly therein, and we have only allowed it to appear in the net revenue account, where it has caused a deficit of £126.

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

Aberdeen (Municipal)	Jan.	6, 1899	Lancaster (Municipal)	Oct.	21, 1898
Ayr (Municipal)	Sept.	22, ,,	Leeds (Municipal)	Dec.	1, 1899
Bedford (Municipal)	May	19, ,,	Leicester (Municipal)	Jan.	20, ,,
Belfast (Municipal)	Sept.	15, ,,	Leyton (Municipal)	Sept.	8, ,,
Birmingham (Company)	Sept.	15, ,,	Liverpool (Municipal)	June	9, ,,
Blackpool (Municipal)	Sept.	29, ,,	Manchester (Municipal)	Aug.	11, ,,
Bournemouth (Company)	April	21, ,,	Newcastle and District (Co.)	Oct.	6, ,,
Bolton (Municipal)	Nov.	24, ,,	Newcastle-upon-Tyne (Co.)	April	14, ,,
Bradford (Municipal)	April	14, ,,	Newport (Mon.) (Municipal)	Dec.	15, ,,
Brighton (Municipal)	May	12, ,,	Northampton (Company)	Oct.	20, ,,
Bristol (Municipal)	July	14, ,,	Norwich (Company)	Nov.	17, ,,
Burnley (Municipal)	Aug.	25, ,,	Notting Hill (Company)	Mar.	17, ,,
Burton-upon-Trent (Mun.)	April	21, ,,	Nottingham (Municipal)	July	21, ,,
Bury (Municipal)	Sept.	22, ,,	Oldham (Municipal)	Dec.	1, ,,
Cambridge (Company)	Mar.	10, ,,	Oxford (Company)	May	19, ,,
Cardiff (Municipal)	Dec.	15, ,,	Pontypool (Company)	May	5, ,,
Charing Cross (Company)	Mar.	17, ,,	Portsmouth (Municipal)	July	14, ,,
Chelsea (Company)	Mar.	31, ,,	Prescot (Company)	Dec.	8, ,,
Cheltenham (Municipal)	Nov.	10, ,,	Preston (Company)	Sept.	29, ,,
Chester (Municipal)	June	23, ,,	Reading (Company)	Oct.	13, ,,
City of London (Company)	May	12, ,,	Richmond (Company)	Oct.	12, ,,
Clerkenwell (Company)	Aug.	18, ,,	Scarborough (Company)	Nov.	3, ,,
Derby (Municipal)	Dec.	9, 1898	St. Helens (Municipal)	Dec.	8, ,,
Dewsbury (Municipal)	Nov.	24, 1899	St. James' & Pall Mall (Co.)	Feb.	24, ,,
Dover (Company)	June	2, ,,	St. Pancras (Vestry)	May	26, ,,
Dundee (Municipal)	Nov.	4, 1898	Sheffield (Municipal)	Dec.	29, ,,
Eastbourne (Company)	July	22, ,,	Shoreditch (Vestry)	Oct.	27, ,,
Edinburgh (Municipal)	Nov.	17, 1899	Southampton (Municipal)	Nov.	10, ,,
Exeter (Municipal)	Aug.	5, 1899	Southport (Municipal)	July	7, ,,
Glasgow (Municipal)	Sept.	1, 1899	South Shields (Municipal)	July	7, ,,
Guildford (Company)	May	5, ,,	Stafford (Municipal)	Dec.	29, ,,
Halifax (Municipal)	July	21, ,,	Sunderland (Municipal)	July	28, ,,
Hammersmith (Vestry)	May	26, ,,	Taunton (Municipal)	June	16, ,,
Hampstead (Vestry)	Aug.	25, ,,	Tunbridge Wells (Mun.)	Sept.	1, ,,
Hanley (Municipal)	April	28, ,,	Wakefield (Municipal)	Dec.	1, ,,
Harrogate (Municipal)	Oct.	20, ,,	Walsall (Municipal)	June	23, ,,
Harrow (Company)	June	16, ,,	Wandsworth (Company)	Aug.	18, ,,
Hast'gs & St. Leonards (Co.)	April	20, 1893	Westminster (Company)	Feb.	24, ,,
H'use-to-H'useCo. (K'ns'gt'n)	Mar.	31, 1899	Whitehaven (Municipal)	July	28, ,,
Hove (Company)	Mar.	10, ,,	Windsor (Company)	Dec.	21, ,,
Huddersfield (Municipal)	Oct.	6, ,,	Woking (Company)	Dec.	22, ,,
Islington (Vestry)	Oct.	27, ,,	Wolverhampton (Municipal)	June	30, ,,
Kens'gton & Knightsbr' (Co.)	Mar.	3, ,,	Woolwich (Company)	Jan.	12, ,,
Kingston-upon-Hull (Mun.)	June	9, ,,	Worcester (Municipal)	April	7, ,,
Kingston-on-Thames (Mun.)	April	21, ,,	Yarmouth (Municipal)	Nov.	3, ,,

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	DUNDEE.		ABERDEEN.	
Undertaking Worked by	Dundee Corporation.		Aberdeen Corporation.	
Date of Commencement of Supply	March, 1893.		March, 1894.	
System of Supply	Three-wire continuous-current, with batteries.		Three-wire continuous-current.	
Chief Engineer	W. H. Tittensor.		J. A. Bell.	
YEAR ENDED	DEC. 31, **1897.**	DEC. 31, **1898.**	DEC. 31, **1897.**	DEC. 31, **1898.**
QUANTITIES—				
Units generated	411,521	557,900	317,552	471,965
„ SOLD (TOTAL)	323,187	451,942	287,072	412 353
„ sold to consumers	315,680	407,339	271,762	376.088
„ sold for public lighting, &c.	7,507	44,603	15,310	36,265
„ used on works	41,914	37,818	6,524	11,553
UNITS SOLD PER 8 C.P. LAMP CAPACITY	18·5	24·2	15·04	13·2
Maximum supply demanded	448	623	368·5 kilowatts	510·4 kilowatts
Number of public lamps	4 arc	44	22 arc, 2 (32-c.p.) glow	36 arc, 200 glow *f*
Number of consumers	338	400	279	395
Connections to mains in 8-c.p. lamps	21,374	28,341	29,635	35,794
CAPACITY OF PLANT IN 8-C.P. LAMPS	17,500	18,700	19,080	31,250
CAPACITY OF PLANT IN KILOWATTS	560	683	610·8	1,000
CAPITAL—	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.
AUTHORISED (TOTAL)	£40,000 / £71·4	£96,000 / £141	£52,000 / £85·1	£67,000 / £67·0
Share	— / —	— / —	— / —	— / —
Loan (including Debenture charges)	40,000 / 71·4	96,000 / 141	52,000 / 85·1	67,000 / 67·0
RECEIVED (TOTAL)	41,450 / 74·1	41,450 / 60·7	45.086 / 73·8	62,741 / 62·7
Share	— / —	— / —	— / —	— / —
Loan (including Debenture charges)	41,450 / 74·1	41,450 / 60·7	45,086 / 73·8	62,741 / 62·7
AUTHORISED BUT NOT YET RECEIVED-(TOTAL)	—[a] / —	— / —	6,914 / 11·31	4,259 / 4·26
Share (unissued)	— / —	— / —	— / —	— / —
Share (uncalled)	— / —	— / —	— / —	— / —
Loan (including Debentures)	—[a] / —	— / —	6,914 / 11·31	4,259 / 4·26
REPAID (TOTAL)	11,750 / 21·0	15,250 / 22·3	2.155 / 3·53	3,078 / 3·08
RESERVE OR SINKING FUND	191 / 0·341	903 / 1·32	— / —	— / —
DEPRECIATION FUND	— / —	— / —	2,865 / 4·69	4,328 / 4·33
EXPENDED (TOTAL)	39.750 / 71·0	45,409 / 66·6	48,423 / 79·3	66,107 / 66·1
Lands and buildings	4,594 / 8·21	4,634 / 6·79	8,677 / 14·2	9,564 / 9·56
Plant	18,384 / 32·8	21,071 / 30·9	23,505[a] / 38·5	28,559 / 28·6
Mains	13,904 / 24·8	16,688 / 24·5	16,242 / 26·6	27,984 / 28·0
Miscellaneous	2,863 / 5·12	3,016 / 4·42	— / —	— / —
BALANCE OF CAPITAL ACCOUNT	+1,700 / +3·04	−3,959[d] / −5·80	−3,337[b] / −5·46	−3,366[b] / −3·37
REVENUE—	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.
TOTAL	£6,015 / 4·465d.	£7,267 / 3·860d.	£5,708 / 4·772d.	£7.622 / 4·438d.
Revenue from supply	5,875 / 4·360d.	6,774 / 3·595d.	5,373 / 4·490d.	7,068 / 4·115d.
„ meters, &c.	— / —	— / —	78 / 0·065d.	nil / —
„ public lighting	140 / 0·104d.	493 / 0·262d.	257 / 0·215d.	554 / 0·323d.
„ sale of lamps, &c.	— / —	— / —	— / —	— / —
„ miscellaneous sources	— / —	— / —	— / —	— / —
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	£3,227 / 2·396d.	£3,809 / 2·024d.	£2,596 / 2·168d.	£3,379 / 1·967d.
WORKS COSTS	2,063 / 1·531d.	2,460 / 1·307d.	1,659 / 1·387d.	2,166 / 1·261d.
Generation of electricity	*1,920 / 1·426d.*	*2,247 / 1·194d.*	*1,502 / 1·256d.*	*1,958 / 1·141d.*
Fuel (including cartage, &c.)	840 / 0·624d.	1,061 / 0·564d.	451 / 0·377d.	770 / 0·448d.
Oil, waste, water, stores	206 / 0·153d.	219 / 0·116d.	146 / 0·122d.	182 / 0·106d.
Wages at station	532 / 0·395d.	542 / 0·288d.	554 / 0·463d.	650 / 0·379d.
Repairs and maintenance at station	343 / 0·254d.	425 / 0·226d.	351 / 0·293d.	355 / 0·207d.
Distribution of electricity	*26 / 0·019d.*	*94 / 0·050d.*	*157 / 0·131d.*	*208 / 0·121d.*
Wages, &c.	26 / 0·019d.	94 / 0·050d.	— / —	— / —
Repairs, renewals of mains, &c.			157 / 0·131d.	208 / 0 121d.
Public lighting	*117 / 0·087d.*	*119 / 0·063d.*	— / —	— / —
Attendance	117 / 0·087d.	119 / 0·063d.	— / —	— / —
Renewals			— / —	— / —
MANAGEMENT AND PROPERTY CHARGES	1,164 / 0 864d.	1,349 / 0·717d.	937 / 0·784d.	1,213 / 0·706d.
Royalties	— / —	— / —	— / —	— / —
Rent, rates, taxes	*701 / 0·520d.*	*744 / 0·395d.*	*402 / 0·336d.*	*520 / 0·303d.*
Management	*463 / 0 344d.*	*605 / 0·321d.*	*535 / 0·447d.*	*693 / 0·403d.*
Salaries	342 / 0·254d.	482 / 0·256d.	313 / 0·262d.	336 / 0·196d.
Stationery, &c.	38 / 0·028d.	72 / 0 038d.	100 / 0·084d.	130 / 0·076d.
Establishment charges	66 / 0·049d.	34 / 0·018d.	97 / 0·081d.	87 / 0·051d.
Law charges, &c.	17[b] / 0·013d.	17[b] / 0·009d.	25[c] / 0·021d.	140[g] / 0·082d.
FINANCIAL RESULTS—	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded
WORKING PROFIT FOR YEAR	£2.787 / 7·24%	£3.459 / 8·12%	£3,111 / 7·32%	£4,242 / 7·42%
Sum carried to Depreciation Fund	— / —	— / —	1,024 / 2·41%	1,463 / 2·56%
Sum carried to Reserve or Sinking Fund	700 / 1·82%	700 / 1·64%	768 / 1·81%	905 / 1·58%
Net interest on loans (incl. Debenture charges)	765 / 1·99%	818 / 1·92%	1,150 / 2·71%	1,405 / 2·45%
BALANCE FROM LAST ACCOUNT	1,064 / 2·77%	1,714 / 4·03%	— / —	— / —
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	2,386[c] / 6·21%	3,273[c] / 7·70%	169[d] / 0·398%	— / —
Deficit	— / —	— / —	— / —	*126[h] / 0·22%*
ORDINARY DIVIDEND PAID	— / —	— / —	— / —	— / —
PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE	53·7%	52·4%	45·5%	44·4%
Expenditure per kilowatt capacity	£5. 15s. 4d.	£5. 11s. 7d.	£4. 5s. 0d.	£3. 7s. 7d.
REVENUE PER KILOWATT CAPACITY	£10. 14s. 10d.	£10. 12s. 10d.	£9. 7s. 0d.	£7. 12s. 5d.
Expenditure per 8-c. lamp capacity	3s. 8½d.	4s. 0½d.	2s. 8½d.	2s. 2d.
REVENUE PER 8-C.P. LAMP CAPACITY	6s. 10½d.	7s. 9½d.	5s. 11½d.	4s. 10½d.
REVENUE PER 8-C.P. LAMP CONNECTED	5s. 7½d.	5s. 1½d.	3s. 10½d.	4s. 3d.
Price charged for lighting, per unit	5d. to 4d., less 5%	4d. to 3d.	6d to 3d.[e]	6d. to 3d.
Price charged for power, per unit		2d.		4d. to 1½d.
Price charged for public lighting		£16. 10s. per lamp per [ann.		6d. to 3d.

DUNDEE.—REMARKS—*a* £1,450 borrowed over and above the £40,000 sanctioned. *b* Insurance. *c* Out of which £673 is "repaid to Gas Department." *d* Over-expended. *e* After deducting £281 repaid to Gas Department.

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The Oldest Electrical Journal (established as a weekly Journal 1861—1878)

Published every Friday, Price Sixpence; Post Free, Sixpence-Halfpenny
Editorial, Publishing and Printing Offices,
I, 2 & 3, SALISBURY COURT, FLEET ST., LONDON,
Telephone: 949 Holborn. *Telegrams:* "ELECTRICIAN NEWSPAPER LONDON."

All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher "THE ELECTRICIAN," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN" *Printing and Publishing Company, Limited, and be crossed* "*Coutts and Co.*"

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FUEL SUPPLY PROSPECTS.

The most urgent matter at electric power stations, at the present moment, is the difficulty of obtaining fuel; the most alarming feature in the outlook—the prospect of a further rise above the exorbitant figure to which the price of coal has already risen. We do not take an alarmist attitude; we are not of the same mind as those who recently have been proclaiming that the end of cheap and abundant coal supply has arrived in England. But we cannot ignore the facts, that prices have rapidly risen to a figure which must seriously affect the cost of production of electric energy, that prices once up usually show great disinclination to fall to their former level, and that supplies of coal of any sort are limited, and supplies of really good steam coal even still more restricted. Speculation is rife as to the cause of this coal famine. Some have blamed the South African war, forgetting that vessels which require coal for transport purposes would otherwise require it for ordinary service, and overlooking the fact that the war—as our contemporary the *Statist* rightly points out—has reduced nearly to zero the normal coal consumption on South African railways. No doubt there are certain demands, such as the special requirements of the Admiralty, which have contributed to bring about this lowness of commercial stocks and highness of prices; but we believe that these results are to a far greater extent due to artificial limitation of output for the express purpose of inflating prices. If this view be the correct one, colliery men are playing a dangerous game, the effects of which must recoil disastrously upon their own heads. Whether, indeed, it be true, as our contemporary believes, that "in dear coal we perceive the first signal of the coming reaction," it is certain that in prolonged inflation of prices such as exists now industry will be seriously embarrassed. And the electric supply industry will not be the last to suffer therefrom. True, allied industries, such as the manufacture of coal gas, will correspondingly suffer, and this may temper the relative amount of injury wrought. But even though the advantages of rival industries like these may not be relatively disturbed, the absolute costs of production and the quantities of the commodities sold—whether of electricity or gas—are

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certain to be prejudicially affected. This alone is sufficient to produce a period of depression in electrical supply; and it will be small comfort to the supply undertakers to reflect that their gas rivals are in a similar plight.

The prospect of continuance for some time of this high price of coal leads us to a consideration as to whether other sources of fuel supply are adequately available. We should also pay some attention to the probable influence such a change of market would produce. Failing the best steam coal, usually obtainable from South Wales, we have already been compelled to make shift with limited supplies of the inferior and far from smokeless coals of the North Country. Public opinion has been compelled for the time being to suspend the customary objection to smoke production, and, indeed, the public may be thankful at this time for even small mercies. But there are not wanting indications that the prices and limited stocks of these inferior steam coals will soon render their general use difficult and costly. When best Welsh coal rules at from 27s. to 30s. per ton, and 16s. to 18s. is obtainable for Newcastle coal, this prospect is far from being imaginary. Coke naturally suggests itself; but, so far as electric power works are concerned, it is unfortunately the fact that the gas companies are in a position to lay the first hands on this fuel, as they can readily employ it to manufacture a certain proportion of their gas by the carburetted water gas process. We understand that the coke supplies are even more restricted than are those of steam coal. It is therefore practically certain that a prolonged or permanent reduction in the supply of coal, and consequent heavy inflation of prices, would place the industrial world at the mercy of petroleum-yielding countries. Chief among these are Russia and the United States of America; and it is singularly unfortunate in this connection that there is so little petroleum obtainable in any of our present British possessions. We are convinced, however, that in forecasting the time when petroleum will seriously take the place of coal we are looking forward to a very distant date—with the obvious exception, of course, that temporary use might be made of petroleum during transient coal crises such as the present.

Difference of opinion among electric supply engineers might not unnaturally arise as to the applicability of liquid fuel to electric power stations. The experiment of using it in a portion of the boiler plant has been made, with some success, under Mr. Crompton's direction; and it will be remembered that Mr. Crompton rather strongly advocated its use in a Paper on the "Cost of Electrical Energy" which he read before the Institution of Electrical Engineers on April 26th, 1894. Ordinary refined petroleum is too costly for this purpose; but it was pointed out by the advocates of oil fuel that on some of the Russian railways and river steamers petroleum residuum—known as *astatki*—was being used; also that the Great Eastern Railway Co. had adopted oil fuel for one of their locomotives, green oil being used in this latter case. Since that date the employment of oil fuel has greatly increased, even in this country; but it has not been adopted, save in one or two experimental instances, in our electric power stations. It must be admitted, even by the strongest advocates of oil fuel for ordinary steam raising, that with coal at a reasonable price the cost of oil fuel is, generally speaking, prohibitive. Undoubtedly there are advantages in its use which may recommend it for auxiliary purpose, as, for example, in stand-by boilers. Home supplies of this class of fuel are, indeed, so extremely limited that a small rise in the demand would soon send prices up to a prohibitive figure. As to the Russian astatki, it is of barely more than academic interest to know that this can be obtained in the Caucasus for sixpence per ton; the vital question is its price delivered in English works, and there is practically no transport of the commodity to this country. The same remarks will apply to American residuum, which, however serviceable in the United States, costs too much in transport to be of general utility here. On the other hand, the present high prices of steam coal are dangerously near the limit at which it would pay better to use Russian astatki, even allowing for a rise in the cost of transport of this article. There opens up, therefore, no unreal prospect that a considerable market for petroleum refuse may be created in this country by a prolongation of the coal famine. Our present purpose, however, is to inquire whether it would not be advisable for electric power station engineers to make suitable provision for the use of oil fuel as a stand-by. We believe that this form of fuel might advantageously be adopted for a certain proportion of the boiler plant at all times, leaving the remainder of the boilers to be fired by coal in ordinary circumstances. But even these latter could easily be constructed so that conversion from coal firing to oil firing could quickly and cheaply be effected. Armed with arrangements of this description, the power station engineer could defy coal famines on the one hand and petroleum rings on the other. He would always be in a position to choose his market, and neither scarcity of coal nor artificial prices of liquid fuel would seriously embarrass him. And, we would add, what is true in this respect of electric power stations is true also of all steam generating plant for industrial purposes. The way is open for the industrial world to shake off the fetters of a coal crisis by alternatively using cheap oil fuel.

REVIEWS.

(Copies of any of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price.)

The Rontgen Rays in Medical Work. By David Walsh, M.D. Second edition, 257 pp., 103 illustrations. (London: Bailliére, Tindall & Cox. 1899.) 10s. 6d.

A call for a second edition of this book so soon after the publication of the first proves its usefulness to workers with the X-rays. In many respects it is an excellent work. Dr. Walsh divides his subject into two distinct parts. Part I. treats of the sources of electricity, and gives a good and full account of the induction and Tesla coils, the vacuum tube, and the method of exhaustion and other accessory apparatus. In describing the stereoscopic method of working with the X-rays we think Dr. Walsh has not put sufficient stress on this beautiful method of taking skiagrams. In the second part of the book Dr. Walsh deals with the application of the X-rays to surgery and medicine, and gives a very good description of the method of localising foreign bodies in the tissues. The chapter on the use of the X-rays in medicine is not perhaps quite so full as it might be. There are short chapters on the use of the Röntgen rays in dental and aural surgery, as also one on the application of the rays to obstetrical practice. The book is illustrated with some very good skiagrams but they are very unequal in merit: the skiagrams, for instance, on p. 145 might really be anything. In the anatomical section of the book there are two very beautiful skiagrams, by Dr. Dawson Turner, of an injected kidney and heart. There are a few clerical errors, which might be corrected in a future edition. On the whole, Dr. Walsh has produced a very good book, which should be in the hands of all X-ray workers.

Magnetism and Electricity for Beginners. By H. E. Hadley, B.Sc. (Lond.), A.R.C.Sc. (Lond.). (Macmillan and Co. 1899.)

This little book was primarily intended by its author to meet the requirements of students preparing for the elementary stage of the Science and Art Department's examination in magnetism and electricity, but its scope has been enlarged so as to include the additional portions needed in examination for the London matriculation. A chapter on force, work, and energy has been inserted early in the book, because

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want of knowledge of their elementary facts often handicaps a beginner in the study of magnetism and electricity, and they are treated simply and clearly. The method of the book is experimental, and the student who works carefully through it will have learnt by his own experience the facts on which the theories of magnetism and electricity have been based. But although the experimental principle is a good one, it may be doubted whether it is not carrying it too far when the instructions are given with as much minuteness as they are in this book. A student learns more from one experiment which he has experienced some difficulty in performing than from a dozen which have been so carefully explained to him that he has not been required to use his own intelligence at all in their performance.

Magnetism and Electricity. An Elementary Treatise for Junior Students, Descriptive and Experimental. By J. PALEY YORKE. (London: Edward Arnold. 1899.) 3s. 6d.

In an elementary text-book one cannot expect to find any great novelty of treatment, and all one has to consider is what was the aim of the author and how far he has succeeded in attaining it. Mr. Paley Yorke has endeavoured to state clearly the fundamental facts and laws of magnetism and electricity, with experimental proofs, and to indicate the train of thought to be followed in order that the subsidiary facts and applications of the subjects may be easily understood. This manual does not pretend to take the place of lectures, fully illustrated by experiments, or the laboratory, where experiments may be performed by the students themselves, but it is supplementary to both; and although the requirements of the examiners for the London University and other similar bodies have not been overlooked, they have not been kept perpetually before the student, as though the passing of examinations were the end and aim of his work. The subject of terrestrial magnetism has received special attention, and the magnetic charts have been reproduced from the "Admiralty Manual for Deviations of the Compass." The author's object has been to produce a book which should stimulate the student to think and use his own faculties, and, in so far as this can be effected by any book, he should have attained his end.

The Arithmetic of Chemistry. Being a Simple Treatment of the Subject of Chemical Calculations. By JOHN WADDELL, B.Sc. (Lond.), Ph.D. (Heidelberg), D.Sc. (Edin.). (Macmillan and Co. 1899.) 2s. 6d.

In works of this sort it is too often assumed by their authors that readers possess the very knowledge which they seek to acquire from the book, but Mr. Waddell has fallen into no such error, and has taken the greatest pains to be thoroughly explicit. This is noticeably the case in the chapter which deals with gases and their alteration in volume with changes of temperature and pressure. There is a very great difference between knowing a fact and understanding the full meaning of it, and this has been fully recognised by the author, so that when the student has worked through this book he should have a more thorough grasp of the science of chemistry than he previously possessed. Many examples are given of questions set in examination papers of a number of important universities in Britain and America, in order that the student may have the advantage of seeing problems presented in different ways, and thus becoming trained in interpreting different modes of expression. The work concludes with an appendix, which includes the French system of measures, arithmetical calculations, comparison of thermometric scale, a table of calculation or atomic weights, equations in frequent use, pressure of aqueous vapour, and a table of logarithms.

Arithmetic of Electrical Measurements. By W. R. P. HOBBS. (London: Thomas Murby.) 1s.

It is difficult to see what useful purpose can be served by this volume of numerical questions such that the least resourceful teacher would have no difficulty whatever in extemporising. The author has, it appears, an antipathy to the word "parallel," preferring to employ the expressions "joint circuit," "compound circuit," "multiple circuit," and speaking of cells being "joined abreast," or "for quantity." Moreover, he confuses the terms conductivity with conductance and EM.F. with P.D.

OUR ELECTRIC UNITS: WHAT SHALL WE DO WITH THEM?

BY DR. J. A. FLEMING, F.R.S.

(*Concluded from p. 368.*)

Any consideration of this subject demands, however, some brief discussion of electric and magnetic nomenclature generally. It can hardly be denied that there is room for improvement in the terminology and symbolism employed in treatises on electricity and magnetism. Numerous committees have been appointed at various times to deal with the subject. Much discussion has taken place, resulting in the adoption of a few new terms. We are indebted to Mr. Oliver Heaviside more than anyone else for a suggestive and successful treatment of the subject.

The terminology of every science is an up growth, the result of evolution and successive improvements. In each department of technical knowledge there are words and terms of various ages; just as the crust of the earth is composed of and includes rocks of different antiquity. We cannot altogether abandon familiar words which are yet saturated with defective theories or erroneous hypotheses. We certainly cannot manufacture at once a faultless nomenclature. We may, however, with advantage discuss some points in the construction of a terminology we might adopt if with our present knowledge of electrical and magnetic phenomena we could abolish some current phrases and technical expressions and begin over again to name and relate the various quantities with which we are concerned.

Prof. Clerk Maxwell once remarked in his paradoxical manner to the writer that "progress in scientific nomenclature was shown by making our words continually mean less and less." By this epigram he meant purging them more and more of unnecessary hypotheses and adopting terms not involving or implying special theories. Approaching the subject in this spirit, let us consider the principal quantities which should be named in dealing with electric and magnetic effects as we now understand them. We find at every point in space where there are electric and magnetic operations two agencies present which are commonly called *electric* and *magnetic force*. The term *force* is a very hard-worked word. We not only use it as the name for any agency causing or changing motion in matter, but we also use it in many figurative senses, as when we speak of *force* of circumstances, moral *force*, *force* of public opinion, intellectual *force*, police *force*, armed *force*, and naval *force*. We use it in electrical and magnetic science in several phrases, as, for instance, in the terms magnetic *force*, magnetomotive *force*, electromotive *force*, electric *force*. Students at first are apt to confuse magnetic force with the mechanical force exerted on a magnet or piece of iron when in a region of magnetic force. The fact that Maxwell himself was not satisfied with the use of the term *force* in connection with the phrase *electric force* is shown by the change made in his nomenclature between the publication of the first and the second edition of his "Treatise on Electricity and Magnetism." In the first edition, published in 1873 (p. 45, § 41) he defines the *electric force* (R) at any point in an electric field by the equation

$$F = eR,$$

where F is the mechanical force acting on a small body carrying a charge, e, placed in that field.

In the second edition (posthumous), published in 1881, the first nine chapters of which, however, were revised by Maxwell himself, he changes his name for the quantity R and calls it the *resultant electromotive intensity*. In the same manner other writers have used the phrase *magnetic intensity* to describe that which is commonly called *magnetic force*. Hence the suggestion may be made to abandon the term *force* altogether in this connection, and adopt the terms *voltivity* (v) and *gaussivity* (g) to denote the so-called electric and magnetic forces. These terms are analogous to the words *velocity* or *vorticity* already in use to define the state of a fluid motion at any point of a mass. As regards the

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names themselves, Gauss was a great mathematician and magnetician, and his name deserves to be commemorated as well as that of Volta in any manufacture of fundamental terms. In any region where the agencies voltivity or gaussivity exist they each produce at least one and perhaps two physical states: one of these states can be created either in free æther or most kinds of matter, the other only in special forms of matter. These states exist in virtue of certain specific properties of the æther and of matter. These intrinsic properties are—

the permeability (p),
the susceptibility (u),
the permittivity (k),
the conductivity (c).

The term permittivity here adopted is one coined by Mr. Oliver Heaviside to denote the quality commonly called the dielectric constant or the specific inductive capacity of the medium, whether ether or material. The four corresponding physical states are—

the flux (f).
the magnetisation (m).
the displacement (d).
the conduction (q).

The term *flux* here denotes that quantity usually called *the induction* or *the induction density*, or *the number of lines of force per square centimetre*, or equivalent terms by different writers.

The four effects and four specific qualities are related to the two agencies as follows:—

Gaussivity (g) { acting through *permeability* (p) produces *flux* (f). / acting through *susceptibility* (u) produces *magnetisation* (m).

Voltivity (v) { acting through *permittivity* (k) produces *displacement* (d). / acting through *conductivity* (c) produces *conduction* (q).

By conduction is meant the permanent passage of electric charge or bodies conveying it through a section of the circuit or path, and it is measured by the quantity of electricity so conveyed.

The time rate of change of conduction ($=\dot{q}$) is current density.

By displacement is meant the elastic or reversible movement of electric charge across any plane, such that when the voltivity is removed the displacement disappears either immediately or in course of time.

In both cases of conduction and displacement we are to consider the transfer to be that through unit of area normal to the direction of transfer.

The term magnetisation denotes that quantity commonly called the intensity of magnetisation and denoted by I, and the term flux that commonly called the induction and denoted by B.

The above quantities are related by four very simple equations, viz.:—

$$f = pg$$
$$m = ug$$
$$d = kv$$
$$q = cv$$

Let it here be remarked that a dot placed over a quantity, thus $\dot{x}$, denotes its time-rate of change or time differential (dx/dt), and a dot placed under a quantity $\underset{\cdot}{x}$ denotes its time-integral or $\int x dt$. Hence a dot put on the top annuls a dot put underneath, or $\dot{\underset{\cdot}{x}} = x$.

The quantities voltivity and gaussivity are directed or vector quantities, and can be distributed in space in two ways. First, they may be distributed in *a non-circuital manner*.

The characteristic of this distribution is that if a closed line is drawn in this field of gaussivity or voltivity the line integral round this circuit is zero in value.

On the other hand, they may otherwise be distributed in *a circuital manner*, and in this case their line integral taken round the closed line or circuit has a finite value and is increased by the same value each time the circuit is traversed.

It is necessary to have a word to indicate these line-integrals or the values of $\int v\,dx$ or $\int g\,dx$ where dx is an element of the circuital or other path and v or g the *voltivity* or *gaussivity* in the direction of this element. The terms voltage (V) and gaussage (G) have been appropriately employed for this purpose by Mr. Heaviside, and are therefore here taken as the equivalents of that which is usually called the electromotive force, or the magnetomotive force if circuital, and the difference of electric or magnetic potential if non-circuital.

The *voltage* therefore between any two points or round any circuit is *the line integral of the voltivity*, and the *gaussage* is similarly *the line interal of the gaussivity* along or around that path. In other words the voltivity is the voltage per centimetre and the gaussivity is the gaussage per centimetre.

We have next to consider four quantities which are the surface integrals of the flux, magnetisation, displacement, and conduction respectively, and it is convenient to make words for these end in the termination *-age* to correspond with voltage and gaussage. In common life words ending in *-age* are often used as collective nouns. Thus, *peerage* stands for the whole number of the peers, *wreckage* for the whole collection of our wrecks; we have also the words *baggage*, *breakage*, *frontage*, *wastage*, *cartage*, *freightage*, and *storage* in common use which have a collective sense or application. Hence no one can fairly object to the manufacture of four words *fluxage* (F), *displaceage* (D), *magnetage* (M), and *conductage* (Q), to signify the surface integrals of flux, displacement, magnetisation, or conduction over any area. These are respectively the values of the surface integrals $\int f\,ds$, $\int m\,ds$, $\int d\,ds$, $\int q\,ds$, where ds is an element of surface and f, m, d, q are the flux, magnetisation, displacement, or conduction taking place normally through that element. These surface integrals, F, D, M, and Q, are related to the line integrals voltage (V) and gaussage (G) in the following manner:—

Gaussage (G) { acting through permeance (P) produces fluxage (F). / acting through susceptance (U) produces magnetage (M).

Voltage (V) { acting through permittance (K) produces displaceage (D). / acting through conductance (C) produces conductage (Q).

The quantities called

the permeance P,
the susceptance U,
the permittance K,
the conductance C,

are integral qualities of the magnetic and electric circuits in which the effects are produced, and they are products of the specific qualities—viz., the permeability, the susceptibility, the permittivity, and the conductivity of the several parts of the circuit and its geometrical dimensions or shape factors. These integral qualities are related in the following simple manner:—

$$F = PG,$$
$$M = UG,$$
$$D = KV,$$
$$Q = CV.$$

There are, moreover, certain interconnections of an important kind.

Faraday showed that when an electric circuit is linked with a magnetic circuit any variation of the fluxage or magnetage in the magnetic circuit produced a voltage in the embracing electric circuit, and that this voltage is measured by the time-rate of change of the fluxage and magnetage. Hence the first interconnection is given by the equation

$$V = -(\dot{M} + \dot{F}).$$

The minus sign is inserted because the insertion of fluxage into the electric circuit generated a voltage in such a direction that it acts to create an opposing fluxage in the field. The next interconnection is given by the fact that the circuital

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gaussage round an electric circuit is equal to the sum of the time-rate of change of conductage and displaceage in that circuit or $G = \dot{D} + \dot{Q}$.

By the conductage is meant the whole quantity of electricity carried across the section of the circuit since the beginning of the action, and its time-rate of change ($= \dot{Q}$) at any moment is called the *total conduction current*. In the same way, the time-rate of change of the surface integral of displacement is called the displacement current, and is denoted by $\dot{D}$.

It will thus be seen that so far there are *ten specific quantities* with which we are concerned and *ten corresponding integral quantities*. The specific quantities denote states or qualities *at points* in the medium, and the integral quantities denote states or effects added up along lines or over sections of circuits.

Of the ten specific quantities, five are magnetic and five electric. The gaussivity (magnetic force), in consequence of the permeability or susceptibility of the material or medium, produces in it flux or magnetisation. Magnetisation can only occur in ferromagnetic matter; flux can occur in any substance, or even in free ether.

The voltivity (electric force), in consequence of permittivity (specific inductive capacity) or conductivity of the material or medium, produces in it displacement or conduction. Conduction can only occur in certain materials (metals, electrolytes, &c.); displacement can occur in any substance, or even in free æther.

Of the four specific qualities, the æther possesses only permeability and permittivity, but not, as far as we yet know, susceptibility or conductivity. The conductivity of material bodies, as far as we know, is independent of the magnitude of the voltivity or the time of its application (Ohm's law), but the permittivity depends greatly on the time of application of the voltivity in the case of most substances. Likewise the permeability of all slightly permeable bodies is constant and independent of the gaussivity, but in the case of ferromagnetic bodies the susceptibility varies with the magnitude of the gaussivity.

The whole phenomena presented by dielectrics under the action of voltivity can be simply explained by supposing that the permittivity is divisible into two parts, one part such that the corresponding displacement responds instantly to every change in the voltivity, and one part varying so that the displacement is a function of time of application of the voltivity and of its magnitude. In addition, there is superimposed in the case of all material dielectrics some degree of true conductivity.

The whole of the phenomena exhibited by polar magnets are easily intelligible if we admit that flux and magnetisation are essentially quantities of a similar nature, as far as voltage production in an embracing electric circuit is concerned, and are therefore additive in their effects in certain cases. Moreover, in the magnetic circuit the sum of the two must be continuous in amount, hence where magnetisation ends or terminates—that is, where magnetic poles occur—these regions must be the starting point for new flux; in other words, sources of gaussivity must exist.

In considering the two circuits, electric and magnetic, we find there is an analogy between magnetisation and displacement, and also between flux and conduction, in the following respects: Under indefinitely increased gaussivity the magnetisation of every ferromagnetic tends to a limit, and in the same manner, under indefinitely increased voltivity the true elastic displacement tends to a limit beyond which, however, rupture of the dielectric occurs.

On the other hand, flux and conduction can be increased, as far as we know, indefinitely with continually increasing gaussivity or voltivity, but with this difference: that under constant voltivity the conductivity of the electric circuit permits a continuous process of conduction to go on with continuous dissipation of energy, whereas in the magnetic circuit under constant gaussivity there is no change in the flux and no dissipation of energy. Hence the four specific states—flux, magnetisation, displacement, conduction—can be divided into two classes.

(i.) The necessarily circuital, including *flux* and *conduction*.

(ii.) The not necessarily circuital—viz., *magnetisation* and *displacement*.

The first group may be furthermore divided into—

(*a*) The non-dissipative state, viz., *flux*.

(*b*) The dissipative state—viz., *conduction*.

It will be found on examination that probably all the electric and magnetic phenomena with which we are acquainted can be simply described and discussed in terms of these *ten* defined specific and integral quantities.

The analogies of the magnetic and electric circuits, their interactions and relations, are properly displayed by this nomenclature, and not concealed, as by the existing terminology and system of units. Each of the ten quantities is measurable as above described. The gaussage in gausses or dekampere-turns, the voltage in volts, the voltivity in volts per centimetre, the gaussivity in dekampere-turns per centimetre. The fluxage and magnetage are measured in the same units—viz., the equivalent of the C.G.S. line, or in fractions of a weber such that 10^8 lines = 1 weber.

The displaceage and conductage are reckoned in dekacoulombs and their time-rates of change in dekamperes, each being identical in magnitude with one (present) C.G.S. unit of electric quantity or current.

The permeability is reckoned in multiples of that of the ether, taking that of the ether as equal to 4π. The permittivity in the same way is reckoned by taking that of the ether as $1/4\pi r^2$ where $r = 3 \times 10^{10}$.

In such language and units the phenomena of electrical and magnetic science are measured and described in rational and precise terms, free from ambiguities and arbitrary or unmeaning constants, and their relations easily expressed in simple and suggestive algebraic equations.

Those who have experience in teaching will agree that a clear view of the fundamental facts and statements is essential if the student is to make any satisfactory progress in handling advanced problems and ideas. In the class-room, no less than in the workshop, everyone concerned with electromagnetic phenomena needs exact conceptions and not confused ideas of first principles. Experience shows that our present system of unitation and our existing terminology in describing electric and magnetic effects are not well adapted to facilitate this clearness.

We may then ask: Should not the entrance into the twentieth century be inaugurated by some attempt to organise, simplify, and render more symmetrical the language and symbols in which are described the phenomena of electricity and magnetism, with the object of making calculation more easy and thought more precise?

The above outlines of a scheme are not intended to be a dogmatic or self-assertive expression of the direction such reform should take, but merely a contribution to a discussion of the subject.

ELECTRIC ETCHING.

We gave an account some time since of a method of etching metal plates electrolytically. The method consisted in applying a metal plate to a matrix in plaster and making the metal plate the anode, so that those parts of the plate which are in contact with the plaster cast at its highest points are corroded until the plate settles down on the plaster and fits the matrix exactly. Since the publication of that description the process has been further studied, with a view to overcome the defect which arises from the separation on the etched surface of the unattackable constituents on the steel when this metal, as is usual, is the material to be etched. For biting into the steel to a depth of one millimetre a period of four to five hours is requisite, of which only a small part is occupied in the actual etching, because it is necessary in the course of that time repeatedly to lift the plate from its matrix and to remove mechanically the debris from its dissolution. A further obstacle to the method as originally formulated is that the plate must always be replaced mathematically exactly on the matrix, in order to ensure obtaining a precise copy. Another difficulty

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arises from the use of plaster, which, though giving a fairly exact matrix, is mechanically weak and by no means completely insoluble in the electrolyte; moreover, if unduly porous, the matrix is apt to present too much electrolyte to the anode, and in the reverse case presents so little that the process is much delayed. The matter is complicated in the case of steel etching by the possible separation of hydrated oxides of iron in the matrix. Numerous experiments showed that it was necessary to use plaster of selected quality and gauged with an accurately-determined proportion of water, in order to obtain satisfactory matrices. The concentration of the electrolyte is also important, it being found that for the etching of steel a 10 per cent. solution of ammonium chloride acidulated with a little hydrochloric acid (the acidity of the electrolyte being maintained during the etching) was the most effective. A suitable current density is 20 amperes per sq. decimetre, this corresponding with a pressure of 8 to 12 volts. Presumably the current density is reckoned on the whole surface of the matrix, because it is stated that at the beginning of the etching process, when only the most prominent parts of the matrix are in contact with the plate, the current density must be lower, and can be raised when all portions of the plate are in contact with the matrix. The choice of a proper mixture for preparing the matrix, and the device of a suitable mechanism for removing, cleansing, and replacing the plate to be etched, have been worked out commercially, and the process has now been put on a manufacturing basis at Leipzig.

CHRISTMAS LECTURES AT THE ROYAL INSTITUTION.

(*Concluded from p.* 369).

The following is a brief summary of the last three "juvenile" lectures on "Fluids in Motion and at Rest," delivered by Mr. C. Vernon Boys, F.R.S., at the Royal Institution :—

Lecture IV.—Thursday, January 14th.

A number of practical applications of the principle of change of pressure of a liquid in moving through an orifice of varying diameter were then referred to, the Körting ejectors, injectors, and filter pumps being shown. Greathead's fire-hydrant was given as a further instance of the same kind, it being explained how with this apparatus the great pressure of water in the London mains could be utilised for the production of an enormous water-jet of great volume and power. The apparently paradoxical behaviour of a plane circular disc, held near and parallel to a similar disc through a central hole in which was fitted a small tube for blowing air through, was then shown in more striking fashion by an experiment in which the lower disc could have suspended from it a 28lb. weight, while through the tube at the top could be blown a blast of air under enormous pressure—1 ton per square inch. In both of these experiments it was found that the discs remained in contact with each other though absolutely unconnected. The explanation of this seeming paradox is that as the air was forced out in all directions, the velocity rapidly diminished away from the centre, and hence the pressure increased towards the circumference. At the circumference the pressure was that of the atmosphere, and hence between the plates the pressure is everywhere less than that of the atmosphere, and the plates would be maintained in contact. An analogous experiment was successfully shown with a powerful jet of water issuing from a hydrant having a hemispherical nozzle, from which a brass ball was not forced away. Some practical applications of powerful jets were next referred to. Photographs were thrown on the screen illustrating how in British Columbia powerful water-jets had been used for bringing down the side of a hill in mining operations. The Pelton water-wheel was next described, and the Laval steam turbine as an evolution of the Pelton wheel. It was explained that for maximum efficiency the cups must, in both cases, move at half the velocity of the issuing fluids. It was next explained why a tube through which water was passing could be coiled up and yet would have no tendency to straighten itself out. This was due to the exact equilibrium of pressures between the outward pressure at every point and the pressure inwards due to the curvature of the tube. When, however, there were open ends this equilibrium was shown not to exist. A modification of a Hero engine was shown in illustration of the back-pressure at the ends of tubes through which fluids were passing. Reaction engines based on the same principle were next referred to, and elicited a high tribute of praise to the Hon. C. A. Parsons for his success in having converted, after something like 20 years' patient plodding experimental investigation, a shadowy theoretical possibility into a highly useful practical engine. The Parsons steam turbine was now a recognised standard engine, and a beautiful model was shown of the "Viper," a torpedo-catcher built for the Admiralty on which the Parsons engines were fitted.

Lecture V.—Saturday, January 6th.

Mr. Boys began this lecture with the subject of aeroplanes, which he had touched on at the conclusion of the previous lecture, by showing that flat pieces of card or paper dropped from a height did not pursue a straight path, but were soon set into a rapid whirling motion, the general direction being away from the vertical. No satisfactory explanation of this "flight" had yet as been given. The principle received an important application in the large kites now being employed in American meteorological observatories. Such kites have been known to rise to heights of as great as two miles. The problem of artificial flight was next approached. It was explained that the two main problems to be solved in connection with artificial flight were: (i.) successful balancing when in the air, and (ii.) the getting on board sufficient power for purposes of balancing. The names of Lilienthal and Pilcher were mentioned as two aeronauts who had paid the penalty of their lives whilst making experiments with their soaring machines. Mr. Maxim's flying machine was then illustrated by means of photographs, and an account of a very striking trip which Mr. Boys had made, in company with Lord Kelvin and Lord Rayleigh, given. This concluded his references to aeronautics. The question of fluids moving with velocities greater than that of the containing vessel was next taken up. It was shown that by gently stirring a saucer filled with tea and containing tea leaves, all the tea leaves settled into a little heap at the centre, and the tea could be very readily poured off absolutely free from leaves, dust, &c. The explanation of this action was not that owing to the greater specific gravity of the tea leaves these tended to settle down, but that, owing to the viscosity of the liquid, the velocity of any particle increased from zero at the side of the saucer to a maximum at the centre of the liquid surface. The path of a particle was therefore along a spiral, and the force acting on it was towards the centre. The flow of water round river bends, and its effect upon the banks and scenery, received an analogous explanation. The machine known as the "Cyclone," used especially in large flour mills for clearing the atmosphere of small dust particles such as flour, sawdust, &c., was shown in action and its principle explained in a similar manner, the fluid air taking the place of the liquid water. The question of tornados was next discussed. The air at a certain spot becoming strongly heated, rises upwards, and is replaced by a rapid influx of air from all sides. Under the influence of the earth's motion this new air was set into rapid rotation, and gave rise ultimately to these destructive tornados. Two experiments of Cornu's, due to Weber, were shown to illustrate some meteorological phenomena. In one the formation of a "water spout" was clearly demonstrated. A centrifugal fan was placed at the top of a large glass tank, the bottom of which was filled with hot water giving off visible steam. When the fan was in action a column of steam became visible down the central line of the tank. By adding soap solution the column could be seen to be in great perturbation, causing the tearing away of soap bubbles from the centre of the liquid surface. Some experiments of Prof. Osborne Reynolds on the question of "dilatancy" were next reproduced, but were explained to have no direct connection with the subject in hand.

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Lecture VI.—Tuesday, January 9.

Until now the lecturer had treated of the properties of fluids in general, and every experiment made with a liquid was shown to give rise to a corresponding experiment in the case of gases, and *vice versâ*. The properties to be treated in the present lecture would, however, apply only to liquids, because they depend fundamentally on the possession of a surface. It was explained that all the phenomena of surface tension which he was about to illustrate and to explain were all satisfactorily accounted for on the hypothesis that the surface of every liquid behaves exactly and in all respects like a stretched thin elastic membrane. The behaviour of a camel's hair brush when taken out of water, the possibility of supporting water in a fine-meshed sieve, were readily explained on this simple assumption. A number of amusing toys, depending in their action on the properties of surface tension, were illustrated and explained. A piece of egg-shell, having some light and grotesque figures mounted on it, when placed on the rim of a dinner plate, previously wetted, would run rapidly along the rim, spinning round at the same time. A series of exceedingly interesting and beautiful photographs, taken by Prof. Worthington, showing the splash formed when a rough or smooth ball was dropped into water, were next shown. Spiders made use of the property of surface tension in walking over a liquid surface, and more ingeniously still in the construction of their webs. A water-dropping vibrating pendulum, first devised by Prof. Miller and now in the loan collection at South Kensington, was next shown. The pendulum was fitted with an arm containing a small bottle open at both ends. At one swing the bottle came into contact with a reservoir of water and was thus filled, the water being detained in the bottle owing to its surface tension, while at the next swing the bottle was emptied by being arranged to touch a pin that caused its contents to escape. Though the amount of water which escaped weighed but about half a grain, this sufficed to keep a pendulum going, weighing 8lb. The strength of these elastic skins varied with different liquids. A tube of water, if not too deep, might be turned upside down without the water pouring out; but if the surrounding atmosphere contains ether vapour, this skin will be weakened and the water will pour out. The "tears of wine" and the burning of a candle were also explained in this connection. Mr. Boys then went on to the question of soap bubbles, which lead themselves to many beautiful experiments of great interest. Some bubbles blown with saponium were first shown, and their peculiar behaviour, and appearance of shrivelling up when the air was withdrawn was next shown. A number of attractive experiments, all of which are to be found fully described in the lecturer's little book on "Soap-Bubbles," concluded the course, to which he added the expressions of his indebtedness to the assistance obtained from all sources, from manufacturers and the South Kensington officials for loans of apparatus, to the Royal Institution staff, and especially to the skilled assistance of Mr. Edser.

INSTITUTION OF ELECTRICAL ENGINEERS.

Report of the Swiss Visit Committee on the Visit of the Institution of Electrical Engineers to Switzerland in September, 1899.

The report of the Swiss Visit Committee was presented at a meeting of the Institution last night, and a discussion thereon was opened by Mr. R. E. B. Crompton with a comparison between British and Continental practice in electrical engineering. This report, which is of a voluminous character, summarises in its introduction the tour made by the members, and in the remaining portion gives a statistical digest of the various works and power stations visited. It is mainly a report for reference purposes, and consisting as it does of a mass of statistical data, we have decided to present our readers only with a short abstract of its contents.

It will be remembered by our readers that prior to the visit of the Institution a special correspondent of *The Electrician* made a tour of the places on the Institution programme, and contributed to our columns a detailed description of the numerous works visited. The series of articles in which these descriptions were embodied appeared in *The Electrician*, Vol. XLIII., as below:—

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The introductory part of the Institution report commences with a short account of the manner in which the visit was arranged. Then follows a series of notes describing the programme carried out. These particulars have already been presented to our readers, and therefore need not be repeated here. The report announces that at a meeting of the Institution, held on Wednesday, September 6th, in the Aula of the Polytechnikum, in Zurich, after an address of welcome by Prof. Dr. Gnehm, a Paper was read by Dr. Alfred Amsler on "The Utilisation of Water Power at Schaffhausen." A discussion ensued, in which Mr. Gisbert Kapp, Mr. E. K. Scott, Prof. J. Perry, Prof. Prásil, Mr. Uehlinger, and Mr. Addenbrooke took part. It was decided that Dr. Amsler's Paper should be printed in the *Journal* of the Institution.

Following the introductory portions above described, the report gives a series of statistical digests of the works visited, the character of which is well indicated by the following example which we have selected, this example referring to the central station at Zurich.

THE CENTRAL STATION, ZURICH.

Owned by the community of Zurich. Built 1891-92. Started working in August, 1892. Principal extensions 1898 and 1899.
(*Visited Monday, September 4th.*)

Power.

Water power.—600 to 1,200 H.P. Low-pressure turbines are driven direct by the water of the Limmat. High-pressure turbines are driven by water accumulated in reservoirs.

Steam power.—300 H.P. Steam reserve for water supply, and 2,700 H.P. with steam engines for electrical plant.

Area of Supply.

Power.—Current is provided for small motors in business quarters, and for the sub-stations at the Tonhalle, and at the physical and chemical laboratory buildings, and for the Post Office.

Light.—All private and public lighting in the town of Zurich.

Trams.—Current either direct or through the sub-station "Selnau" (at present 4—and when other proposed lines are completed 10—lines in use, partly private and partly belonging to the town).

Water Power Plant.

(Property of the Municipal Water Supply.)

The whole of the river Limmat with dam, conveyed by canal to turbines.

Fall.—Varying from 1·5 to 3 metres.

Turbines (including those for the water supply).—10 Jonval-reaction turbines of 101-150 H.P., two high-pressure turbines driven from accumulated water at 15 atmospheres pressure, 300 H.P. at 200 revs. per min. The accumulated water is pumped up into a reservoir for driving the high-pressure turbines. 300 H.P. steam engine as reserve, valve regulation.

Steam Plant.

Galloway boilers, fired with gas coke.

Horizontal steam engines:—
Compound engines, with valve regulation.
Tandem engines, with the Frikart method of regulation.

Electrical Plant.

System.—Single-phase alternating current, at 50 cycles per second and 2,000 volts, for light and power. Three-phase current, at 50 cycles and 2,000 volts, for the tramway sub-station. Continuous-current, 500 volts, for driving trams direct.

Generators.—The older alternating-current generators are of the Kapp type, with rotating armature. New three-phase generators, with stationary windings of the Oerlikon inductor type. Parallel running of both generators (two phases of the three-phase current in series for single-phase current).

Conductors (entirely underground):—
Primary lines with several main leads consisting of many cables in parallel are run to the distributing points, and from there to transformer stations, with a maximum loss of 5 per cent. Three-phase cable to the converter station is quite separate. Secondary conductors from each single transformer station are separate, but in case of necessity can be switched in parallel; three-wire system, 2 by 100 volts.

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Transformer stations for 80 kw. to 120 kw., with parallel connected transformers of 20 kw.

EXTENSION AND OUTPUT.

Water power.—Minimum 600 H.P., normal 1,000 H.P., maximum 1,600 H.P. Provision for enlarging buildings to utilise the maximum horse power.

Turbines for the water supply :—
4 Low-pressure at 175 H.P., 6 at 100 H.P.
2 High " 300 H.P., and 2 at 30 H.P.

Steam engines :—
1 Steam engine at 750 H.P. and 2 at 1,000 H.P., total 2,750 H.P.
1 " 300 H.P. for water supply.

Electric generators :—
4 units of 300 H.P., 1 unit at 750 H.P., and 2 of 1,000 H.P., total 3,950 H.P.
1 unit of 300 H.P. for continuous current.

Transformers :—
30 stations, 60 transformers at 20 kw., total 1,200 kw.

Conductors :— Underground cables.

Primary, total length of line	12	kilometres.
Length of wire	43	ditto.
Greatest distance	6	ditto.
Secondary, total length of line	50	ditto.
Length of wire	200	ditto.

Area of supply by the whole plant about 6 square kilometres.

Lighting.—Connections equivalent to that of 39,000 16 c.p. normal lamps.

Power.—200 motors, with a total of 300 H.P. Tram sub-station 3 motors, at 300 H.P., or a total of 900 H.P.

Then follows a list of the engineers and contractors.

We give below a list of the electrical undertakings and engineering works of which digests in the above form are embodied in the report :—

Alioth Electricity Co.'s Works, Munchenstein.
Messrs. Brown, Boveri and Co.'s Works, Baden.
Maschinenfabrik Oerlikon Works.
Messrs. Escher, Wyss and Co.'s Works.
Engine Shops and Iron Foundry of Messrs. Sulzer Bros., Zurich.
Swiss Locomotive Works, Winterthur.
Iron and Steel Works of Messrs. G. Fischer, Schaffhausen.
Ruti Silk Weaving Factory, Zurich.
Schaffhausen Worsted Mills, Schaffhausen.
Kraftübertragungswerke Rheinfelden, Aktiengesellschaft.
Zurich Central Station.
Rathausen Central Station, near Lucerne.
Central Station on the Kander.
Zurich City Tramways.
Zurich-Oerlikon-Seebach Electric Tramway.
Electric Tramway in the Industriequartier, Zurich.
Electric Tramway, Lucerne.
Stansstad-Engelberg Electric Railway.
The Jungfrau Railway.
The Burgdorf-Thun Electric Railway.

It will be seen from the foregoing summary that the Institution report forms an admirable work of reference with regard to the present condition of electrical engineering in Switzerland. Our readers will doubtless turn to the report as occasion requires, in order to obtain therefrom data concerning the numerous and large electrical engineering factories and electricity supply works in that country. We hope to present our readers with an account of the discussion on this report in our next issue.

ELECTRICAL TIME SERVICE.

The following is an abstract of the discussion which followed the reading of Mr. F. Hope-Jones' Paper on "Electrical Time Service," at the Institution of Electrical Engineers, on Dec. 14 :—

Mr. J. A. LUND suggested the following classification of electric clocks in preference to that of Mr. Hope-Jones—viz., (1) impelled clocks, (2) controlled clocks, and (3) synchronised clocks. An impelled clock was one which, as in Mr. Jones' and other systems, was driven by the current ; a controlled clock was one by which, by properly controlling the vibration of the pendulum, correct time was obtained ; while the object of a synchronised clock was to have an independent timekeeper which, whatever happened, would never be more than a small part of a minute wrong, the arrangements being that every hour the time current was made to clip the minute hand and set it right. The advantages of synchronised clocks were—they would still have the time if the regulating line broke down, provided the clock was fairly well regulated, and they certainly need not to be more than half a minute out if it broke down every 24 hours. These were considerable advantages as compared to the disadvantages of impelled clocks, for if the current working a series of clocks broke down, each clock had to be separately attended to, so that they might all start off together. In the matter of impelled and controlled clocks his firm had put this sort of clock up in the Post Office department at Mount Pleasant and several other places, and he hoped, in relating his experiences with them, Mr. Jones would not think he was depreciating his (Mr. Jones') name or system. The first telegram he received, after the erection of these clocks, was to tell him to go to one of the offices, where he found the gentleman there nearly mad through the tap, tap, tap, every half-minute. In the end an ordinary clock had to be fitted up and the "impelled" one disconnected. This happened with every one of the impelled clocks which his company had put up. Referring to the battery used in the electrical working of clocks, he said something better than the Leclanché battery was needed before they could keep the clocks going and be sure of them not breaking down. A battery placed there would last six times as long as the same battery placed elsewhere. The Silvertown Co. took an immense amount of trouble to produce a battery for this purpose, and for which they made no charge. They succeeded in producing a very compact battery, which would go inside any ordinary dial case, and he had known them to run for three years with the clock being constantly wound up every hour.

Mr. H. E. HARRISON, referring to electrically synchronised clocks, thought it would be absolutely useless to talk about using clocks in this way with hourly impulses if overhead lines were used. Half-minute impulses would certainly be necessary, at any rate in London. He thought that it would not be worth the while laying down an expensive underground line for so paltry a purpose as the working of clocks. The line being of considerable length, would have very high inductance, and a very appreciable E.M.F. would have to be applied. He doubted whether it would pay, and even at the prices named in the Paper, which were not high, he did not think they would be universally taken up ; while if they reduced the terms, they had still less chance of paying interest on the money outlay in underground wires and other plant which was necessary. The ingenuity that Mr. Jones had displayed in some of his mechanisms had struck him as being simply marvellous, particularly in his standard clock for sending out half-second impulses ; but he was afraid that the actual dial movement would suffer in the course of time from a good deal of wear and tear ; but then dials were cheap, so perhaps that did not matter very much.

Mr. J. S. RAWORTH did not look at this matter in quite so pessimistic a light as Mr. Harrison, who seemed to be rather of opinion that this thing would not pay on account of the difficulty of distributing the current. But there was no doubt that it did pay already in some places. Taking a large hotel with 400 or 500 rooms, he said it was not until one had lived there for a week that one appreciated the advantages of an electrically controlled clock. He had had some experience of these clocks in Paris, and the only difficulty, as far as his experience went, was the continual tick, tick, tick. He had gone into the matter some years ago, and if he had only had Mr. Jones' Paper in hand at the time, he did not doubt but that he would have come to a successful issue with his experiments instead of a complete failure. Mr. Jones's system was a very ingenious one, which ought to be perfectly reliable.

Mr. A. H. BATEMAN, speaking from the practical point of view, referred to the installation of a series of Mr. Jones' clocks in a parish hall (the name of which he did not mention), which had all worked with only one set of batteries perfectly well. The only objection to them was the loud ticking, but since then Mr. Jones had shown him a similar clock working perfectly silently, so that evidently this nuisance could be overcome.

Mr. STOCKWELL said there was no use denying the fact that there was a very big future indeed before electric clocks. With regard to the step-by-step movement advocated by Mr. Jones, he said before the lecture started he had touched the minute hand of one of these clocks and away it went for a quarter of an hour for one click. At Liverpool-street station, however, his firm had erected a clock with four dials 6ft. in diameter, the principle of which was entirely new and had as yet only been protected by a provisional specification. It was a one-wheel movement and a step-by-step movement, and he would defy anybody to move it more than one tooth at a time, even if a ton weight was put upon the hands. There had been great stress placed on the noisiness of electric clocks, but it was perfectly possible to make them silent. He had them in his own home in every room, and there they were as silent as could be. With a little rubber attachment he was enabled to make them so silent that they would not think there was a clock in the room. With regard to the Post Office, they were so far satisfied with the system installed on their premises that they had placed an order for their Mount Pleasant premises, accommodating some two or three thousand sorters, to be entirely fitted up with electric clocks. With regard to the battery power, he drew attention to the fact that a clock exhibited by Mr. Jones, having 4ft. or 5ft. hands, required seven dry cells to drive it. Fortunately, his firm drove them with only one cell; but at the same time, whether they had one cell or seven cells, they would give out. They did give out. They, as clockmakers, were doing their very utmost to introduce to the market a reliable, sound, and commercial article, and a thing which would be of value not only to themselves but to the world at large ; but they relied upon the electrical profession to find them some sort of constant battery that would not fail them ; such a thing as that was badly and sadly wanted. In conclusion, he thanked Mr. Jones exceedingly for his Paper. He had read it, re-read it, and re-read it again, but he could see nothing novel in it to what Mr. Jones had told them at the Horological Institute three years ago.

The PRESIDENT said that some time ago he had occasion to go over the Institution of Mechanical Engineers building, and he noticed the whole of the building was fitted with Mr. Hope-Jones' system of electric clocks. He had also been invited to pay a visit to the new building of the Surveyors' Institute, and there he found the same clocks installed again. Was there anyone present who knew whether the clocks in these two places had been giving satisfaction ?

Mr. E. WORTHINGTON (secretary of the Institution of Mechanical Engineers) stated that the clocks referred to by the President had been in use for twelve months. They at first had a good deal of trouble, but fortunately he at last found the cause of the trouble, which had nothing to do with the clocks. It was a very bad piece of wiring, and since that was made right the clocks had given almost perfect satisfaction. Mr. Rogers,

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the secretary of the Surveyors' Institute, had told him they were quite satisfied with the clocks in that building.

Prof. W. E. AYRTON asked whether the rate of going was found to be at all affected by the time constant. In other words, was there any intentional interval between the lifting of the weight and when it began to depress the wheel? They would see the weight fall and made contact with the armature when it had fallen by a convenient amount. Then how long it took at rest depended, he supposed, on the battery and the time constant of the circuit. Supposing he were to put say a self-induction in the circuit, would this tend to make the master-clock go a little faster or a little slower, or was there in this arrangement any intentional interval of time after the raising, before it began to introduce a driving force? In an electric clock which he had had to test some 15 years ago, and in which there was a similar contrivance, there was an intentional interval of time before the weight began to exert a driving force and its being lifted, so that naturally it was commenced to be lifted at a given point; then the pendulum went on alone, driving the clock for a short interval of time. Consequently, the weight being lifted quickly or slowly on account of the weakness or strength of the battery, the time when the weight began to exert a driving force was always exactly the same.

Mr. G. W. FRODSHAM held very much to the view that every clock should have in it some internal force remaining independent of the current. This was the principle of the Belgian system. With regard to the current of a synchronised clock not being fully occupied, he thought it would be very easy to introduce clocks with contacts which could be made every minute or every quarter of an hour, so that if they had 50 clocks each would be synchronised at a different time. Some years ago he thought it would be a good thing for observatory purposes to devise an instrument which would give astronomers the power of recording half-seconds upon a strip of paper. He thought he would break the current every half-second by passing it through the escapement of a chronometer. He had discovered a difficulty, however, which had also been experienced by somebody else at Geneva, and that was that the current passing through the escapement of the chronometer created an attraction between the spring and the fixed screw, which altered the rate of the chronometer, so that it had been necessary to make two trains of wheel-work, one to make it keep time and the other to make it break.

Capt. ACLAND had what he thought was one of the worst specimens of Hope-Jones clocks in his front hall, which had been running quite satisfactorily. It was true there was a tapping noise, but he got used to that; but within the last year he had purchased a movement which was so silent that when he put his ear to the case he could not hear it. His idea of how to attack these problems was not to invent new ideas, but to remove the difficulties in the way of the old ones.

Mr. HOPE-JONES, replying to Mr. Lund, said that in adopting his own classification of electrical clocks he had followed the accepted classifications in France and Germany, where this matter was much more fully gone into. They must recollect also that the standard works on this subject were all published abroad. Mr. Lund had pointed out that in the method advocated by him (the author) contact was required every half-minute, involving considerable waste of battery power. But he would point out to Mr. Lund that the demand made upon the battery was somewhat less than that made by synchronising. For the amount of current required to overcome the friction upon the hands was considerable, and for that purpose a contact of at least one second duration was required. With regard to the question of silencing the ticking of his clocks, he showed a simple arrangement which completely deadened the sound. It was not a difficult matter to silence clocks, and he might safely say that if the gentleman referred to by Mr. Lund had been provided with one of these arrangements, which was cemented to the back of the dial, he would not have complained any more. In regard to Prof. Ayrton's remarks, he pointed out that in the pendulum movement exhibited probably the maintaining spring had not been noticed. The clock, which supported the weighted lever, communicated its thrust to a running disc, but that running disc was not, as drawn in his diagram, mechanically connected with the wheel. There was also a back step click provided, engaging with a running wheel, which came into operation just before the winding took place. The result was that the pressure was never off the escapement, even at that very instant of time when the winding was taking place. He only applied this in order to be theoretically perfect as a timekeeper. In connection with the absence of lock in turret clock movements, his explanation was this. They would observe the pair of hands on the movement exhibited were ribbed aluminium and very light indeed. They were driven off a very small movement for hands of that length. The intention was to work behind a sheet of glass in exactly the same way as shown. As a matter of fact, he had in his workshop the dial, glass, and frame from which these hands and movement had been taken out, but he did not think it worth while bringing them with him. It was an instrument for working behind glass. If the hands were exposed to the weather, then of course the lock would have to be made equal to the occasion. With regard to the clocks in the Institution of Mechanical Engineers, the principal trouble had been due to the flooding of a conduit box, which caused blowing of the main fuse and stopped the lights, and consequently the clocks.

The PRESIDENT mentioned that for more than a year he had had some of Mr. Hope-Jones' clocks in the Technical College at Finsbury, two dials in the lecture theatre and two others, but he had not yet been sent to the madhouse by the noise. Until they had good batteries the clocks had given trouble, but once he had obtained some good batteries, which was just a year ago, not one of the dials had been a fraction of a minute out. They had kept absolute synchronism all through. He had ordered two more dials for the chemical laboratory, because there could not possibly be a better clock than an electric clock, which could be sealed up hermetically, so that the fumes of the chemical laboratory did not get inside.

A vote of thanks was then passed to Mr. Hope-Jones, and the discussion terminated

THE ELECTRIFICATION OF THE ATMOSPHERE.*

From a report recently issued by the United States Weather Bureau we gather that the electricity of the atmosphere continues to be a subject of systematic observation for several American meteorologists. It is curious to notice the extensive use which they make of kites as a means of electrical exploration. The kites flown by Mr. Alexander McAdie and his associates are not, however, quite as simple in build as the memorable one sent up from a field in the neighbourhood of the Philadelphia of 1752; they differ as much from the Franklinian original as the air-ships of to-day differ from the fire-balloons of Montgolfier. The well-proportioned kites of the Hargrave pattern, while better able to cleave their way through the air and to remain poised in equilibrium for a long time, have only this branch in common with their historical prototype—that the fine cord which serves to fly them has a thin copper wire wound spirally round it. The end of this conductor is connected at the observing station with the needle of an electrometer, one pair of quadrants being kept at a constant high potential and the other at an equal negative potential. This arrangement affords the best means we have to-day of determining the electrical conditions of the higher stretches of our atmosphere. During the first few months of 1899 ten kite ascents were made at the Blue Hill meteorological observatory, situated 10 miles south-west of Boston. The average altitude attained was 7,600ft., the greatest being 12,300ft.†

The most notable results obtained in the earlier experiments made at the Blue Hill Observatory showed that showery or thunderstorm weather is not the only meteorological state which gives strong electrical indications. At other times, even with a clear and cloudless sky, the needle of the electrometer would move sometimes creepingly and at other times violently from its zero position. From the instrument room of the observatory it was easy to tell, by watching the spot of light focussed on the scale, whether the kite was rising or falling, or whether it was stationary, the needle promptly responding to every change of altitude. On one occasion a kite was raised at 11 in the morning and kept up until 10 at night. Towards sunset the spot of light became restless, and shortly afterwards a storm was observed looming up from the west. While it continued a perfect fusillade of sparks could be drawn from the wire; and, as the darkness increased, a torrent of sparklets played between the air-gaps of the quadrants, the incessant sizzling threatening at times to burn the instrument out. For the sake of safety it was decided to sever the connection with the electrometer; but this was not effected without some apprehension, and without the operator's experiencing a shock which is described as somewhat more than gentle. The end of the wire was finally carried out of the observatory and made fast on the hillside, a little distance away. When courage was restored various experiments were tried, as the opportunity was considered to be too good to be thrown away. A 105 volt lamp was connected with the wire, but there was no incandescence of the filament, though some illumination was observed, which was probably due to a creeping of the charge over the surface of the bulb. Stinging sparks were drawn from the wire, which were greatly augmented in brightness and report by placing a condenser in the circuit. This leads one to think that interesting results should be obtained by forming the receiving end of the kite wire into an appropriate coil and placing a suitable secondary within it. Then, on inserting a rapid contact breaker in the outer primary, the current derived from the air could be transformed down into one of lower potential and greater amperage, thereby "harnessing" the electricity of the atmosphere and realising at last the ardent hopes of many a modern Franklin. But of course such a transformer has to be built, and the means of securing a constant supply of high voltage to be found.

Mr. Frank Eldy, of Bayonne, N.Y., was possibly working on these, or on parallel lines, last February. His experiments, however, appear to have had more of the sensational element than of the plain scientific character about them. On one occasion he sent up a kite to which was attached a pasteboard Leyden 15in. in diameter. When it attained a height of about 400ft, sparks were easily drawn from the wire. Two jars were then joined up together, and when this battery was connected with the kite wire, powerful discharges are said to have been obtained. This achievement is specially noteworthy, as it is probably the first instance we have of a condenser being sent aloft.

The following table shows the potentials recorded at two stations in Washington on a November day, the first being 500ft. above the ground and the second 45ft. The apparatus used at both were the usual water-dropping collector and its associated electrometer.

* From *Engineering*, Jan. 5, 1900.

† M. Teisserenc de Bort sent up a kite from the Trappes meteorological station in France, which is said to have reached a height of 4,300 metres (14,100ft.). These heights are ascertained by measuring a base-line, and the angles of elevation of the flying-kite at the two extremities of it.

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Time.	Monument.	Signal office.	Difference.
P.M.	Volts.	Volts.	Volts.
1.30	900	216	684
1.32	888	246	642
1.34	900	216	684
1.36	862	246	616
1.38	875	240	635
1.40	825	222	603
Mean	875	231	644

Higher potential differences frequently occur in electric storms. Mr. McAdie relates that, one May afternoon, while up in his Washington eyrie, 500ft. above the surrounding thoroughfare, he noticed over the Virginian hills a patch of dark cloud, and thereby knew that a thundersquall was at had. "At ten minutes to three," he writes, "the clouds are overhead, and this is the last we shall see of the outside world until the storm is over, for it is necessary that the heavy marble door windows be swung to. All is dark in the monument, save for the beam of reflected light travelling along the ground-glass scale. From the south window the nozzle of the water-dropping collector protrudes through a small opening. The wind rises, and we notice the needle moving steadily towards the point marked 1,000 volts positive. This means that the pull upon the air is steadily increasing. Suddenly the needle flies to the other side of the scale, and we know that the air, like a piece of overstretched rubber, has snapped and given way under the strain. The pull is now negative; the needle dances about, and we hear outside the rumble of the distant thunder. Nearer comes the storm, judging from the rapid fluctuations of the needle. Values of 3,000 or 4,000 volts are recorded.* The deflections are at times greater than the scale-limits. Placing the eye close to the peep-hole through which the nozzle protrudes, the little stream of water is seen twisting and breaking into spray, but becoming normal as soon as a flash occurs, only to begin to twist and disturb itself again"

Such, in brief, is the history of most of our thunderstorms, as it also is of snowstorms, and especially of hail-storms. During these last the behaviour of the spot of light is often of the wildest character, thereby denoting electrical disturbances of a high order. This fact, taken in connection with Mr. Frank W. Very's observation of the existence during such atmospheric perturbations of vast whirlwinds with horizontal axes, has enabled that American meteorologist to propound a theory of the formation of hail which appears somewhat plausible. Such a wind would whirl the warm, damp, surface air up to high, cold regions. In passing through these refrigerating layers the vapour would condense and freeze out into small ice-crystals. These needles, initially small, would share in the gyratory movement of the air, and be carried round the spirals of the whirlwind, making important additions to their masses at each passage through the lower moist strata. It will be seen that this explanation accounts for many of the peculiarities of a hailstorm, such as the lowering of temperature, the zonal structure of the hailstones, and the accompanying manifestations of electric energy. Indeed, the whirling mass of air, together with its granules rapidly increasing in size and number, forms a veritable electric generator of the frictional type. As already stated, the continuous observation of atmospheric electricity shows that the air is electrified at all times, storm or no storm, and also that the distribution of electric density is far from being uniform. In fair weather the potential of the air—the normal potential, as it is called†—is usually positive, its numerical value increasing with distance from the ground. In Great Britain the rise is about 50 volts per foot, but steeper gradients are not uncommon. In warm, dry countries the rate is still higher. It has been asked whether this electric field which surrounds our globe extends indefinitely out into space, or whether its lines of force pass beyond the region of clouds and end where invisible particles separate the sunset red from the midday blue. To answer this question, we must appeal to observations taken at the greatest possible distances from the surface of the earth. An analysis of the records of the Sonnblick Observatory, situated in Salzburg, at an altitude of 10,000ft., as well as of observations taken in balloon ascents, tends to show that this normal field, like our atmosphere, is confined within comparatively small limits. While the latter does not much exceed 100 miles or so, the former seems not to extend beyond 10,000ft. or 15,000ft. At this and greater altitudes there appears to be such little appreciable variation of potential that we may say the field is practically constant. This would mean that the earth's lines of electric force end at about that elevation, and that we have there the location of the positive charge corresponding to the negative electrification of the ground. This layer and the surface of the earth form the coatings of Nature's great condenser. Our buildings and monuments project some little distance up between them, and the heavier clouds of our skies sail about at varying heights through this heterogeneous dielectric.

It is not enough, however, to recognise the fact of this electrical separation; we want further to know what may be the causes of so remarkable and permanent a phenomenon. At one time evaporation pure and simple was looked upon as the principal agent; but Faraday dispelled the illusion by showing that the electrification observed in laboratory experiments was due, not to the mere escape of vapour particles from the surface of the heated liquid, but to the friction which took place between the spray produced and the sides of the vessel. This conclusion has never been invalidated; recent researches, on the contrary, tend to confirm it.

Abandoning, then, the evaporation hypothesis, we have nothing left as an efficient cause of the electrification of the air but "some form of contact," as Prof. Schuster says, "or of friction between drops of water and air, or between water and ice, or between any two of the various bodies present in the atmosphere." According to Trowbridge, "the friction of water particles against material substances is abundantly able to produce a high degree of electrification." Dr. Lodge attributes the electricity of the atmosphere to the same cause which produces the charge in the hydro-electric machine. Here the exciting agent is known to be the friction of water drops driven by steam over the solid surface of the jet. In like manner, winds driving the spray of mist against rock and ice surfaces must set up a difference of potential between the higher layers of the atmosphere and the earth. Prof. Tait is of the same mind, for he holds that the mere contact of particles of vapour with those of air, as they interdiffuse according to the kinetic theory, is sufficient to bring about a difference of potential.

The rubbing of dust and sand particles against the air has also been referred to as a potent cause of electrification, and this is well borne out by observations made in the Sahara, especially during the prevalence of the warm dry wind known as the "sirocco,"* and also in the neighbourhood of the Pyramids, as shown by the following very curious experience of Dr. Werner von Siemens. Having ascended the Great Pyramid of Cheops with a number of friends, he relates that he soon obtained evidence of the highly electrical condition of the surrounding medium, notably from a bottle of wine which he held in his hand, and which surprised him with a strong shock when he attempted to touch the tinfoil covering of the cork. He then realised that he was holding not merely a bottle of invigorating liquid, but an electrical condenser of unexpected capacity. The inner coating—the wine—was brought into connection with the tinfoil through the damp cork, whilst the metallic label forming the outer coating was earthed through the hand of the experimenter and the body of the Pyramid. In the interesting account of this event which Dr. Siemens has left, he adds that the Arabs, having watched his proceedings for several days with suspicion, and having discussed the matter among themselves, concluded that the travellers were a party of sorcerers, and therefore ordered them to discontinue their incantations. Perceiving that there might possibly be some trouble, he took out his biggest bottle and charged it from the ambient air, believing that it might prove an excellent means of defence in case of aggressive measures on the part of the sons of the desert. And it was well he did so, for the Arab chieftain, irritated by his persistence, suddenly seized him by the arm, and tried to drag him down the slope of the Pyramid. "At this critical moment," writes Dr. Siemens, "I brought the top of the bottle to within striking distance of the tip of his nose. The charge exceeded my utmost expectation. The chieftain, whose nerves had never before received such a shock, rushed away with a loud howl, and vanished from our vicinity, followed by all his comrades."

A very important contribution to the subject of atmospheric electricity was made in recent years by Dr. Philipp Lenard† in his Papers on the electrical condition of the air in the neighbourhood of fountains and waterfalls. By a very careful investigation he showed that when drops of water fall upon a water surface they give a negative charge to the air; and if allowed to fall upon a hard wet slab of any material the air-charge is considerably increased. He also satisfied himself that no charge was communicated to the air while the drops were actually falling, the seat of electrical disturbance being the agitated water at the foot of the fall or the rocks on which the drops impinged. He also found that the negative electrification of the air was modified by the presence of common salt dissolved in the water, as small a quantity as 1 per cent. sufficing to change its sign. With 5 per cent. the development of positive electrification was a maximum.

* At the Eiffel Tower, in Paris, values as high as 10,000 volts have been registered.

† Elster and Geitel—two indefatigable workers—have done good service in insisting on the distinction between the *normal* electric field and the *accidental*. The latter is of the nature of a disturbance brought about by precipitation, the presence of clouds, snow, dust, smoke, whirling air, &c.

* A. Féret, writing in *Cosmos*, October 17, 1899, says: "Il suffit alors d'une couverture brusquement déployée, d'un peigne vite passé dans les cheveux ou la barbe pour produire des étincelles. Les tentes se transforment en autant de bouteilles de Leyde, d'où l'on peut tirer, au plus leger frôlement, des étincelles de 15 et même 25 centimetres."

† Formerly assistant to Dr. Hertz, and now Professor of Physics in the University of Kiel.

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These results appeared to have such an important bearing on electrical theory in general, and also on the origin of atmospheric electricity, that they were repeated by Lord Kelvin and Mr. Magnus McLean in the physical laboratory of the University of Glasgow. All Lenard's observations were confirmed but one, the exception being a very important one. These Glasgow experiments did not show, as Lenard inferred from his, the absence of all electrification while the drops were passing down through the air; for, when there was no obstruction to the artificial shower, evidences of a small degree of negative electrification were always detected. This is a very significant and suggestive observation, because meteorological records almost always indicate strong negative values while rain is falling.

From these researches we conclude that every raindrop falling on the ground or on ponds, lakes, and rivers, as well as every drop of fresh-water spray falling back on a fresh-water surface, sends a minute quantity of negative electricity into the air; whilst every drop of salt-water spray falling back into the sea from breaking waves sends positive electricity into the atmosphere. As by far the greater part of the earth's surface consists of saline waters, positive electricity must greatly preponderate. It is not unlikely, then, that we have in the tossing and wind-driven surfaces of our oceans a distributed power house ever at work in generating the normal positive electrification of our atmosphere. It is true that negative electrification has also been registered during fine weather; but this could generally be attributed to the heavy rains which fell in the vicinity, or at least to the very moist conditions that prevailed there. In the case of snowstorms it has been noticed that when the flakes were large the sign of the electrification was often negative. This, too, is precisely what one would expect, inasmuch as large flakes are remarkable for the incompleteness of their crystalline structure, and also for the amount of condensed moisture which they contain. They are practically equivalent to an assemblage of tiny water drops held together by the texture of the flake, and hence the negative electrification which they produce as they slip through the successive layers of the atmosphere.

We have already referred to the marked electrical manifestations that frequently accompany a hailstorm. For a satisfactory explanation we must remember two facts established by experiment—viz, that water becomes positive when rubbing against air and negative when rubbing against ice. From these we infer that there must be a strong potential difference between ice and air, the former being positive to the latter. Consequently, the displacement of the ice-particles as they are churned round and round in a hailstorm must be competent to develop no inconsiderable degree of electrification.

Although people say "there is thunder in the air," when they really mean that their feelings, or their experience, or both, indicate the approach of an electric storm, it is curious to note how reticent electrical instruments are about the matter. It is not, indeed, until the clouds begin to rain that the electrometer gives notice of any disturbance. Then the variations of potential follow in great rapidity, being often so violent as to send the spot of light off the scale. From what has preceded we can readily understand the fitful behaviour of the electrometer needle as soon as rain begins to fall, but how are we to explain its previous inaction? Prof. Schuster supplies the answer. The two oppositely electrified cloud masses, or electrified layers at different levels, produce strong fields between them and weak ones without. The storm-cloud from which the lightning strikes is nearly always associated with a cirrus layer above it, so that the flash occurs more frequently between these than between the cloud and the ground. Therefore, the instruments of our observatories, being so far away from the field of force, can but imperfectly indicate the electric stress or the distribution of electric potential in the neighbourhood of a cloud.

The whole subject of atmospheric electricity is one that comes directly home to us. We are familiar with its most impressive manifestations, and we are naturally anxious to know the agents that are concerned in establishing the earth's normal and accidental fields, as well as the precise mechanism which liberates the horse-power of our electric storms. But we must be content for the present with very slow approaches to the solution of this great meteorological problem. It is a difficult one, because it aims at nothing less than a close inspection of the inner workings of Nature. The old Roman was particularly well inspired when he wrote, "*Felix qui potuit rerum cognoscere causas.*" The few advances made during recent years encourage the hope that we may soon be able to penetrate further, and that the older theories and terms which we cannot yet abandon may be replaced by views and a terminology that will correspond to something neither fictitious nor merely descriptive, but very real in the world around us.

Boers and Electricity.—A correspondent of the *Morning Post* states that the Boers have stretched wires across the roads in the immediate neighbourhood of their positions, which when they are touched ring electric bells near the pickets.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *December 30, 1899.*

Telephone Service in New York.—On January 1, 1900, the New York Telephone Co. puts in force the following schedule of message rates for telephone service in the borough of Manhattan. The rates apply to party line stations, two stations on a line.

Number of messages to be sent in one year.	Annual rate.	Additional local messages.
600	$60	8c.
800	75	8c.
1,000	87	8c.
1,200	99	7c.
1,500	117	7c.
1,800	135	6c.

This new schedule, which offers a minimum rate of $60 a a year, or $5 a month, for 600 local messages, is in line with the policy pursued by the New York Telephone Co. since the introduction of message rates in 1894, of reducing the rates as experience showed any reduction or modifications to be practicable. The introduction of two-party line service in Manhattan is largely due at the present time to the extensive progress made with the installation of the common battery or relay system in the equipment of the New York Co's exchanges. One of the various novel features of the relay switchboard is a selective signalling device, which enables either station on a two-party line to be rung up without making a sound on the bell of the other. This of course provides a satisfactory party-line service for moderate users, as the principal disadvantage of party line service has hitherto been the ringing of both bells whenever either subscriber was called by the exchange. There will still remain the fact that two parties connected to a single telephone line cannot both use it at once; but since this class of service is principally directed to moderate users, this should offer no great hindrance to its extensive adoption, in view of the cheap rate at which it allows New York telephone service, with its rapid communication and vast facilities, to be supplied. The steady reduction of rates made by the New York Telephone Co. and the extensive publicity in which it has indulged during the past few years have resulted in a very rapid growth of the system. The number of telephone stations added to the New York Co.'s system in Manhattan and the Bronx during the year 1899 was about 10,500, or rather more than the total number of telephone stations in old New York city in the middle of 1894, when the Metropolitan Telephone and Telegraph Co. had been in existence for over fifteen years. In five years after the introduction of message rates the New York Telephone Co. more than trebled its system, and the increase has been at a sharply increasing rate, as shown by the enormous gain of the past year.

Tariff on Electricity from Canada.—The officials of the United States Treasury Department are considering a proposition to levy a tariff duty on an electric current generated in Canada and conducted across the border into the United States. The question was raised by the Niagara Falls Power Co., of Niagara Falls, N.Y., against the Ontario Power Co., the rival concern across the river at Niagara Falls, Ont. The Ontario Power Co. proposes to extend its lines to as many points as possible in the United States, selling its light and power to as many customers as it can get. This business, of course, competes seriously with that of the American company, and in a communication to the Treasury Department on the subject the officers of the company represent that, inasmuch as the electric current is a thing of value, bought and sold, and that since it comes in competition with an American industry, it should be made subject to duty. The Secretary of the Treasury has submitted the question to several leading collectors of Customs in various parts of the country, with a view to obtaining their opinions. Five or six years ago it was proposed to levy tariff duties on natural gas piped across the

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Niagara river from Canada, the Treasury Department holding that the gas was "an enumerated, unmanufactured article" under the McKinley law. The Board of General Appraisers upset this ruling, declaring that gas is not an "article," and on appeal by the Government the Supreme Court of the United States upheld the Board of General Appraisers.

Havana Street Railways.—At a meeting last week all the street railway interests in the city of Havana were consolidated, terminating a contest which has been running more than a year. The Havana Electric Railway Co. acquires the rights and stocks of the Havana Traction Co., which becomes part of the Havana Railway Co., the electric company turning over to the traction company certain interests in the united company. It is expected that a complete system of electric railway will be in operation by June 1. The capitalisation of the company remains unchanged—namely, $5,000,000 of preferred stock, $5,000,000 of common stock, and a first mortgage representing $5,000,000 of 5 per cent. 50 year bonds.

Wireless Telegraphy in the Navy.—A dispatch from Washington states that the Navy Department has decided to make its own experiments in developing wireless telegraphy, and to abandon the proposition of Marconi for furnishing the navy with apparatus and other appliances. Rear-Admiral Bradford, chief of the Equipment Bureau, will shortly establish two stations, one at Newport and the other on Coasters Island across the bay from the Newport apprentice school, where classes will be formed to begin the work of developing wireless telegraphy. This decision was due to the terms presented by Marconi, which the naval officers believed excessive. Marconi, it is stated, offered to supply the navy with 20 instruments at an annual rental of $1,000 each, and refused to allow less than this number to be secured. Admiral Bradford was willing to purchase two sets of instruments with which to make tests on ships of the service, but Marconi's refusal to sell that number brought an end to the negotiations. Admiral Bradford believes that by careful experiments the navy will be able to develop a wireless telegraph system that will be superior to that of Marconi. Classes of officers are to be ordered to the Naval War College to undertake the plan. The army is now making its own experiments, and so far, Gen. Greely (the chief signal officer) declares, with success.

CORRESPONDENCE.

ELECTRIC WIRING AT BONN.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I think we are much indebted to your energetic correspondent, Mr. Bathurst, for his letter in your current issue describing the method of wiring at Bonn, where the bare return is adopted. The method, however, is apparently in use for economical reasons only, for since the bare return is run separately from the insulated lead in the metallic pipe, there is not much gain, if any, in the matter of safety. This I maintain can only be secured by combining the insulated lead and bare return under one metallic covering,

Notwithstanding your note at the end of Mr. Bathurst's letter, I cannot help having the impression that you, Mr. Editor, have leanings towards the old system of wiring with wood casing. When I was at school I once asked my master to define the difference between a Tory and a Radical, and he replied that "a Radical calls for change for change's sake, but a Tory only called for a change when it is really required." In view of recent events, of which the daily papers have no doubt made more than was warranted, the advocates of metallic tubing like your correspondent, Mr. Bathurst, and myself, have strengthened their position in demanding a change in the present practice. I certainly think that we may now claim it is required.

Some seven or eight years ago I approached the leading electrical firms on the subject of my earthed system of wiring. My frontal attack was, I regret to say, ineffectual; but I kept my guns and stuck to my system, which I have used successfully ever since. Now Mr. Bathurst appears, and by a flanking movement obliges the contractor to use his tubing; but at present with both wires insulated. Still, however, by persistent efforts I have no doubt he will succeed eventually in getting the "outer earthed."

Mr. Bathurst hints at further information, and should this take the form of a Paper before the Institution of Electrical Engineers, the result cannot but be instructive; and I for one would endeavour to attend, although living so far north. In the meantime I wish him every success in his endeavour to get our mutual views adopted, and also that he may issue triumphantly out of his electrical Mafeking.—Yours, &c.,

Stirling, Jan. 9. R. FREDERICK YORKE.

LEGAL INTELLIGENCE.

Turner and Son v. Brinsmead.

This action came before Mr. Justice Matthew yesterday, and was brought by Messrs. Turner and Sons, of Denton, Manchester, to recover from defendant money due for the erection of an electric lift. Defendant admitted the claim, but counterclaimed for breach of contract to erect the lift according to terms of contract. Plaintiffs, he urged, were to erect on flats in the course of erection at Maitland Park, Haverstock-hill, London, N.W., an electric lift. This was to be completed by Jan. 1, 1898, and was to be executed to the satisfaction of the defendant's consulting engineer, the Vestry of St. Pancras, and the insurance company's inspector. This contract was (defendant alleged) not carried out. The lift was not finished by Jan. 1, nor, in fact, till November, 1898; and it was so defective both in design and construction as to be useless and dangerous, so that neither defendant's consulting engineer nor the Vestry officials nor the insurance company's inspector would pass it. The work was too fragile to bear reasonable strain, and parts were so exposed as to be liable to injury from damp, dust, and fire. Owing to these and other deficiencies, defendant had to employ another contractor to erect another lift.

Mr. MORGAN WILLIAMS said he was electrical inspector to the Chelsea Vestry. In his opinion the design was bad and the work was badly carried out.

The JUDGE suggested the advisability of having a scientific assessor, and counsel decided to obtain the services of Prof. A. B. W Kennedy. The case was adjourned for this purpose.

Hilary Sittings.

The following cases having an electrical interest have been entered for hearing at the Royal Courts of Justice during the Hilary Sittings:—

SUPREME COURT OF JUDICATURE.

COURT OF APPEAL.

Chancery General Appeals.

Alexander *v.* the Automatic Telephone Co. (Appeal of plaintiff from order of Mr. Justice Cozens-Hardy dated May 12, 1899.) (Order not perfected.)

National Co. for Distribution of Electricity, &c. (Ltd.) *v.* Gibbs. (Appeal of defendant, H. O. Ruelle, from order of Mr. Justice Cozens-Hardy dated April 28, 1899, and cross-notice of plaintiff company dated Oct. 24, 1899.)

The Electric Construction Co. (Ltd.) *v.* Imperial Tramways Co. (Ltd.) (the British Thomson-Houston Co. (Ltd.) third parties). (Appeal of plaintiffs from order of Mr. Justice Cozens-Hardy dated Nov. 14, 1899.)

Heyl-Dia *v.* Edmunds. (Appeal of plaintiff from order of Mr. Justice Kekewich dated Nov. 11, 1899.)

HIGH COURT OF JUSTICE—CHANCERY DIVISION.

Before Mr. Justice Stirling.

The British Motor Syndicate (Ltd.) *v.* J. Taylor and Sons. (Adjourned summons.)

Before Mr. Justice Wright (sitting as an additional judge of the Chancery Division).

The Phaeton Electrical Co. (Ltd.). (Petition of A. Vandam and Co.)

Before Mr. Justice Farwell.

Rucker *v.* London Electric Supply Corporation (Ltd.). (Action.)

Fox *v.* National Telephone Co. (Ltd.). (Action and counterclaim.)

Steljes *v.* Exchange Telegraph Co. (Ltd.). (Action.)

QUEEN'S BENCH DIVISION.

Special Juries.

Hampstead Electric Supply Co. (Ltd.) *v.* Bromwich and another. (Bill.)

Stray Currents and Magnetic Fields.—According to *Engineering*, Prof. Marini has made some very timely observations on the disturbing effects due to trolley wires carrying the usual pressure required for actuating electric traction systems. In the course of his inquiry he found (1) that the current in the insulated conductor exercises a direct magnetic effect, which can be detected at a distance of 150 metres; (2) that the leakage from the earthed rails forming the return circuit extends out to a distance of 2,000 metres, whilst (3) the action of the soft iron masses of the motors was limited to about 10 metres.

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TRADE NOTES AND NOTICES.

[Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.]

NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers, or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London:—

NOW READY.

"The Electrician" Electrical Trades' Directory and Handbook for 1899.—The *Second Edition* of the "Big Blue Book" for 1899 is now ready. The volume contains the large Sheet Tables of Electricity Supply Stations and Electric Railways and Tramways. The price of the Directory and Handbook is now reduced to 5s. post free 5s. 9d.; abroad, post free, 6s. 6d. (United States 7s. 6d.).

"Submarine Cable-Laying and Repairing."—By H. D. Wilkinson, M.I.E.E., &c., fully illustrated; price 12s. 6d. This work gives a detailed technical summary of modern practice in manufacturing, laying, testing, and repairing submarine telegraph cables.

"Practical Notes for Electrical Students."—By Messrs. A. E. Kennelly and H. D. Wilkinson. Price 6s. 6d., post free. The authors give in a clear and concise manner a good summary of the general principles of electrical science.

"Magnetic Induction in Iron and other Metals."—By Prof. J. A. Ewing. Price 10s. 6d., post free. *New Edition nearly ready.*

"The Incandescent Lamp and its Manufacture."—By Gilbert S. Ram. Price 7s. 6d., post free. The principles underlying the manufacture of the incandescent lamp are carefully and fully dealt with in this volume.

"The Steam Engine Indicator and Indicator Diagrams."—Edited and enlarged by W. Worby Beaumont. Price 3s. 6d., post free. This work is a concise guide to the objects, construction, and use of the steam engine indicator and to the interpretation of indicator diagrams.

"The Art of Electrolytic Separation of Metals."—A second issue of Dr. Gore's book is now ready, price 10s. 6d., post free. The author treats fully both the theoretical principles of the art of electrolytic separation of metals and the practical rules and details of technical application on a commercial scale. The work is adapted to the use of the manufacturer as well as the student.

"The Manufacture of Electric Light Carbons"—A Practical Guide to the establishment of a Carbon Manufactory. Fully illustrated, price 1s 6d.; post free, 1s. 9d. In this work the author gives useful hints as to the manufacture of electric light carbons, including the preparation of material, firing, saturating, and coring, together with a description and estimate of cost of the plant required.

"The Centenary of the Electric Current, 1799-1899."—By Dr. J. A. Fleming. Price, paper covers, 1s. net, post free 1s. 3d.; strong cloth, 2s. 6d., post free.

"Localisation of Faults in Electric Light Mains."—By F. C. Raphael. Price 5s., post free. The book deals with the important subject of localising faults in electric light and power cables; and the various methods of insulation testing are here collected and discussed.

"Motive Power and Gearing for Electrical Machinery."—By E. Tremlett Carter, C.E., M.I.E.E. Price 12s. 6d., post free. In this comprehensive work an account is given of the scientific principles and modern practice in the use of engines for dynamo driving, not only for isolated power plants, but also for public electric lighting and power stations. The various forms of gearing in the power station and for electric motors are also dealt with; and the book contains, in addition, numerous tables giving exact data of the equipment and working of electric power stations.

"The Manufacture of Carbons for all Electrical Purposes."—by Francis Jehl. 10s. 6d., post free. This is a practical handbook giving a complete description of the art of making carbons for electric lighting, electrodes, &c., with particulars of the various gas generators and furnaces used in carbonising. The work also contains particulars of the cost, &c. of erecting and working carbon works, and plans of a model factory.

"Drum Armatures and Commutators," by Mr. F. Marten Weymouth, also ready. Price 7s. 6d., post free. Propsectus on application. This is a complete treatise on the theory and construction of drum winding, and of commutators for closed coil-armatures, together with a *résumé* of the principal points involved in their design, and an exposition of armature reactions and sparking.

"Wireless Telegraphy: Signalling across Space without Wires by Electric Waves." A Review of the Work of Hertz and his Successors.—By Dr. O. J. Lodge, with a large number of illustrations. New and Enlarged Edition, 5s. nett. *Now ready.*

"Electromagnetic Theory."—By Oliver Heaviside. *Vol. I.*, 12s. 6d. *Vol. II.*, 12s. 6d.

"Electric Motive Power," by Albion T. Snell, contains the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. Price 10s. 6d., post free; abroad, 11s.

"Electrical Testing for Telegraph Engineers."—By J. Elton Young, M.I.E.E. The scope of the book aims at furnishing a fuller treatment of the subject, from the standpoint of the Telegraph Engineer, than it has hitherto received, whilst it endeavours to facilitate a thorough comprehension of the theory of testing as applied to electrical lines in general. Demy 8vo, fully illustrated. 10s. 6d., post free.

"Electro-Chemistry."—By Dr. G. Gore. Third Edition Price 2r., post free.

TENDERS INVITED.

The *Plymouth* Corporation invite tenders for the supply and erection of a 500 kw. high-speed steam dynamo, motor-generators, &c., 500 kw. high-speed steam alternator, 260 accumulator cells, four Lancashire boilers, and high and low-pressure, paper-insulated and lead-covered mains, &c. Further particulars are set out in an advertisement, and conditions, &c., can be obtained from the borough electrical engineer (Mr. John H. Rider), Prince-rock, Plymouth. Tenders must be delivered to the town clerk (Mr. J. H. Ellis) by Wednesday, 31st inst.

The *Hull* Electric Lighting committee require tenders for the supply and erection of 30 cast-iron street section pillars, each containing eight switch fuses, &c. Specifications may be obtained at the city treasurer's office, and tenders must be delivered to the chairman of the committee, Town Hall, Hull, by noon of Thursday, 25th inst. Samples of designs must be delivered to the city electrical engineer (Mr. A. S. Barnard), Dagger-lane, Hull, by Wednesday, 24th inst. An advertisement contains further particulars.

The *West Ham* Guardians invite tenders for the supply and erection of plant for the electric lighting of the workhouse and school premises at Union-road, Leytonstone, and for the erection of an engine and battery house. An advertisement contains further particulars, and plans and specifications may be inspected at the clerk's office, where forms of tender, &c., can also be obtained. Tenders must be sent to the clerk (Mr. Fred. E. Hilleary) by 4 p.m of Feb. 7.

The *Sunderland* Corporation invite tenders for the supply of a tramway switchboard. Specifications, &c., can be obtained from the borough electrical engineer (Mr. John F. C. Snell), Dunning-street. An advertisement contains further particulars, and tenders (addressed to chairman, Lighting committee) must be delivered at the office of the town clerk (Mr. Fras. M. Bowey) by noon of 26th inst.

The *Glasgow* Corporation invite tenders for an electric or hydraulic lift for the new Art Galleries. An advertisement contains further particulars, and tenders must be sent to the town clerk (Sir J. D. Marwick), City Hall, Glasgow, by 29th inst.

The *Glasgow* Corporation also invite tenders for supplying and erecting electric motors and shafting for laundry machinery, mechanical stokers, elevator and conveyor at the Ruchill Fever Hospital. Tenders to the clerk, Police Department, by 24th inst.

The *Ilford* Urban District Council require tenders for (*a*) water-tube boilers, fittings, economiser, feed pumps, &c.; (*b*) pipe work, &c.; (*c*) engine, steam dynamos, motor and boosters; (*d*) batteries; (*e*) main switchboard and connections; (*f*) overhead travelling crane; (*g*) underground mains, conduits and roadwork; (*h*) arc lamps and posts; (*k*) station lighting. Tenders (addressed to chairman) must be delivered before 12 noon of 20th inst.

The *Barking* District Council invite tenders for the supply of two continuous-current transformers and switchgear, underground cables and roadwork, for their Creeksmouth extension. Tenders (addressed chairman of Council) must be in before noon of Jan. 23.

The *Newcastle-upon-Tyne* Corporation invite tenders for the construction of about 11 miles of double track tramway—rails, fastenings and poles being supplied by the Corporation. Tenders (addressed New Tramways committee) must be in by noon of Jan. 24.

The *Belfast* Electric committee invite tenders for the supply and erection of 400 kw. steam dynamos. Specifications, &c., can be obtained on application to Mr. Victor A. H. M'Cowen, city electrical engineer, and tenders must be lodged at the office of the town clerk (Sir Samuel Black) by Thursday, Feb. 8.

The *Westminster Electric Supply Corporation* require tenders for four dry back marine boilers. Tenders to secretary, Eccleston-place, London, S.W., by 23rd inst.

The *Tunbridge Wells* Corporation invite tenders for a 400 kw. steam alternator. Tenders to town clerk (Mr. W. C. Cripps) by 25th inst.

The *Tunbridge Wells* Corporation also invite tenders for surface condensing plant for their electricity station. Tenders to Mr. W. C. Cripps by Jan. 15.

The *Sheffield* Electric Light committee invite tenders for the supply and erection of extensions to the steam and exhaust pipes, and an independent jet condenser. Tenders, addressed to town clerk (Mr. Henry Sayer), must be in by noon of 20th inst.

The *Aberdeen* Electric Lighting committee invite tenders for the supply of a 420 kw. direct-coupled continuous-current dynamo. Tenders must be sent in by 22nd inst.

The *Bermondsey* (London) Vestry invite tenders for the construction, supply, and erection of a dust destructor, with furnaces, flues, water-tube boilers, economiser, fans, and forced draught appliances. Tenders to Mr. F. Ryall, Town Hall, Bermondsey, before noon of Jan. 13.

Tenders are invited until the 24th inst., by the Prussian State Railway authorities at Frankfort-am-Main, for the supply of 270,000 arc lamp carbons.

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The *Rathmines* and *Rathgar* (Dublin) Council invite tenders for wiring the electricity works buildings. Tenders by 17th inst.

The *Great Indian Peninsula Railway Co.* invite tenders for the supply of iron telegraph wire. Tenders by 18th inst. to secretary, 48, Copthall-avenue, London, E.C.

Tenders are being invited until the 25th inst., by the municipal authorities of Bechi (Castellon), for the concession for the electric lighting of the town for six years. Tenders to el Secretario del Ayuntamiento.

The municipal authorities of Montforte (Alicante), Spain, invite tenders until the 24th inst. for the concession for the electric lighting of the town for ten years. Particulars from and tenders to el Secretario del Ayuntamiento.

TENDERS RECEIVED AND ACCEPTED.

The Rathmines and Rathgar District Council, at their meeting last week, had under consideration the report of their consulting engineer (Mr. Robert Hammond, M.I.C.E.) upon the tenders received for the extension of the electricity supply mains. Tenders were received from the following firms:—

British Insulated Wire Co. (*accepted*)	£4,130	Callender Co.	£4,374
W. F. Dennis & Co.	4,125	W. T. Henley's Co.	4,523
St. Helens Cable Co.	4,311	W. T. Glover & Co.	4,701
		Western Electric Co.	4,724

The following tenders have been received by the Islington (London) Vestry for the supply of condensing plant for their electricity works:—

Wheeler Eng'g & Condenser Co. (*accepted*)	£4,292	Worthington Engine Co.	£5,249
G. K. Stothert & Co.	4,297	W. H. Allen, Son & Co.	5,990
G. Wailes & Son	4,535	D. Adamson & Co.	6,370
		Klein Engineering Co.	6,655

The Bradford City Council have accepted the tender of Messrs. Witting Bros., Ltd., representatives of Électricité et Hydraulique, soc. anon., Charleroi, Belgium, for 100 car equipments, instead of 75 as originally ordered. It was stated that 100 would be required in two and a half years, and an offer of 10 per cent. reduction had been made if the increased order were placed within a fortnight. By the revised arrangement the Corporation save £80 per car, or £2,100 on the order.

The following tenders have been received by the Blackpool Town Council:—

Babcock and Wilcox, four boilers, accessories, pumps, and piping.
C. A. Parsons and Co., steam alternators.
Cowans (Ltd.), switchboard.
British Insulated Wire Co., mains.
British Electric Transformer and Manufacturing Co., transformers.
Hart Accumulator Co., storage battery.

The following tenders have been accepted by the Gloucester Corporation for their electricity supply undertaking:—

Tinkers (Ltd.) (boiler house plant)	£955
Mather and Platt (engine house plant)	3,988
Crompton and Co. (switchboard extension)	251
E. Curtis and Co. (condensing plant)	492

The Hastings Corporation have accepted the tender of Messrs. Belliss and Morcom for the supply of a steam engine similar to the last one supplied, at £1,385; and the tender of the Brush Co. for the supply of an alternator at £1,455, an increase of £175 on the amount paid for the last machine. The alternator is to be delivered by Sept. 1 and the engine by Oct. 1.

The Sheffield Tramways committee have authorised their General sub-committee to order from the Brush Co. 20 double-deck and 15 single deck cars on Brill trucks, for £11,906. 2s. 6d.; and from the British Thomson-Houston Co. 20 G.E.52 and 15 G.E.58 standard electric brake equipments for the above cars, for £10,814. 16s. 6d.

Edmundson's Electricity Corporation have placed with Messrs. C. A. Parsons and Co. the order for two 75 kw. condensing type turbo-dynamos for the electric lighting of Melton Mowbray.

The Grays Thurrock District Council have accepted the tender of Messrs. Meldrum Bros. for the erection of a refuse destructor (in conjunction with their electricity supply scheme) at £1,935.

The Walsall Town Council have accepted the tender of Messrs. Bumsted and Chandler for an additional steam engine for the electricity supply works at £980, and the tender of Messrs. Thomas Parker (Ltd.) for a dynamo at £924.

The Birkenhead Corporation have accepted the tender of the British Thomson-Houston Co. for the supply of 13 single-deck and 31 double-deck electric motor cars.

The tender of Messrs. Drake and Gorham has also been accepted for the supply of two ornamental arc lamps and pillars for lighting the approaches to the Town Hall at £55.

The Birkenhead Corporation have also accepted the tender of Mr. A. Wenner for the supply of condensing plant, re-cooling tower, &c., for their South-End generating station. The tender of Messrs. Carrick and Ritchie has been accepted for the supply of an overhead travelling crane, and that of the British Insulated Wire Co. for feeder mains for the New Ferry route.

The tender of Mr. R. Robson has been accepted by the Newcastle-on-Tyne Corporation for the wiring of the central police buildings at £460.

APPOINTMENTS VACANT AND FILLED.

The Manchester Tramways committee require an electrical engineer to act as chief assistant to the city electrical engineer in the carrying out of the electrical engineering work connected with the tramways department. An advertisement contains further information, and all other particulars may be obtained from the general manager of the tramway department (Mr. J. M. McElroy), Town Hall, Manchester. Applications to town clerk (Mr. W. H. Talbot), by 20th inst.

An electrical engineer is required for the Hertford County Lunatic Asylum, St. Albans. Further particulars are given in an advertisement, and applications must be sent to Prof. W. E. Ayrton, F.R.S., 41, Kensington Park-gardens, London, W.

The Brush Electrical Engineering Co. require a superintending engineer to superintend, from their London head office, the execution of the company's lighting, power and traction contracts. An advertisement contains further particulars, and applications must be sent to the company, 49, Queen Victoria-street, London, E.C., by 22nd inst.

A telegraph foreman is required for the telegraph department of the Gold Coast (West Coast of Africa), at a commencing salary of £250 per annum. An advertisement contains further particulars, and applications must be sent to the Crown Agent for the Colonies, Downing-street, London, S.W., by 22nd inst.

Two switchboard attendants are required for the Edinburgh electricity works. An advertisement contains further particulars, and applications must be sent to the resident electrical engineer (Mr. Frank A. Newington), Dewar-place, Edinburgh.

There is a vacancy for an improver at the Canterbury electric works. Applications to the chief engineer (Mr. Norman Staniland). See advertisement.

The Council of the borough of West Ham invite applications for a meter inspector for their electricity department. Applications to town clerk by Jan. 15.

An outside assistant is required for the Hull electricity works. Applications to the city electrical engineer (Mr. A. S. Barnard). See advertisement.

Mr. G. F. Broadley, of Sheffield, has been appointed electrical engineer at the Bethnal Green new infirmary.

Mr. J. Hame, of the Cork Electric Lighting and Tramway Co., has been appointed chief assistant electrical and tramway engineer at Wigan.

Mr. J. Sadler has been appointed clerk at the Hampstead electricity works.

BUSINESS NOTICES.

Messrs. G. E. Taylor and Co., Lombard House, George-yard, London, E.C., inform us that they have commenced business as electrical engineers and contractors.

Mr. F. J. A. Matthews, having been appointed electrical engineer to the Vulcan Boiler and General Insurance Co., has resigned his position as chief electrical engineer to Messrs. Ashton, Frost and Co. (Ltd.), a position Mr. Matthews has held for four-and-a-half years.

BANKRUPTCIES, LIQUIDATIONS, &c.

At a meeting of the Reason Manufacturing Co. (Ltd.), on Dec. 14, it was resolved to wind up the company voluntarily for the purpose of reconstruction, and to appoint Mr. E. Wright, 76, Cheapside, London, E.C., liquidator, with authority to consent to the registration of a new company, particulars of the registration of which are given on p. 418 of our present issue.

Claims against Arthur Blackburn and James Walker (trading as Blackburn, Walker and Co.), electrical and mechanical engineers, Upper Lane Mills, Cleckheaton, must be in by 24th inst. Mr. J. A. Binns, 31, Manor-row, Bradford, is trustee.

A first and final dividend of 1s. 1d. is payable, at the office of the trustee, 52, Belvoir-street, Leicester, in the bankruptcy of W. A. Charles and J. S. Blackwell (trading as the Central Electrical and Engineering Co.), 74 and 111, Church-gate, Leicester, and 22, Kennington-road, London, S.E.

The final general meeting in the winding up of F. H. Royce and Co. (Ltd.) will be held at Manchester on Jan. 30. This winding up is part of the scheme of reconstruction whereby the business was transferred to a new company, called Royce (Ltd.), with increased nominal capital. The business is carried on by the new company at the same place.

At the York Bankruptcy-court, Henley Lionel Howard, electrical and mechanical engineer, lately trading as Thompson, Howard

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and Co., at 16, Stonegate, York, and 17, Carlisle street, Hull, was examined last week. The statement of affairs showed liabilities £1 998. 10s. 5d.; the unsecured liabilities included 69 trade debts, £761; two for money lent, £249; one for furniture, £254; and bank overdraft, £706. Deficiency, £1,307. In his deficiency account debtor showed a loss on the Parliament-street business of £200 in eight months, £170 lost in establishing a business in Hull, and £300 loss in Stonegate, York. The Official Receiver pointed out that debtor had only been in business since 1898, and there was this large deficiency. Debtor attributed his insolvency to "business losses." Case adjourned, and an order made for further details as to these losses.

Personal.—Mr. Frederick Grover, M.Inst.M.E., has resigned his position at the Yorkshire College, Leeds, and has commenced business as a consulting engineer at Greek-street chambers, Leeds.

Mr. William Allan Fraser, borough electrical engineer to the Lancaster Corporation, who is a sergeant of the Middlesex Yeomanry, has started for the front. In recognition of his spirited action he was entertained in the Town Hall last week, when he bade farewell to his friends. The Lancaster Corporation, besides granting Mr. Fraser leave of absence, have made him an allowance. We look forward with pleasure to welcoming Mr. Fraser on his return after the termination of hostilities.

Electrical Engineers R. E. Volunteers and the War.—At a well-attended meeting of the Institution of Electrical Engineers last evening, Major R. E. Crompton announced that the services of the Electrical Engineers R.E. Volunteers had been provisionally accepted by the War Office. In response to a circular issued by Major Crompton to the members of the Institution and electrical engineers generally asking for financial support, a sum of about £900 has been subscribed out of a total of £1,400 required for the equipment of the corps. The War Office will undertake a portion of the equipment provided the full sum above-mentioned is subscribed to enable the remainder of the equipment to be carried out by the corps. Reference to "The Electrician" Electrical Trades Directory and Handbook shows that the corps was established in 1896, and consists of about 570 members. Of this number 5 officers and 50 rank and file have been offered for service in South Africa. The following are the officers of the corps:—

Hon. Colonel	Lord Kelvin.
Major Commanding	R. E. Crompton.
Adjutant	Capt. D. Brady, R.E.
Captains	R. S. Erskine and B. Hopkinson.
Lieutenants	A. E. Le Rossignol, W. A. Vignoles, H. M. Leaf, and A. Bain.
2nd Lieutenants	J. J. F. O'Shaughnessy, A. H. Pott, Hon. R. C. Craven, and J. E. Pearce.

Valparaiso.—We learn that a concession can be obtained for electric lighting and power working in this town. Water power is available and can be developed from the Aconcagua, and this power will be highly valuable. It is pointed out to us that it would be well worth the while of a reliable British firm considering the question of electric lighting in this part of the world. A gentleman in England at the present time is willing to furnish reliable information, and letters addressed "F. W. K.," *The Electrician* office, will be forwarded.

Plant Sale.—Messrs. Wheatley Kirk, Price and Co. will sell by auction, at an early date, the entire contents of the works of Lloyd and Davis, 62 and 64, Sumner-street, Southwark, London, S.E., comprising the motive power and gearing, fixed and loose engineering plant, loose tools and utensils, stores, &c. Further particulars are given in an advertisement. Admission by catalogue only, which can be obtained gratis, together with any further particulars, from Mr. Alfred Hammond, solicitor, 25, Bedford-row, W.C.; and of the auctioneers, 49, Queen Victoria-street, London, E.C., and Albert-square, Manchester.

Two 11 kw. dynamos, with two overtype boilers, engines, 53 accumulators, &c., are for sale on May 1. Particulars from Messrs. O'Gorman and Cozens-Hardy, 66, Victoria-street, London, S.W. See advertisement.

The Past Year's Work.—The highly-trained technical staff and employés engaged at the Queen's Engineering Works, Bedford, by Messrs. W. H. Allen, Son and Co., have been busily employed during the past year in the manufacture of the special types of plant supplied by this firm, which include machinery for (1) exclusive use on board ship, (2) for deck use in port, (3) for large irrigation schemes, (4) for electric lighting, power, and traction. It is claimed that there is scarcely a vessel of any importance leaving the United Kingdom that has not some piece of machinery on board turned out by the Bedford works. No less than 75 of Her Majesty's warships have been supplied with machinery, as well as 40 torpedo destroyers. The specialities for marine working manufactured by this firm include engines for starting the main engines on board, condensing engines, rotary fans for forced draught, and dynamo electric machinery for lighting and power driving on board ship. A recent addition to the machinery sent out by this house is furnace air-blowing engines for the delivery of sprays of air over the flames of furnaces of boilers of the Belleville type, and these engines have been fitted to a number of Her Majesty's ironclads. Among a large number of important installations of the electric light on board ship may be mentioned the "Oceanic," which was fully described and illustrated in *The Electrician* for Jan. 5. On this vessel close upon 2,000 lights are provided, and the first class cabins are heated and a large proportion of the cooking and ventilating is accomplished by electricity. Of the new fleet belonging to the White Star line, ten vessels in all have been entirely fitted up with the electric light by Messrs. Allen, Son and Co.; and the list of steamers trading to all parts of the world, and varying in tonnage from 1,000 to 15,000 tons each, which have been similarly equipped during the past year, is a lengthy one. Ten auxiliary engines have been supplied to Her Majesty's new yacht "Victoria and Albert." The firm have in hand one of the largest pumping engines ever constructed, having branches no less than 54in. in diameter and driven by a triple-expansion engine indicating from 800 to 1,000 H.P. This engine is capable of delivering an equivalent of 4,000,000 gallons per hour. During the year two 800 H.P. engines have been erected and are now working at Hull, and large plants for the transmission of power have been completed at Belfast, Liverpool, and Glasgow, the Belfast installation being of 600 H.P. Electric tramway and lighting machinery is in hand for Bexhill, Reigate, Rotherham, Luton, Glasgow, and Llandudno. A new department has been created for manufacturing complete sets of condensing plants for electric light stations. In connection with this plant some interesting problems have been worked out, the chief of these being the substitution of electricity for steam engines, the object being to have only one set of engines for driving the main generators in all large lighting stations, the whole of the auxiliary and small gear being driven entirely by electric motors. Glasgow, West Ham, Bristol, Croydon, Malta, and Rotterdam have during the year been supplied with plant of this description. Large extensions have been made to the Bedford works during the year, and the report is that these are all fully employed, and further extensions are the order of the day.

Messrs. Geipel and Lange report continued large sales of the Geipel steam trap. These traps have been fitted on the new Royal yacht, and about 70 will be used for draining the steam pipes at the Paris Exhibition. A new bayonet lampholder, recently introduced, has been well received, especially for 200 volt work.

Messrs. S. W. Royse and Co., in their report on the chemical industry for 1899, state that the production of chemicals by electrolysis continues to gain ground. The Leblanc process appears latterly to have taken a new lease of life.

"General" Apparatus.—The January sheet list issued by the General Electric Co. describes and illustrates portable electric radiators, dynamo field rheostats, wireless telegraph apparatus, some new patent glass shades, &c., &c. These sheets can be obtained on application.

B. T. H. Plant.—Pamphlets Nos. 49 and 52 issued by the B. T. H. Co. deal respectively with B. T. H. transformers and with direct-current carbon-feed enclosed arc lamps. Several types of these transformers and lamps are illustrated and described.

Calendar. A useful blotting-pad calendar is sent out by the Cape Asbestos Co. (Ltd.), of 8, Mincries, London, E.C.

"Engineering Magazine."—The January issue of this magazine contains articles on "The Steam Engine for the Electric Traction Power House," "The Revolution in Machine Shop Practice," "Recent Progress in Automobile Construction," "Actual Experience with the Premium System," "Mechanical Transport in Mining and Engineering Works," and an article on the South African situation, by J. H. Hammond.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Jan. 3 to Jan. 9, with the ports of destination:—

Africa—Alexandria, £147; Durban, £1,332 (including £926 telegraph material); *Argentina*—Buenos Ayres, £221. *Australasia*—Melbourne, £370; Otago, £1,357 (telegraph wire); Perth, £225; Sydney, £1,098 (including £1,058 telegraph material); Wellington, £1,227. *Belgium*—Ghent, £55; Ostend, £38. *Canada*—St. John's (N.F.), £25. *China*—Shanghai, £48. *France*—Boulogne, £41. *India*—Calcutta, £2,306. *Japan*—Osaka, £144; Yokohama £56. *Russia*—St. Petersburg, £24. *Straits Settlements*—Singapore, £177 (including £97 telegraph material). *West Indies*—Jamaica, £13. Total £8,905, against £233,171 in the corresponding week last year (Jan. 4 to Jan. 10).

MUNICIPAL, FOREIGN, AND GENERAL NOTES.

Alfreton.—A report on the cost of establishing electricity supply has been prepared for the Electric Lighting committee by Mr. J. S. Barnes. The report states that the cost of supplying electric current in the town would not be greater than that of gas. The estimated capital expenditure is put at £11,500. A canvass of the town is being made.

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Alleged Embezzlement.—At the Greenwich police court, on Saturday, Arthur William Longman, clerk, was remanded on a charge of stealing £200 by falsifying the accounts of his employers, Messrs. Elliott Bros., the well-known firm of electrical instrument makers, Century Works, Lewisham. When arrested prisoner admitted the offence, and said the amount might be more. It was said that the firm were examining the books, and had already found that the defalcations, which had extended over some years, were considerable.

Alleged Theft of Electricity.—At the London County Sessions on Wednesday, before Mr. W. R. McConnell, Q.C., the charge of fraudulently abstracting electricity by diverting the current by means of an alleged improper contrivance, preferred by the Hammersmith Vestry against Alfred John Harrison, ended by the grand jury returning no bill.

Bacup.—The Council have resolved to establish municipal electricity works, a previous resolution in favour of transferring the provisional order to a company having been rescinded. The Local Government Board is to be asked to sanction a loan of £22,400.

Blackpool.—At the meeting of the Council last week contracts amounting to £30,000 were given out for the supply of additional electrical plant. A full list of the tenders is given on another page. The chairman of the Electric Light committee (Ald. Brodie) said that with regard to Messrs. C. A. Parsons and Co.'s tender for steam dynamos and condensing plant they had already had satisfactory dealings with the firm. The switchboard contract was left over. In reference to the tender of the British Insulated Wire Co. for cables he pointed out that the Corporation dealt with that company three years ago, and then obtained a 10 years' guarantee, and the same terms applied to the present contract.

Cardiff.—An investigation is to be made by the Electrical and Lighting committee into the cause of the recent breakdowns in electricity supply. In the discussion last week it was announced by the chairman of the committee (Ald. P. W. Carey) that though there had been friction amongst members of the staff, Mr. Appelbee was now in supreme command of the department, and had full power to employ and discharge the members of the staff. In future, therefore, Mr. Appelbee alone would be responsible for the undertaking.

Carlisle.—On the recommendation of the Electric Lighting committee it has been decided to abolish electric meter rents. Seven additional arcs are to be erected, and the charge for arcs has been fixed at £23 per annum. Current is to be supplied for lighting the Corporation's offices at 2d. per unit.

Caterham.—The Council have arrived at an undestanding in regard to the proposal of the Urban Electric Supply Co. to establish electricity works in Caterham and Warlingham, and the application to the Board of Trade for a provisional order will not be opposed.

Chesterfield.—On the motion of Ald. Clayton, the Electric Energy committee has been asked to consider and report "upon the desirability of using gas engines for the purposes of the generating station to be provided for the borough." The mover pointed out that the Corporation had a two-thirds interest in the gas works, and that it was impossible to provide cheaper gas unless they had a largely increased consumption. He was told gas engines could be worked as cheaply as steam engines, and that being so it would be suicidal not to use gas for the purpose required.

Club Lighting.—The Penang (Straits Settlements) Club is now lighted electrically. The machinery consists of a steam-driven dynamo, supplying current to an equivalent of 280 8 c.p. lamps. The plant includes a battery of D.P. accumulators. The whole of the plant and apparatus was supplied by Messrs. Drake and Gorham, and the work was carried out under the supervision of Mr. O. V. Thomas, M.I.E.E., of Penang.

Coventry.—The Board of Trade have intimated that the extensions of the Coventry and District Tramways Co.'s system will be certified for public use on the company undertaking to carry out certain requirements, including the relaying of the lines on Priestley's Bridge.

Dewsbury.—The Local Government Board have sanctioned the borrowing of £8,920 for electric lighting.

Douglas (Isle of Man).—The committee appointed to carry out the electric lighting of this city on the lines laid down in the report by Prof. J. A. Fleming recently recommended that a site adjacent to the gasworks should be acquired for electricity supply works, and this recommendation was lengthily discussed at the Council meeting on Wednesday. After a heated debate the recommendation was rejected, and the committee now contend that their duties have, by the rejection of the recommendation, been terminated.

Dundalk.—After many delays, the deed of transfer of the Council's provisional electric lighting order has been finally settled. The company propose to establish electricity supply works for lighting and traction.

Eastbourne.—A cheque for £88,135 was paid over to the Eastbourne Electric Light Co. by the Corporation on Jan. 1, this sum representing the purchase price of this company's undertaking.

Edinburgh.—Between Dec. 8 and the 4th inst. the equivalent of 5,294 8 c.p. lamps was applied for.

Electric Progress in Italy.—A company, with a capital of 2,000,000fr., has been formed at Florence by Dr. A. Banti, of Rome, editor of *L'Elettricista*, for the purpose of establishing telephone exchanges in Italian towns. A project has also been brought forward for the construction of an electrical railway of about 140 kilometres (about 87 miles) in the Florence district.

Electric Traction in South Africa.—In summing up the electrical progress made during the past year in South Africa, the *British and South African Export Gazette* states that the realisation of the various electric tramway schemes previously mooted was the principal work during the past year. At East London the tramways would ere this have been in working order had not delay occurred in the delivery of cars by the contractors, English and American. The conversion of the present horse system into an overhead trolley line at Durban was taken in hand, and tenders were called for material. Extensions of the Capetown tramways to the suburbs and docks were under construction, and an agricultural tramway at Hex river was also decided upon. It was resolved to inaugurate electric tramways at Pietermaritzburg as well as at Howick.

Gloucester.—Tenders for additional electric lighting plant were accepted by the Corporation on Tuesday, when it was decided to apply to the Local Government Board for power to borrow a further £9,425 for extensions which have become necessary owing to the increase in the demand for electric current. The capacity of the original plant is equal to about 12,000 8 c.p. lamps, and 10,771 have already been applied for. For the municipal buildings, &c., about 2,000 more will be required. Application is also to be made for borrowing £8,575 for a refuse destructor.

Grays (Essex).—The Local Government Board have intimated to the District Council that they have had under consideration the report recently made by Col. Durnford into the application to borrow £13,000 for electricity supply. The Board regard the evidence that the scheme was likely to be a financial success as very vague and general, and ask for further and more detailed evidence that there was such a demand as justified the Council in constructing the proposed works, and with calculations showing how the estimated results were arrived at. In the meantime, in view of the fact that the Council were required to complete the purchase of the land, and that they proposed to erect a dust destructor on part of this land, the Board had decided to sanction a loan of £6,000 for its purchase. The matter was referred to the consulting engineer (Mr. A. H. Preece), and a canvass is being taken to ascertain the probable demand for electric current in the district.

Greenock.—Notwithstanding the extension of time for sending in tenders for leasing the tramways, the Burgh Commissioners have only received one tender—*i.e.*, that of the Greenock and Port Glasgow Tramways Co.

Kidderminster.—The Council have approved the proposed extension of the electric tramway to Bewdley.

Lancashire Electric Power Scheme.—A conference of local authorities affected by this scheme has been convened for Tuesday, 23rd inst., at the Town Hall, Manchester, under the presidency of the Lord Mayor (Mr. J. Briggs).

Lecture.—With a view to acquainting the citizens of Northwich with the advantages of electric traction, and of making them familiar with the features of the application now before Parliament for powers to construct an electric light railway in the district, Mr. R. H. Scotter, C.E., delivered an interesting and instructive lecture on "Locomotion: Past, Present, and Future," at Northwich last week. Mr. Scotter pointed out that the distance from Warrington to Northwich was nine miles by road, but was an hour and a half distant by rail. The proposal was to run a light electric railway to connect these and other important points in the district. The system to be adopted had not yet been decided. The lecture was presided over by the chairman of the Northwich Council, and other members of this Council were present and gave a general support to the scheme.

Light Railways.—The Light Railway Commissioners have submitted the Aldershot and Farnborough, the Rhyl and Prestatyn, the East Anglian (Lowestoft and Kessington), and the Mid-Suffolk (Haughley to Halesworth) light railway orders for confirmation by the Board of Trade. Objections to the two former orders must be lodged by 27th, and to the two latter by 29th inst.

The proposal to construct a light (electric) railway from Warrington to Northwich is receiving local support, and the parish councils of Little Leigh, Barnton, Anderton and Winnington have had conferences with the engineer (Mr. R. H. Scotter), to see if arrangements could be made for the scheme to include the villages named. If the promoters agree to the suggested extension the scheme will be supported by the councils.

An inquiry was held by the Light Railway Commissioners on Monday and Wednesday into the applications of the Bath Corporation and a private syndicate for orders to construct electric tramways

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in the district. The proposed capital expenditure involved was in each case about £250,000, and both applications were opposed by the Somerset County Council. The chairman announced that they were not convinced that there was any widespread desire, either in the city or in the adjacent districts, for an extension of the tramways in the city, or from the city to the outside districts. Moreover, they thought in such a case the Act pointed to a combined scheme between the several authorities interested, or else to leaving the matter in the hands of a company which would command the confidence of the authority. On the whole, they could not recommend the order to be given to the Corporation. The application of the syndicate could not succeed in view of the opposition of the two road authorities—the County Council and the Corporation. The decision, which involved the refusal of both applications, caused some surprise in local circles.

An inquiry was held on Wednesday into the application of the British Electric Traction Co. to construct a light (electric) railway in Aberdare. Mr. Wedderburn, Q.C., who appeared for the Aberdare Council, raised a preliminary objection that the application was for a line which would lie wholly within one urban authority, and this authority opposed. After argument the Commissioners refused the application without taking evidence.

The Whitehaven Town Council have sanctioned the scheme of English Industrials for constructing a light (electric) railway from Whitehaven to Workington.

Liverpool.—The estimated expenditure for street lighting for 1900 is put by the Electric Power and Lighting committee at £52,884, nearly £1,000 less than the approximate expenditure of 1899, and the receipts are estimated at £3,000. The electric lighting estimate is £1,600 less than the actual cost in 1898.

Marylebone (London).—The Marylebone Electric Supply Co., which is applying for a provisional order for this district, has asked the Vestry to sanction the application. In the communication it is stated that as soon as the provisional order has been obtained the company proposes to lay down a network of mains over the whole parish, and to give a supply of electric current, from two stations in the district on the system which is employed in the neighbouring parish of St. James's. It was decided to oppose the application.

Mexborough.—Consent to a loan of £1,428 for purchasing land for erecting electricity works has been obtained by the Council.

Motor Car Combine.—A big scheme of incorporation of motor car interests is announced. A company has been incorporated in the United States with a nominal capital of $75,000,000, the object of the undertaking being to control all motor car patents and to manufacture rapid electric, oil, gas, and other motor vehicles. The president is Mr. W. W. Gibbs, of Philadelphia, who is described as the former president of a group of companies owning patent rights for electric vehicles and storage batteries.

Municipal Telephony.—The Barrow-in-Furness Council have informed the Association of Municipal Councils that they intend to establish a municpal telephone exchange.

New York.—The Consolidated Gas Light Co. has absorbed the New York Electric Lighting and Heating Co. This makes the Consolidated Co. the most powerful lighting company in New York. In financial quarters it is considered probable that an attempt will be made to unite all the gas and electric light concerns in the city.

Northallerton.—Public lighting was inaugurated on Monday last. Solar arc lamps, of the long-hour type, are used for lighting the main thoroughfares, and the side streets and lanes are illuminated by incandescents. One feature of the installation is the adoption of aluminium conductors for the overhead mains. Members of the District Council, which is presided over by Mr. H. Clider, J.P., have materially aided the movement for the substitution of electric for gas lighting. The present plant consists of two generating sets, but extensions are being carried out as the present works are not sufficient to cope with the demand for current for public and private lighting. The works have been designed and carried out to the specification of Mr. J. Ernest Hutton, A.I.E.E., to whom is due the formation of the local company.

Oldham.—An inquiry was held here on Wednesday into the application of the Corporation to borrow £36,000 for electric lighting extensions. The town clerk (Mr. A. Nicholson) supported the application, and said that the extensions to the generating station were rendered necessary by the great demand for electric current. The electric lighting had been the most satisfactory undertaking the Corporation had taken in hand. This was the fourth time they had had to apply for borrowing powers to extend the undertaking, and with the completion of the present scheme the whole of the available site would be built upon. The Corporation proposed to erect a new station some little distance away. The total capital expenditure to date was £57,109, and the total borrowing powers £52,000, so that the Corporation had over-expended by £5,109, against which, however, they had a sum of £5,159 in reserve. Their engineer (Mr. S. W. Newington) said the increased demand since March 25 last was 37 per cent. A ratepayer, while not objecting to the expenditure, disapproved of the practice of carrying out the works first and then applying for leave to borrow. In this case large contracts had been let and partly carried out. The inspector said he would certainly have to report on that matter to the Local Government Board.

Pickering.—The question of introducing electricity supply has been before the Council, and inquiries are being made as to costs, &c.

Plymouth.—The Corporation have decided to apply for sanction to a loan of £48,000 for electric lighting extensions, which are to be carried out on the recommendation of the borough electrical engineer (Mr. John H. Rider), who in his report says that, besides the arc lighting and the tramways, their present machinery could supply 7,500 8 c.p. lamps at one time, and they had already a demand for over 12,200 lamps. It was not usual to find that more than about 60 per cent. of the lamps connected were burning at one time, and on this basis they could supply the present connection. To provide for the demand still existing, and for the ordinary growth of the undertaking, it was absolutely necessary to put down additional lighting machinery before next winter. The difficulties in the way of quick delivery from manufacturers were so great that orders must be placed at once if they were to have the plant in time. He recommended that a 700 H.P. steam generator for 500 kw. output, with two additional boilers, steam piping, economiser, and connections, be provided. This would increase their plant capacity to a total of 1,100 kw., and, allowing the necessary spare plant, would permit of the connection of about 28,000 8 c.p. lamps, in addition to the arc lighting and tramways. The present spare space at the works would be occupied by the tramway plant already authorised, and to make room for the proposed addition the buildings must be enlarged. As still further extensions of plant would certainly be required in 1901, to provide for the new tramways and private lighting, he strongly recommended that the buildings be lengthened at once by about 90ft., thus giving engine and boiler rooms of 190ft. long each. This would allow four additional 700 H.P. sets to be erected, over and above those already proposed. Applications for supply had been received from many parts of the town where at present there were no mains laid, and as they were bound under the provisional order to give such supply, Mr. Rider recommended that low pressure cables be procured for certain streets set out in the report. Cables for the Compton trams would be laid in Mutley-plain and Tavistock-road, and the lighting cables could be laid all at the same time. These extensions of mains would necessitate two additional high-pressure feeder cables and two more transforming sub-stations, one by Sherwell Chapel and the other on Mutley-plain. The estimated cost was put as follows: Steam generator, £6,250; boilers, piping, economisers, &c., £2,800; mains, £7 890; service cables, meters, &c., £1,570; sub stations and transformers, £1,910; switchboards and connections, £250; extensions to buildings, £12,500; additional work already authorised by Council—viz., raising wharf wall, coal conveyers, negative booster, laying pipes in Cattewater, mains in Tothill-road, Greenbank and Elliot-street, motor for stoker gear, office furniture, £2,710; estimated amount overspent on original sanction, as already reported, £10.720; contingencies, £1 400; making a total new loan of £48,000. This additional loan would not only enable them to add some 12,500 lamps to their load, but would also provide buildings for considerable extensions of plant. The extra lamps should bring in a revenue of about £5 000 per annum, while the enlarged buildings would allow future extensions to be carried out at a greatly reduced proportionate outlay. The interest and sinking fund charges on the additional capital, reckoned at 2¾ per cent. and 25 years repayment, come to £2,760 per annum, while the additional works charges for coal, water, wages, &c., would come to about £1,500 per annum, or a total expenditure of some £4,260.

Portsmouth.—Some difficulty has arisen in connection with the taking over of the tramway undertaking by the Corporation. A meeting of the Tramways committee was held on Saturday, when it was reported that the company had offered to work the undertaking for another year, and to waive the claim that the Corporation must take over the omnibuses, hearses, &c., in addition to the tramways, subject to the Council agreeing to allow the company to retain the lines from North End (one of the suburbs) to Cosham, which is outside the borough boundary. The company, it is understood, is desirous of working this section of the line in connection with the proposed Waterloo and Cosham Light (Electric) Railway, the terminus of which would be at North End, instead of Cosham, as originally intended. The committee are willing that the company should retain the lines for another year, but in other respects the company's proposals have been declined.

Private Bill Legislation.—The Knott End Railway Bill, which is being promoted by shareholders of the Knott End Railway Co., is being opposed by the directors. No opposition has been notified against the bills promoted by the Preston, Liverpool, Stockport, Lancaster, Manchester, Southport, and Oldham Corporations, the Manchester City Railway Co., the Manchester-Liverpool Express Railway Co., the Southport and Lytham Tramroad, the South Lancashire Tramways, the Wirral Railway Co., and the Lancashire Electric Power Co.

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Rugby.—The Council are considering the advisability of establishing electricity supply, and in order to ascertain the probable demand for current, a circular has been sent out giving a comparison of the cost of electric and gas lighting, and inviting ratepayers to state their probable requirements in regard to electric lighting.

Sheffield.—At the Corporation meeting on Wednesday it was reported that out of the loan for £100,000 recently applied for, the Local Government Board had only sanctioned £71,000. The following sums were excluded from the proposed loan: Proposed expenditure on machinery, £12,280; steam boilers, pipes, condensers, &c., £9,000; machinery connected with the proposed public lighting, £7,600. The Board have deferred decision on this portion of the application until the Council are in a position to submit more precise information.

The Intake electric tramway route was officially inspected on behalf of the Board of Trade on the 8th inst., and was opened for traffic on Wednesday. At the Council meeting this week Ald. Clegg referred to the fact that the cars had commenced running that day, and said the public must for the present rest satisfied with two cars, as there was not sufficient electric energy to admit of more being run. For the week ended Dec. 31 they carried 339,994 passengers, the largest number they had ever carried by over 30,000, and the receipts amounted to over £2,000.

Sleaford.—At the District Council meeting last week a scheme for the electric lighting of the town was decided upon. A provisional order is being applied for.

Smethwick.—The Midland Electric Corporation for Power Distribution are to submit proposals in writing to the Council for supplying electric current in this district.

Swansea.—It is anticipated that the work of electrically equipping the local tramways will be complete by March, and that electric cars will be running in that month. Delay has occurred owing to difficulty in obtaining plant.

Taunton.—The scheme of the Taunton and West Somerset Electric Railways and Tramways Co. for the construction of electric tramways in the borough has been approved by the Council.

Tonbridge.—Mr. F. H. Medhurst has been asked his terms for preparing a report on electricity supply.

Walsall.—The General Purposes committee reported, at the Corporation meeting on Monday, that the Board of Trade had renewed the licence to the South Staffordshire Tramways Co. for the use of electric traction for four years.

West Hartlepool.—The electric lighting mains are to be extended to Foggy Furze. Extensions of the tramway system were also approved at the Council meeting on Wednesday.

PATENT RECORD.

The following list of Applications for Patents and Specifications published has been compiled for this journal by Messrs. J. C. CHAPMAN and Co., *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs, and Trade Marks may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after the acceptance of the complete Specification. The names within parentheses are those of communicators of inventions. When complete specification accompanies application, an asterisk is affixed.*

December 8, 1899.

24,439. THE BRITISH THOMSON-HOUSTON CO. (LTD.). London. Improvements in systems of electric distribution, particularly applicable to electric railway systems. (The General Electric Co., United States.)*

24,440. M. H. L. CLARK. London. Improvements in or applicable to searchlight, heliograph, and wireless telegraph apparatus.

24,450. J. A. L. DEARLOVE and S. G. BROWN. London. Improvements in electric telegraph apparatus.

24,451. H. H. LAKE. London. Improvements in storage batteries. (C. Bruno, Italy.)

24,458. R. B. RANSFORD. London. Improvements in supporting electrical contact rubbers or brushes below rail or tramway vehicles. (La Compagnie Générale de Traction, France.)*

24,473. W. MAJERT. London. Improvements in accumulator plates.*

24,514. A. J. BOULT. London. Improvements in or relating to electricity meters. (F. Saldaná, France.)*

24,524. G. LEVE and THE MONOBLOC ACCUMULATOR SYNDICATE (LTD.), Hampstead. Improvements in or connected with electric accumulators.

24,536. L. GOTTSCHO. London. Improvements in thermoelectric piles.*

December 11, 1899.

24,567. J. S. STEVENS, C. G. MAJOR, E. C. STEVENS and P. H. STEVENS. London. Improvements in controling apparatus for electric lifts and other electric machines.

24,594. F. E. GREENSTREET and E. J. SELBY. London. Improvements in or connected with automatic electrical cut-outs.

24,614. E. E. RIES. London. Improvements in telephone system and apparatus.*

24,624. A. FRASER, W. JUDD and G. DRAPER. London. Improvements in and relating to perforators for use in connection with automatic telegraph transmitters.

24,629. W. L. WISE. London. Improvements in talking machines. (The Universal Talking Machine Co., United States.)

24,634. C. A. VICARINO. London. Improvements in apparatus for electrically lighting railway carriages and other vehicles.

24,639. W. P. THOMPSON. London. Improved electric top for gyroscopes and the like. (Berliner Maschinenban Aktien-Gesellschaft vormals. L. Schwartzkopff, Germany.)*

24,641. W. W. PILKINGTON and W. R. ORMANDY. Liverpool. Improvements in the manufacture of accumulator batteries and in porous cells, plates, or diaphragms for the same or other batteries, and for other purposes chemical or mechanical where an extremely porous or hard material is required.

24,643. J. BURKE. London. Improvements in magnet frames for dynamo electric machines and motors.*

24,645. C. L. ROSENGVIST, A. BERGTHEIL and H. W. YOUNG. London. Automatic load-starting apparatus applicable to synchronous alternating-current motors.

December 12, 1899.

24,666. F. HAMER. London. A method of and apparatus for the regulation of electric potential in alternating-current transformers, applicable also to boosters.

24,668. H. M. PUNNETT and H. M. PUNNETT, jun. Birmingham. Improvements in or relating to means to be employed in connection with the electro-deposition of metals upon iron and steel.

24,669. T. FOSTER. Manchester. Improvements in roller gearing and transmission dynamometers.

24,673. J. BUTCHER. Wolverhampton. Improvements in electric clocks.*

24,701. SIEMENS BROS. AND CO. (LTD.) and W. DIESELHORST. London. An improvement in the manufacture of submarine electric conductors.

24,717. B. J. B. MILLS. London. Improvements in fire alarm telegraph apparatus. (The Gamewell Fire Alarm Telegraph Co., United States.)*

24,718. J. E. KINGSBURY. London. Improvements in telephone systems and apparatus. (The Western Electric Co., United States.)

24,723. F. E. HATCH. London. Improvements in the process of smelting ore and in electric furnaces therefor.*

24,739. W. ELY. Liverpool. Improvements in or relating to electric switches.*

24,740. W. ELY. Liverpool. Improvements in or relating to electric switches.*

December 13, 1899.

24,760. E. CROSS. Aberdeen. Improvements in electrolytic meters.

24,780. G. T. MOORE. Dublin. Safety trolley head guard for electric tramcars, &c.

24,791. W. KINGSLAND. London. Improvements in or connected with electrical traction.

24,792. W. KINGSLAND. London. A new or improved method of and means for carrying and connecting strikers to motor vehicles for mechanically operating electric switches.

24,799. M. B. FIELD. Lee. A new or improved method of measuring the difference of electric pressure between points of a circuit which may be distant from the observer and apparatus therefor.

24,805. SIEMENS BROS. AND CO. (LTD.). London. Improvements in appliances for reversing the current in continuous-current dynamos. (Siemens and Halske, Aktien-Gesellschaft, Germany.)

24,824. C. HOWARD. London. Improvements in electric incandescent lamps.*

24,832. F. KAEFERLE. Liverpool. An improved method of making commutators for electrical machines.*

24,833. C. GRIVOLAS, Fils. Liverpool. An improved diaphragm for phonographs, graphophones, and other machines for reproducing speech, and the like.

December 14, 1899.

24,876. W. P. THOMPSON. Liverpool. Improvements in and in apparatus for the manufacture of mangano calcium carbide without the use of electric current. (P. P. H. Macé, France.)

24,879. W. H. ISHERWOOD. London. Improvements in or relating to electrical conductors.

24,880. Z. STANECKI. London. Improvements in the manufacture of accumulator plates.*

24,887. F. J. DIGBY. London. Improvement relating to electric arc lamps.

December 15, 1899.

24,898. A. J. HOWARD. Newport. Improvements in electric time switches.

24,914. J. W. TAYLOR. Manchester. Improvements in trolley electric tramways.

24,916. A. ECKSTEIN and A. BROOKER. Manchester. An improved mouthpiece for use with telephonic transmitters.

24,942. E. M. TINGLEY. London. Improvements in electric brakes. (Date applied for under Patents, &c., Act, 1883, Sec. 103, 18th May, 1899, being date of application in United States.)

24,956. SIEMENS BROS. AND CO. (LTD.) London. Rotary field measuring apparatus for uniformly loaded rotary phase current systems. (Siemens and Halske, Aktien-Gesellschaft, Germany.)*

24,960. C. LUCKOW, Jun. London. A method of producing electrodes for electrical accumulators.

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December 16, 1899.

24,966. B. HOPKINSON. London. Improvements in electric locomotives.
24,968. B. JONES. London. Process for the production of thermo-electric batteries.
24,970. C. R. SCHMUTZ (trading as K. Robert). London. Improvements in electric hair brushes.*
24,978. W. NORTON. Warrington. An improvement in or applicable to the filaments of incandescent electric lamps.
24,983. W. H. BAKER and F. E. KIP. Wolverhampton. Improvements in and relating to electrically controlled automatic weft or filling supplying mechanisms for looms.
25,011. W. P. THOMPSON. Liverpool. An improved primary electric battery. (J. P. Fontaine, France.)*
25,012. W. P. THOMPSON. Liverpool. Improvements in electric accumulators. (G. Daseking and A. Brandes, Germany.)
25,019. SIEMENS BROS. AND CO. (LTD.). London. An improvement in safety fuses for electrical circuits. (Siemens and Halske Aktien-Gesellschaft, Germany.)*

December 18, 1899.

25,032. F. S. CARTER. Manchester. Improvements in electric driving mechanism for geared machines generally.
25,053. T. R. SOWERBUTTS. London. Improvements in connectors for electrical wires or cables.
25,054. G. H. CONGDON and F. MCCALLUM. London. An improved method for connecting tubular conduits with rectangular casings for electric conductors.
25,057. O. D. DEACON. London. Electric light magnifying bulbs or burners.
25,072. F. DE MARE. London. Electrolytic interrupter.*

December 19, 1899.

25,164. E. SCHMIDT. London. Improvements in electric igniting devices for lighting gas and like lamps.*
25,177. C. H. R. DE LAMBERTYE-TORNIELLE. London. Improvements in and relating to electrical illuminated advertisements.
25,186. G. MARCONI and THE WIRELESS TELEGRAPH AND SIGNAL CO. (LTD.). London. Improvements in apparatus employed in wireless telegraphy.
25,200. W. H. JOHNSON. London. Improvements in electricity meters.

December 20, 1899.

25,216. G. E. HEYL-DIA. Manchester. Improvements in electric cable conduits.
25,254. O. HOLT. London. Improvements in the construction of reflectors or shades for electric or other lights.
25,274. O. IMRAY. London. Process for clearing the bulbs of electric incandescent lamps. (J. Lux, Austria.)
25,275. E. WEBSTER. London. Improvements in or relating to clock-controlled electric switches.
25,281. H. LANE. Birmingham. Improvements in or relating to electrical traction, particularly applicable for tramways and railways.
25,282. L. J. STEELE. Birmingham. Improvements in earthing devices and safety fuses for electrical circuits.
25,295. J. A. FLEMING. London. Improvements in electrical resistance measuring instruments.*

December 21, 1899.

25,346. A. S FRAMPTON and MUIRHEAD AND CO. London. Improvements in perforators for use in connection with automatic telegraph transmitters.
25,347. M. B. FIELD. Lee. A new or improved method of measuring the difference of electric pressure between points of a circuit which may be distant from the observer, and apparatus therefor.
25,348. G. DAVIS. London. Improvements in or connected with incandescent electric lamps.
25,350. V. SCHOLZ. London. Improvements in electric incandescent lamps.
25,353. E. F. MOY, P. H. BASTIE, and E. F. MOY (LTD.). London. Improvements in liquid resistances for electrical circuits.
25,362. W. P. THOMPSON. London. Improved method of telegraphing on telephone lines and telegraphic recorders for use in connection therewith. (A. Sinding-Larsen, Norway.)*
25,366. S. B. APOSTOLOFF. London. Improvements in electric incandescent lamp fittings or fasteners.

December 22, 1899.

25,391. G. K. B. ELPHINSTONE and A. C. HEAP. London. Improvements in electrical measuring instruments.
25,396. A. ST. V. BURNABY. Brighton. Electric trackway train.
25,403. S. M. MATTHEWS. London. An improved electric low-water alarm for steam generators.*
25,413. W. W. COLLEY. London. Improved means for insulating electric conductors.
25,415. G. DRAPER, K. C. COX, and J. JEFFREY. London. Improvements in and relating to perforators for use in connection with automatic telegraph transmitters.
25,417. L. J. DELAVEAN. London. Improvements in and relating to electro magnets.
25,421. B. G. LAMME. London. Improvements in alternating-current generators. (Date applied for under Patents, &c., Act, 1883, sec. 108, 24th May, 1899, being date of application in United States.)*
25,422. L. B. STILLWELL. London. Improvements in systems of electrical distribution and circuit-breakers for use therein. (Date applied for under Patents, &c., Act, 1883, sec. 103, 24th May, 1899, being date of application in United States.)
25,423. J. DULAIT and O. GARBE. London. Improvements in electrical resistances.
25,426. D. J. BISSELL. Liverpool. Improvements in or relating to electric arc lamps.
25,432. A. E. THIERGARTNER. London. New or improved electrically-actuated air-douche apparatus.*
25,439. E. CADET and C. CHEVALLIER. London. A new or improved electrical contact apparatus.
25,446. THE BRITISH THOMSON-HOUSTON CO. (LTD.). London. Improvements in electric railway motors. (E. D. Priest, United States.)*
25,447. THE BRITISH THOMSON-HOUSTON CO. (LTD.). London. Improvements in electric brakes. (F. E. Case, United States.)*
25,448. THE BRITISH THOMSON-HOUSTON CO. (LTD.). London. Improvements in safety devices for electric vehicles. (F. E. Case, United States.)*
25,449. THE BRITISH THOMSON-HOUSTON CO. (LTD.). London. Improvements in means for controlling electric motors. (A. G. Davis and W. B. Potter, United States.)*
25,450. THE BRITISH THOMSON-HOUSTON CO. (LTD). London. Improvements in sytems of electric train control. (W. B. Potter, United States.)*

SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1898.

21,043. THE BRITISH THOMSON-HOUSTON CO. (LTD.) (Rice). Electric meter systems.
23,410. ELECTRIC FOG SIGNAL SYNDICATE (LTD.) and SYKES. Explosive signalling apparatus for railways.
24,855. ALCOCK. Apparatus for electrically transmitting orders or signal suitable for use as a ship's telegraph and the like.
25,764. STAMP. Devices for making and breaking surface contact on electrical tramways.
26,526. CLARK. Crucible for casting lead or like metals under pressure, especially applicable to the formation of secondary electric battery grids or plates.
26,559. ROSENTHAL. Phonographs and like apparatus.
26,806. THOMPSON. Steam or electric after-steering gear for ships.
27,269. KUNKLEMANN, FRANCOIS and LOUBERY. Apparatus for measuring electricity.
27,334. JUSTICE (Nye). Telephone receivers.
27,335. JUSTICE (Nye). Telephone transmitters.
27,336. JUSTICE (Nye). Apparatus for use in telephone exchanges.
27,636. ARTER. Electric arc lamps.

1899.

2. HIGHFIELD. Apparatus for connecting electric mains.
44. HARFIELD. Apparatus for electrically controlling engines, electromotors, and other machinery.
356. GAUS. Manufacture of incandescent materials and lamps suitable for electric lighting.
485. PAUL. Telegraphic relays.
1,156. LITTLE and IRELAND. Current-collecting apparatus for electric tramways.
1,487. DAVIDSON. Electric light wire casing.
1,834. HIRST and ZEALANDER. Rail bonds for electric traction systems.
1,841. TWEEDY. Collectors or trolleys for electric tramways and the like.
1,941. HIRST and MURPHY. Electric incandescence lamp pendants or brackets.
2,074. ESCHWEI. Electric arc lamp.
2,742. BOWLES. Electric floats for theatrical purposes.
6,687. DOW. Porous diaphragms for electrolytic cells and method of producing the same.
7,523. DUNAND. Clip for shades for electric lamps, candles, or other illuminating devices.
13,008. DEBI. Apparatus for converting alternating currents into continuous current.
15,210. CHAGNAUD. Electric arc lamps.
16,999. WOOLLEY. Magneto-electric telegraphs.

NEW COMPANIES, STATUTORY RETURNS, &c.

CHELTENHAM ENGINEERING CO. (LTD.)—This company was registered on Jan. 4, with a capital of £8,000 in £1 shares, to carry on the business of mechanical and electrical engineers, ironfounders, &c.

WM. HARDILL, SONS AND CO. (LTD.)—This company was registered on Jan. 4, with a capital of £20,000 in £5 shares, to acquire the business carried on under the style of Wm. Hardill, Sons and Co., and to carry on the business of electrical and mechanical engineers, electricians, iron and brass founders, &c.

J. W. MANLEY AND CO. (LTD.)—This company was registered on Jan. 2, with a capital of £3,000 in £1 shares (2,000 preference), to carry on the business of electricians, electrical engineers, and founders, &c. The subscribers are J. G. Machan, J. H. Balleece, M. M. Campbell, S. Mackay, J. W. Manley (engineer), R. Bode, and A. Field. The first directors are J. W. Manley and J. H. Batten.

REASON MANUFACTURING CO. (LTD.)—This company was registered on Jan. 5, with a capital of £50,000 in £1 shares, to acquire certain patents from the Mutual Electric Trust (Ltd.), to take over the business of the Reason Manufacturing Co. (Ltd.) (incorporated in 1891), and to carry

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on any business connected with the distribution, measurement, and utilisation of electrical energy. The subscribers are H. Reason (engineer), W. Paddison, W. Cowderoy (engineer), H. Chier, F. V. Hobbs, L. A. R. F. Kenward, F. M. Lewis (electrician), and H. C. Hughes. Mr. Henry Reason is the governing director, and may retain office so long as he holds one-fifth of the issued capital.

KALGOORLIE ELECTRIC POWER AND LIGHTING CORPORATION (LTD.)—The annual return to Dec. 18 gives the capital as £225,000, in 200,000 preference and 25,000 deferred shares of £1 each. 150,000 have been taken up, 5s. per share has been called up, and £32,423. 5s. has been received, leaving £5,076. 15s. unpaid.

WINCHESTER ELECTRIC LIGHT AND POWER CO. (LTD.)—According to the annual return to Oct. 24, the capital is £25,000, in £5 shares; 2,207 shares have been taken up, and £10,875 received.

BLACKHEATH AND GREENWICH DISTRICT ELECTRIC LIGHT CO. (LTD.)—The annual return to Dec. 8 has been filed. The capital is £150,000, in £1 shares. 101,200 shares have been taken up.

CITY NOTES.

MEMORANDA.—Bank rate 5 per cent. (Jan. 11, 1900). Price of silver 27d. per oz. (Jan. 11). Consols (2¾ per cent.) 98¾—99 for money, 98¾—99 for account; 2¾ per cent. 96¾—97¼ (Jan. 11). Stock Exchange Settling Days: Consols, Feb. 2; Stocks and Shares Continuation Day, Jan. 24; Ticket Day, Jan. 25; Pay Days, Jan. 12 and 26; Mining Share Carry-over Days, Jan. 23 and Feb. 6.

GUTTA PERCHA CORPORATION (LTD.)—A private meeting of this company was held on Wednesday.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee has appointed 17th inst. a special settling day for 100,000 6 per cent. preference £5 (£3 paid) shares (Nos. 1 to 100,000) of the *British Westinghouse Electric and Manufacturing Co. (Ltd.)*, and has also ordered the securities to be quoted in the official list. The 25th inst. has been appointed a special settling day in the further issue of 14,320 £3 (£2 paid) shares (Nos. 32,099 to 46,418) of *Crompton and Co. (Ltd.)*. Application has also been made to the committee to appoint a special settling day in and to grant a quotation to the four per cent. perpetual second debenture stock of the *Brush Electrical Engineering Co. (Ltd.)*, and to allow the further issue of £150,000 four per cent. first mortgage debenture stock of the *London Electric Supply Corporation (Ltd.)* to be quoted in the official list.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	'99–1900	£	£		£	£
*Birmingham Tramways.	Jan. 6	3,928	+ 73	1	3,928	+ 73
Blackpool Corporation...	„ 4	140	− 2	40	20,834	+ 4,263
Blackpool and Fleetwood	„ 6	†140	− 26	1	140	− 26
Bradford Corporation ...	...	...	...	...	...	...
Brisbane Trams	Nov. 22	1,562	+ 411	8	19,712	+ 6,131
*Bristol Trams & Carriage	Jan. 5	2,766	+ 260	1	2,766	+ 260
*Buenos Ayres & Belgrano	Dec. 10	2,574	+ 770	49	106,727	+ 46,685
City & South London Ry.	Jan. 7	1,144	+ 1	1	1,144	+ 1
Dover Corporation	„ 6	158	+ 3	40	8,357	+ 1,004
Dublin United	„ 5	2,136	+ 292	1	2,136	...
Dublin Southern Dist....	„ 5	415	− 23	1	415	...
*Glasgow Corporation ...	„ 6	9,820	− 276	...	...	...
*Liverpool Corporation...	Dec. 30	6,820	− 65	52	357,975	+ 41,410
Liverpool Overhead Rly.	Jan. 7	1,455	+ 116	...	...	...
*Sheffield Tramways	„ 7	1,818	+ 510	1	1,818	+ 510
*South Staffs. Trams.....	„ 5	‡405	− 53	1	405	− 53

* Partly electrical. † Six days. ‡ Five days against six days last year.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Jan. 3.		Price Wednesday, Jan. 10.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Jan. 10. Highest	Lowest
			TELEGRAPHS.					£ s. d.			
£110,900	100	4%	*African Direct Telegraph 4% Mort. Deb. (red.)	99	103	99	103	3 17 8	January and July.....	...	...
25,000	10	...	Amazon Telegraph.....	3	4	3	4	...	June and December ..	...	...
£125,000	100	5%	Do. 5 per Cent. Debentures	85	90	85	90	5 11 1	...	...	...
£875,520	Stock	15/0	Anglo-American	64	67	64	67	5 2 11	Feb., May, Aug., Nov.	6½	64
£3,062,240	Stock	30/0	Do. Preferred	114	116	113	115	5 4 4	„ „	116½	114
£3,062,240	Stock	18/0	Do. Deferred.....	17¼	17¾	17	17½	5 2 10	...	17⅝	16⅝
$10,000,000	$100	$2½	Commercial Cable Capital Stock	...		165	175	...	Jan., Apr., July, Oct.	...	...
£1,332,823	Stock	4%	* Do. 4 per Cent. Debenture Stock	101	104	102	104	3 16 11	„ „	103½	102
16,000	10	8/0	Cuba Submarine Ordinary	8½	9½	8½	9½	8 8 5	February and August	9⅝	...
6,000	10	10,0	Do. Preference 10 per Cent.	19	20	19	20	5 0 0	„ „	...	...
12,931	5	2/0	Direct Spanish Ordinary.....	4	5	4	5	4 0 0	April and October.....	...	...
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference	9	10	9	10	5 0 0	„ „	...	...
£30,000	50	4½%	Do. 4½ per Cent. Debentures	101⅝	105⅝	101⅝	105⅝	4 5 9	January and July.....	...	...
60,710	20	3 0	Direct United States Cable	11½	12	11⅝	12	5 16 8	Jan., Apr., July, Oct.	11⅞	11⅝
£120,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red.)	99	102	99	102	4 8 3	June and December ..	...	...
£4,000,000	Stock	5%	Eastern Ordinary	145	150	143	153	4 12 9	Jan., Apr., July, Oct	151	147½
£1,795,000	Stock	3½%	Do. 3½ per Cent. Preference Stock	96	99	96	99	3 11 3	„ „	98	97
£1,432,268	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.).....	115	120	115	120	3 6 11	May and November ..	...	...
250,000	10	2/6	Eastern Extension	14½	15	14½	15	4 13 4	Jan., Apr., July, Oct	15	14⅞
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	116	121	116	121	3 6 7	February and August	...	...
£16,200	100	5%	* Do. 5% (Austln. Gov. Sub.) Deb.,1900 (reg.) ...	99	103	99	103	4 17 1	January and July.....	...	...
£64,400	100	5%	Do. (Bearer)	100	103	100	103	4 17 1	„ „	...	...
£300,000	100	4%	*Eastern and S. African 4% Mort. Deb , 1909.....	101	104	101	104	3 16 11	February and August	...	...
£200,000	25	4%	Do. 4 per Cent. Mauritius Sub. Debs.(red.)..	101⅞	104⅞	101⅞	104⅞	3 16 10	May and November ..	...	...
180,227	10	1/9	Globe Telegraph and Trust	10⅞	11⅛	10⅞	11⅛	4 13 4	Jan., Apr., July, Oct.	11	10⅛
180,042	10	3,0	Do. 6 per Cent. Preference	14⅞	15⅛	14⅞	15⅛	3 18 8	„ „	15⅛	14⅛
150,000	10	5/0	Great Northern of Copenhagen	31	33	30	32	3 18 2	January and July.....	...	...
£86,300	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb.(red.) ..	99	102	99	102	4 8 3	...	...	...
17,000	25	12/6	Indo-European.....	48	52	48	52	4 16 2	May and November ..	51¾	...
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904 ...	106	109	106	109	5 10 1	March and September	...	...
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.)	101	104	101	104	3 16 11	June and December ..	...	...
11,839	8	4/0	Reuter's.....	7	8	7	8	5 0 0	April and October.....	...	...
3,381	£100 Cert.	6%	Submarine Cables Trust	125	130	125	130	4 13 0	„ „	...	...
15,609	10	...	West African Telegraph	2½	3½	2¼	3¼	4 9 3	December and July ..	...	...
£200,000	100	5%	* Do. 5 per Cent. Debentures (red.)	99	102	99	102	4 18 0	March and September	...	...
30,008	2½	...	West Coast of America	½	1	½	1	...	...	...	...
£150,000	100	4%	* Do. 4 per Cent. Debentures	100	103	100	103	3 17 8	January and July.....	...	...
88,321	10	6d.	West India and Panama	⅝	1⅛	⅝	1⅛	...	May and November ..	...	...
31,563	10	6/0	Do. 6 per Cent. 1st Preference	9¼	9⅝	9¼	9⅝	6 3 1	„ „	9 1/16	...
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	7	8	7	8	7 10 0	„ „	...	...
£80,000	100	5%	* Do. 5 per Cent. Debentures	104	107	104	107	4 13 6	January and July.....	...	...
£389,731	Stock	4%	Western & Brazilian 4 per Cent. Debenture Stock ..	102	105	102	105	3 16 2	June and December ..	...	...
207,930	10	3/0	Western Telegraph (late Brazilian Submarine)	14	14½	14¼	14⅝	4 15 0	Mar., June, Oct., Dec.	14⅞	14½
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1900)	106	109	106	109	4 11 9	June and December ..	...	...
£158,100	100	6%	*Western Union 6 per Cent. Sterling Bonds (red.) ..	98	103	98	103	5 16 6	March and September	...	...
			TELEPHONES.								
44,000	£5	3/0	Chili Telephone (fully paid)	2	3	2	3	6 13 4	August	...	...
224,850	10s.	0/1½	Consolidated Telephone Const. & Manufacturing ...	⅛	¼	⅛	¼	4 15 3	July	...	...
72,680	1	0/6	Monte Video Telephone Ordinary	⅜	⅝	⅜	⅝	5 0 0	October.....	...	...
86,492	1	1 0	Do. 5 per Cent. Preference	¾	1	¾	1	5 0 0	...	...	...
490,000	5	3/0	National	5	5½	5	5¼	5 14 3	February and August	5 1/16	5⅛
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Preference ...	14	15	14	15	4 0 0	„ „	...	...
15,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference ...	14	15	14	15	4 0 0	„ „	...	...
250,000	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref. ...	5⅛	5⅜	5⅛	5⅜	4 13 0	„ „	5⅜	5⅛
1,329,471	Stock	3½%	* Do. Debenture Stock 3½ per Cent. (red.)	98	100	98	100	3 10 0	June and December ..	99	98
171,504	1	0/4	Oriental	¾	1	¾	1	5 0 0	April and October.....	...	...
58,000	5	2/5	United River Plate	4½	5	4½	5	7 10 0	July	4⅝	...
16,439	5	1/4	Do. 5% Cumulative Preference	4½	5	4⅝	5	5 0 0	...	...	...
£179,947	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	102	105	102	101	4 16 2	June and December ...	102	...

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Jan. 3.	Price Wednesday, Jan. 10.	Rate per Cent. Yield.	Dividend Due.	Business Done During Week Ending Jan. 10. Highest	Lowest
			ELECTRICITY SUPPLY COMPANIES.			£ s. d.			
100,000	1	...	Bl'ckh'th & Gr'nw'ch D'st'ct Elec.Lt.Ord.(fully pd.)	¾ 1	¾ 1	...	...	...	...
6,000	10	7/9⅜	Bournemouth and Poole Elec. Supply Ord.	12 13	12 13	3 0 0	...	...	...
6,000	10	4/6	Do. 4½ per Cent. Cumulative Pref.	10 11	10 11	4 1 10	...	...	...
19,661	5	2/6	Brompton & Kensington Electricity Supply Ord.	7¼ 8¼	7 8	3 15 0	...	...	...
12,000	5	3/6	Do. 7 per Cent. Preference	9 10	9 10	3 10 0	March and September	...	...
20,000	5	...	Calcutta Elec. Supply Ordinary (fully paid)	6¼ 7	6¼ 7	...	...	...	...
30,000	5	4/0	Charing Cross & Strand Electricity Supply Corp.	9¾ 10¼	9¾ 10¼	4 5 9	February and August	9⅜	...
20,000	5	...	Do. (Nos. 3,001 to 50,000)	9¼ 10¼	9¼ 10¼	...	...	...	...
20,000	5	2/3	Do. 4½ per Cent. Preference	5¾ 6	6⅛ 6	3 15 0	,, ,,	...	...
34,000	5	2/6	Chelsea Electricity Supply Ordinary	7¾ 8¼	7¾ 8¼	3 10 7	March	8	...
£100,000	Stock	4¼%	* Do. 4½ per Cent. Debenture Stock (red.)	109 111	109 111	4 1 1	June and December	...	...
$1,200,000	$1,000	5%	Chicago Edison 1st Mort.5% 30 year Gold Bonds(red.)	100 110	100 110	4 10 11	April and October	...	...
60,000	10	7/0	City of London Electric Lighting Ordinary	10 11	10 11	5 9 1	February and August	...	...
40,000	10	6%	Do. 6 per Cent. Cumulative Preference	13 14	12⅞ 13⅛	4 8 11	January and July	...	...
£400,000	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	122 127	122 127	3 13 9	June and December	126¾	125
40,000	10	...	County of London and Brush Prov. Ordinary	10 11	10 11	...	...	10⅝	...
20,000	10	6/0	Do. 6 per Cent. Cumulative Preference	13 14	13 14	4 5 9	March and September	13⅝	...
£200,000	Stock	4½%	Do. 4½% Deb. Stock Certs. (all pd.) (red.)	107 110	107 110	4 1 10	...	...	...
15,000	5	10/	Kensington and Knightsbridge Ordinary	12 13	12 13	4 1 6	...	...	...
10,000	5	6%	Do. 6 per Cent. 1st Preference	7¼ 7¾	7¼ 7¾	3 17 5	January and July	...	...
110,000	3	...	London Electric Supply Ordinary	2½ 2¾	2½ 2¾	...	...	...	...
48,050	5	3/0	Do. 6 per Cent. Preference	5⅞ 6	5⅞ 6	5 0 0	...	...	...
£100,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures	102 104	102 104	3 16 11	Mar., June, Sept., Dec.	101	...
62,500	10	5/0	Metropolitan Elec. Supply Ord. (Nos. 1 to 62,500)	13 14	13½ 14½	3 9 0	April and October	14⅜	14
22,500	10	3/7½	Do. (Nos. 62,501 to 85,000)	13 14	13 14	3 10 0	...	...	...
£220,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage	116 118	116 118	3 16 3	June and December	...	...
£125,000	Stock	24/8	Do. 3½ per Cent. Mort. Deb. Stock (red.)	95 97	95 97	3 12 2	...	95½	95½
6,452	10	6/0	Notting Hill Electric Ordinary	15½ 16½	15½ 16½	3 15 0	March	...	...
10,000	5	5/0	Oxford Electric Ordinary	6¾ 7¼	6¾ 7¼	3 9 0	,,	...	...
300,000	1	8/	Rand Electric	¾ ¾	¾ ¾	10 13 4	...	...	...
£130,070	Stock	5%	River Plate El.Lt. & Tr'ct'n, Ltd., 5% 1st Mor.Deb.	80 90	80 90	5 11 1	...	...	...
150,000	$100	$2	Royal Electric Company of Montreal Shares	150 170	150 170	4 14 2	...	...	...
£123,200	100	4½%	* Do. 4½ per Cent. 1st Mortgage Debentures	104 106	104 106	4 5 6	April and October	...	...
31,980	5	5/0	St. James's and Pall Mall Electric Ordinary	15 16	14 15	4 16 8	February and August	...	...
20,000	5	3/6	Do. 7 per Cent. Preference	9 9½	9 9½	3 13 8	,, ,,	9⅛	...
65,000	5	...	South London Electric Supply Ordinary (fully paid)	4½ 4¾	4 4¼	...	...	...	...
79,900	5	5/0	Westminster Electric Supply Ordinary	13⅜ 14⅜	13½ 14½	4 2 9	March and September	14	13¾
			ELECTRIC MANUFACTURING, &c., COMPANIES.						
125,000	1	7¼d.	Aron Electricity Meter 6 per Cent. Cum. Pref.	¾ ¾	¾ ¾	6 17 2	...	...	...
45,000	1	...	British Electric Works Co. Ordinary	14/6 15/6	14/6 15/6	...	...	...	...
50,000	1	...	Do. 5 per Cent. Cumulative Preference	17/0 18/0	17/0 18/0	...	...	...	...
£50,000	100	...	Do. First Mortgage Debentures	99 101	99 101	...	...	...	...
40,000	5	5/0	British Insulated Wire Ordinary	11¼ 12½	11½ 12½	4 0 0	...	...	...
27,500	5	3/0	Do. Preference	6½ 6¾	6½ 6¾	4 8 11	...	...	...
90,000	2	2/0	Brush Electrical Engineering	1⅞ 2	1⅞ 2	5 0 0	September	...	...
90,000	2	1/2½	Do. 6 per Cent. Pref. Non-Cumulative	2⅛ 2⅜	2⅛ 2⅜	5 1 1	,,	...	...
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Deb. Stock	110 115	110 115	3 18 5	February and August	...	...
£50,000	Stock	4½%	* Do. 2nd Debenture Stock (red.)	102 105	102 105	4 5 9	June and December	...	...
20,000	5	5/0	Callender's Cable Construction Ordinary	13⅛ 13½	12½ 13½	5 11 1	,, ,,	12⅝	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5¼ 5½	5¼ 5½	4 6 11	...	5⅛	...
£90,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb. (red.)	110 115	110 115	3 18 3	November and May	110½	110
300,000	1	0/9⅝	Castner-Kellner Alkali Co. (fully paid)	1⅛ 1⅜	1⅛ 1⅜	5 16 5	...	1⅛	...
60,000	1	0/7½	Chadburn's Ship Telegraph Ordinary	⅝ 1⅛	⅝ 1⅛	5 6 8	...	...	...
60,000	1	0/7½	Do. 6 per Cent. Cumulative Preference	⅝ 1⅛	⅝ 1⅛	5 6 8	...	...	...
32,098	3	2/1½	Crompton and Co. (Nos. 1 to 32,098)	3½ 4	3½ 4	4 10 9	January and July	...	...
£100,000	100	5%	* Do. 5 per Cent. First Mortgage Deb. (red.)	98 101	98 101	4 19 0	,, ,,	...	...
60,000	1	0/3	Davis and Timmins 6 per Cent. Cum. Pref.	¾ 1	¾ 1	...	...	...	...
99,261	5	1/9⅜	Edison and Swan United ("A" Shares) (£3 paid)	2 2⅛	1⅞ 2⅛	8 0 0	February and August	2⅛	...
17,139	5	2/9⅜	Do. (£5 paid)	3½ 4⅛	3⅝ 4⅛	6 13 4	,, ,,	...	...
£314,023	Stock	4%	Do. 4 per Cent. Mortgage Deb.Stock (red.)	93 95	93 95	4 4 3	June and December	...	...
26,100	5	5/11⅛	Edmundson's Electric Corporation Ord.(fully pd.)	4⅜ 5⅛	4⅜ 5⅛	5 14 3	Half-yearly	...	...
112,100	2	1/2⅜	Electric Construction Co. (Limited)	1⅝ 2⅛	1⅝ 2⅛	5 8 3	January and July	2⅛	1⅞
25,000	2	2/9⅜	Do. 7 per Cent. Cumulative Preference	2⅜ 3⅛	2⅜ 3⅛	4 6 2	July	...	...
182,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	104 107	104 107	3 15 8	January and July	...	...
91,195	1	...	Elmore's Patent Copper Depositing	⅜ ⅜	⅜ ⅜	...	...	...	...
30,000	5	...	Henley's Telegraph Works Ordinary	12 13	12 13	...	February and August	12⅜	13
15,000	5	...	Do. 4½ per Cent. Preference	5 5½	5 5½	4 1 10	,, ,,	5⅜	5½
£50,000	Stock	4½%	Do. 4½ per Cent. Mortgage Deb. Stock (red.)	111 114	111 114	4 0 0	,, ,,	...	...
50,000	10	10/0	India Rubber, Gutta Percha, &c., Works	20½ 21½	20½ 21½	4 13 0	,, ,,	21	20½
£300,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	100 104	100 104	3 16 11	March and September	...	...
37,350	12	12/0	Telegraph Construction and Maintenance	34 38	35 39	4 12 4	March and July	36½	35½
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909	102 105	102 105	3 16 2	...	...	...
20,000	5	3/0	Do. Manufacturing Ordinary	9 10	9 10	3 10 0	...	...	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5½ 6	5½ 6	4 3 4	...	...	...
30,000	5	5/0	Willans and Robinson Ordinary	10 11	9½ 10½	4 5 9	April and October	...	...
30,000	5	3/0	Do. 6 per Cent. Cumulative Preference	7 7½	7 7½	4 0 0	,, ,,	...	...
£100,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Debentures	104 105	104 106	4 0 2	May and November	...	...
			ELECTRIC RAILWAYS, TRAMWAYS, &c.						
12,000	10	6/0	Blackpool and Fleetwood Tramways	17 19	17 19	3 13 8	...	...	...
£167,900	100	5%	Brisbane Tramway 5 per Cent. Debentures	104 106	104 106	4 14 4	...	...	...
50,000	10	7%	Bristol Tramways and Carriage Ordinary	23 24	23 24	2 17 2	February and August	...	...
25,000	10	...	Do. Cumulative Preference (£6 paid)	6¼ 6¾	6¼ 6¾	...	...	...	...
£100,000	Stock	4%	Do. 4 per Cent. Debentures	117 118	117 118	3 7 3	...	...	...
45,000	10	9/0	British Electric Traction Ordinary	15 16	15 16	1 11 3	...	15⅞	...
30,000	10	6/0	Do. 6% Cum. Pref. (Nos. 30,001 to 60,000)	12⅜ 13	12⅜ 13⅛	4 12 4	...	13⅜	12⅛
£200,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures	125 128	125 128	3 18 6	...	...	...
40,000	5	1/9	Buenos Ayres & Belgrano 6% "A" Cum. Pref.	4⅜ 5⅛	4⅜ 5⅛	5 17 1	...	...	...
27,500	5	...	Do. "B"	4⅛ 5⅛	4⅜ 5	...	...	...	...
265,585	Stock	5%	Do. 5 per Cent. Debentures	106 109	105 108	4 12 7	...	...	...
213,553	10	3/0	Central London Ordinary	9½ 10	9½ 10	3 0 0	June and December	9⅝	9⅜
£865,000	Stock	2½%	City and South London Railway Con. Ordinary	59 62	59 62	3 8 6	January and July	61	6 1
37,000	10	...	Do. (Nos. 22,501 to 60,000) (£4. 10s. paid)	4½ 5½	4½ 5½	...	...	...	...
£150,000	Stock	5%	Do. 5 per Cent. Perpetual Preference (1891)	143 148	143 145	3 8 0	January and July	145	144½
£200,000	Stock	5%	Do. (1896)	135 140	135 140	3 11 11	...	...	...
£87,701	Stock	4%	Do. 4 per Cent. Perpetual Debenture	127 133	125 130	3 1 11	May and November	...	...
20,000	10	7½%	†Imperial Tramways Ordinary	23 24	23 24	...	March and September	...	...
10,000	10	6%	† Do. 6 per Cent. Preference	15½ 15¾	15½ 15¾	3 13 10	,, ,,	...	...
£200,000	Stock	4½%	† Do. 4½ per Cent. Debenture	115⅜ 116⅜	113 115	3 18 6	January and July	...	...
30,000	10	1/3	Kidd'rm'nst'r&Dist.E.L &Tr'ct'n 5%Pref.(£8 pd.)	8 8½	8	...	May and November	...	...
37,500	10	2½%	Liverpool Overhead Railway Ordinary	8⅜ 8¾	8½ 8¾	3 15 4	February and August	...	...
10,000	10	5%	Do. 5 per Cent. Preference	13 13½	13 13½	3 15 6	,, ,,	...	...
125,000	Stock	4%	Do. 4 per Cent. Debenture	102 104	102 104	3 16 11	January and July	...	...
21,000	5	...	New General Traction Ordinary	3⅜ 4	3½ 4	...	...	...	...
30,000	5	6/0	Do. 6 per Cent. Cumulative Preference	5 5½	5 5½	5 9 1	May	...	...
4,000	10	...	Oldham, Ashton and Hyde Elec. Tramway Ord.	18 19	...	...	February and August	...	...
4,000	10	5/0	Do. per Cent. Preference	10⅜ 10¾	...	...	,, ,,	...	...
13,334	10	...	Potteries Electric Traction Ordinary	11¼ 12¼	11½ 12½	...	...	...	...
20,000	10	5/10	Do. 5 per Cent. Cumulative Preference	10 11	10 11	4 10 11	...	...	...
£510,000	Stock	3%	Waterloo and City Ordinary	101 104	101 104	2 18 4	June and December	101	...

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

† The London Stock Exchange Committee refuses to quote these.

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THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,131. [No. 13. Vol. XLIV.] FRIDAY, JANUARY 19, 1900. PRICE SIXPENCE (by post, 6½d.). Abroad, 8d., or 15 cents. or 30 kr., or 70 pf.

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NOTES.

THE President of the Board of Trade received, on Wednesday, a deputation of residents in Marylebone who had a grievance against the Metropolitan Electric Supply Co. because of defective supply. A number of speeches were made, in which specific complaints were advanced, one of the most serious being that during important surgical operations at Middlesex Hospital the operating room had several times been plunged into darkness. Mr. RITCHIE, the President, said that the gravity of the situation was generally admitted, but the Board of Trade was powerless to adopt the course petitioned for by the leader of the deputation—viz., "to introduce, either in a provisional order or a bill, a clause placing the company in the same position as other trading companies, and giving them [consumers] a right to compensation for its breach of contract and duty to them." It is amazing that the idea that this course could be adopted by the Board of Trade should have entered the head of any member of the deputation.

AGGRIEVED consumers have their remedy: they can take out a summons against the company. In the present instance the magistrate has postponed such a summons for three months, evidently on account of the peculiarly trying circumstances affecting the company's supply. To place a statutory electric supply company on the footing of an ordinary trading concern would be grossly unjust to the company. Mr. RITCHIE's remedy for the existing state of affairs is competition. But when we try to follow out the mystic process by which competition is to work a cure, we are utterly perplexed. The difficulties of the existing company are not such as can be removed by the creation of a rival undertaking, liable to precisely the same troubles at, possibly, precisely the same time. Far better to recognise that these difficulties are of a special and transitory nature, and that when the temporary cause of them is removed their recurrence is extremely improbable. The present agitation will do some good, however. It will serve as a warning to supply undertakers, whether company or municipal, to stay their hand when tempted to accept new consumers before they are in a position to supply them.

THE discussion on "The Telephone System of the United Kingdom," at the London Chamber of Commerce dinner on Wednesday evening, was significant chiefly as showing the diversity of opinion which still prevails among the leading spirits of telephonic enterprise. On the other hand, it is satisfactory to note the growing tendency to appreciate the importance of a uniform and combined national system—a system, as one speaker advocated, bounded only "by the four seas." The difficulties likely to arise from the intrusion of municipal and other isolated schemes are also beginning to be apprehended; and although Mr. PROVAND retains his conviction that "there should be as much competition as possible in telephony," nobody else seemed to share it. It may be the case, as he predicts, that Glasgow will "soon be the best telephoned city in the kingdom"; but if so, the result will not be due to competition. Nor can it be admitted that the "best telephoned city," whether Glasgow or London, can be one which has one system of overhead wires and another system of underground wires, two sets of subscribers, and conducted the one on commercial principles, the other by methods which apparently set those principles at defiance.

THERE was a pleasant gathering on Thursday last week, to celebrate the annual dinner of the Liverpool Engineering Society; and the function possessed a special attraction for electrical engineers, inasmuch as the president this year is Mr. A. BROMLEY HOLMES, electrical engineer to the Liverpool Corporation. In a speech paying tribute to the engineering profession, the LORD MAYOR expressed a wish to see the Overhead Railway encircle the city. He also looked forward to another important electrical development—the lightning

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express railway to Manchester. The presidential speech embodied several striking criticisms of the relation of labour to industrial progress and to our national prosperity :—

It is not satisfactory that we should be losing our place in the world's markets as the leading manufacturers of machinery. It is unsatisfactory that we should have to go to America or Germany for plant we ought to be fully competent to make ourselves. Now I, for one, hold that an Englishman can do anything he sets himself to do, at any rate as well, if not better, than anyone else, but his superiority is not so great as to enable him to do it with his eyes shut. We are apt to excuse ourselves on the ground of the lower wages paid on the Continent, but we shut our eyes to the better technical education and the better industrial finance of the great German nation. We recognise the ingeniously-devised and beautifully-constructed machinery by which the Americans produce repetition work, but we are apt to overlook the fact that the American pays higher wages than we do, and can afford to do so, as both employer and employed run the machinery for all that it is worth, and do not restrict the output. It is blind folly in this country to protest against and blame the combinations of labour to raise wages as the cause of all our difficulties. Combinations of labour are not only legal, but they are the absolute right of the worker ; and it will become serious ground for consideration whether it will not be necessary for the professional classes to combine to secure a proportional increase in their rate of remuneration, which has become necessary to bring it more in harmony with the increased wages of the so-called working classes. But although combinations of labour of every class are legal and right when properly used, they are harmful and wicked when employed to limit the freedom of others or to prevent the full use and development of machinery and resources of the country.

Mr. Holmes may be at variance with many of his *confrères* as to the cause and the remedy, but that there does exist a formidable foreign competition, which we ought to be better able to combat, all are agreed. Attention is now being called more forcibly than ever to this state of affairs, and herein may be the prelude to much-needed reformation. But protest alone will not effect reform ; as long as this is a free-trading country, our only course lies in adopting more efficient and less costly practice in manufacture and in commerce. We should always be prepared to admit the foreigner at his own price, taking care all the while that our goods are superior to his and that our price is not higher.

The result of fitting cars with independent rim and electric brakes, and failing to instruct the drivers as to their respective uses, was illustrated by a collision at Aberdeen last week. The driver, desiring to stop quickly on slippery rails, first locked the wheels with the hand-brake and then applied the electric brake—of course, to no purpose. If such difficulties arise in training motormen, a modification in the standard brake arrangements of cars might be made, as this is not the first accident of a similar kind. Either the electric brake should be made with so many stops that it can be employed regularly, and the hand-brake only used on an emergency, or an arrangement could be added to release the hand-brake automatically simultaneously with the application of the electric brake.

After millions of incandescent lamps have been manufactured, during the past 20 years or so, one person has just been injured in the eye by the bursting of a bulb. Probably this is the first victim to an accident of this description, for the newspapers seem to discover in it sufficient novelty to justify a great deal of alarmist comment. We shall now probably manufacture incandescent lamps for another 20 years or so before a similar accident will recur. It is the very rarity of mishap in electrical apparatus, combined with the novelty of electrical matters, that leads to public notice; while the immunity of comment enjoyed by gas and petroleum arises from the superabundance of their mischief.

At the recent conference of science teachers at the Imperial Institute, Prof. Armstrong observed that he would like the term "experimenting" substituted for "science teaching," and the term "workshop" or "workroom" adopted in place of "laboratory." So long as the method of conducting these modes of teaching is sound, it might appear pedantic to quibble about names. Yet we scarcely think that Prof. Armstrong's proposed substitutes are synonyms, or that they represent accurately what goes on—or should go on—in the class-room and laboratory. Science teaching is very far from being all experimenting; and, pompous though the name may sound, "laboratory" more correctly designates the place where the practical teaching occurs than either "workroom" or "workshop." An engineering laboratory, for instance, is quite different from an engineering workshop. After all, as we have hinted, the vital matter is to take care that the science teaching and laboratory work are of the proper character to ensure sound education. In an age when science is illumined by "innumerable farthing rushlights," there is perhaps too great a tendency to mere experimenting, and too little regard paid to that philosophic digestion of the results of experiment by which alone can the essential principles be extracted and assimilated.

Mr. Schaefer's article on indiarubber cables, printed in another column, is of especial interest, coming, as it does, from one who has had many years' experience in the manufacture of this very class of insulated conductors. His warning against "seamless" rubber covering is timely, for our contributor, Mr. Terry, at any rate, has been impressed by the claims put forward by its manufacturers. The failure of rubber insulation underground is not always caused by an opening of the seam, and so far we have no data to show that this new class of seamless rubber cable to which Mr. Terry has referred is in any way more reliable than that made in the longitudinal covering machine.

Mr. Schaefer prescribes that indiarubber-covered cables should be lead-covered when employed for underground mains. The employment of braided rubber cables drawn into iron pipes in former days, if not at the suggestion of the makers, was at any rate done with their approval ; and manufacturers of lead-covered cables with non-waterproof insulation were always met with the objection that lead covering was a necessity in that class of cable, and comparisons of price were usually made on the basis of lead-covered non-waterproof cables as against indiarubber insulated cables simply braided. A point Mr. Schaefer does not mention is the difficulty of pressing a tight lead covering on to rubber cables, especially if the jute braiding which usually surrounds the core is omitted, as it should be. With a hot lead press it is difficult to cover the wire without burning the insulation under these conditions ; and although one firm has employed a cold lead press for several years, this type is not popular, probably

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owing to the possibility of subjecting the core to too great a strain. More information on such matters as these, and especially on the circumstances in which rubber has and has not proved long-lived, would be of great interest.

We announced some time ago that Nikola Tesla had gone to the top of a high mountain in Colorado to experiment not only in wireless telegraphy, but also in the wireless transmission of energy over a long distance. He has now returned to New York evidently well pleased with the result of his experiments, and the following remarks of his to a New York reporter convey his views and anticipations as to future developments :—

> My experiments have been most successful, and I am now convinced that I shall be able to communicate by means of wireless telegraphy not only with Paris during the Exhibition, but in a very short time with every city in the world. My terminal instruments will be absolutely immune from extraneous disturbances, and I hope to obtain a speed of from 1,500 to 2,000 words a minute. I have returned to New York to pursue a series of experiments with a view to solving the greater problem of transmitting power without using wires.

In our advertisement columns this week it will be seen that the Postmaster-General invites tenders for laying underground conduits for telephone purposes in several parts of the metropolis. To render the situation of a Government competing with its own licensee quite complete and worthy of a place in a Gilbert and Sullivan comic opera, it would only be necessary for the National Telephone Co. to be the successful lowest tenderer with its new cement ducts.

Opening of the Govan Electric Supply Station.—The formal opening of this station will take place to-morrow afternoon.

Personal.—M. André Blondel has just been made a Knight of the National Order of the Legion of Honour, on the nomination of the French Minister of Public Works.

South-Western Polytechnic.—A university extension course of ten lectures on the "Direct-Current Motor" will be given by Prof. C. A. Carus Wilson, M.A., on Mondays, commencing Jan. 22nd. The fee for the course is 5s.

Lectures on Polyphase Machinery.—The first of a course of seven lectures on the above subject was given by Mr. A. C. Eborall, at the works of Messrs. Crompton and Co., Chelmsford, on Monday evening last. The remaining six lectures will be given on successive Monday evenings, at eight o'clock.

C.S. "Francois Arago."—We are pleased to be able to state that there is no truth in the rumour that the cable ship "François Arago," belonging to the Société Industrielle des Téléphones, had become disabled off the coast of Newfoundland. On Wednesday she was reported as coaling at St. Johns.

Wireless Telegraphy in the United States Navy.—The *Morning Post* is informed that the United States Navy Department and Lighthouse Board of the United States Treasury Department have been arranging for the establishment of wireless telegraph stations on American lighthouses and lightships.

The Use of Aluminium.—The *Aluminium World* of New York reports that 78 miles of trolley line have just been strung between Kansas City and Leavenworth, a line which is expected to be opened during the present month. The same journal also notes that the Incandescent Arc Light Co. of New York have put on the market telephone transmitters and receivers made of aluminium.

The Royal Society.—Among the Papers down for reading yesterday were: "On the Viscosity of Argon as affected by Temperature," by Lord Rayleigh, F.R.S.; "On the Behaviour of the Becquerel and Röntgen Rays in a Magnetic Field," by Hon. R. J. Strutt; "On an Experimental Investigation of the Thermodynamical Properties of Superheated Steam by Prof. Osborne Reynolds' Method," by Mr. J. H. Grindley.

An "Electrical" Charwoman.—The *Globe* newspaper announces the latest electrical gooseberry, which hails from America. It is nothing less than an "electrical charwoman," which will char all day in any given direction without either stimulus or stimulant. It will be a most pleasant change to effect the house cleaning by means of an "accumulator" that does not smuggle her accumulations away with her.

Cable Interruptions and Repairs:—

	Date of Interruption.		Date of Repair.
Latakia—Cyprus	June 21, 1899	—	...
Cayenne—Pinhieros	Oct. 11, 1899	—	...
Zanzibar—Mombassa	Oct. 27, 1899	—	Jan. 13, 1900
Mozambique—Lourenco-Marquez	Dec. 17, 1899	—	...
Tangier—Tarifa	Jan. 3, 1900	—	...
Iquique—Valparaiso	Jan. 9, 1900	—	...
Serena—Valparaiso	Jan. 9, 1900	—	...

Opening of the Stockport Electric Supply Works.—The formal opening of these works took place yesterday afternoon, before a large and influential local assemblage. The mayor of Stockport (Councillor Thomas Webb) performed the ceremony by starting one of the engines. The system here adopted is a three-wire continuous-current one at a pressure of 460 volts between the outers. The contracts were let in February, 1898, and supply really commenced on December 9, 1898.

Wireless Telegraphy in the Navy.—The Admiralty have determined to fit several vessels of the Channel Squadron (viz., the "Majestic," "Magnificent," "Hannibal," and "Jupiter") with wireless telegraphic apparatus on the Marconi system; and the signal boatswains of the two flagships and two petty signal officers on each of the ships in question are now being instructed in wireless telegraphy on board the "Hector" at Portsmouth. It may be regarded as extremely probable that all the vessels of the navy will eventually be equipped with wireless telegraphic apparatus.

The Glasgow Section of the Institution of Electrical Engineers.—At the meeting of the Institution of Electrical Engineers, on the 11th inst., the President announced that a meeting was to be held in Glasgow yesterday of members, associates, and other gentlemen, who propose to form a local section for that district of the United Kingdom. The Council, he said, would be very glad if any of the members could attend that meeting in Glasgow. Unfortunately, he personally was unable to go, as he had another engagement of some standing, but the Council would be represented by two of its members—viz., Prof. Perry, vice-president, and Mr. Alexander Siemens, past president.

Magnetic Rocks in South Africa.—In his report upon the disaster to Gen. Gatacre's column at Stormberg, *The Times* correspondent lays some stress upon the neglect of compass bearings being taken during the night march. Its correspondent at Cape Town, however, in forwarding the account, says that he thinks this point has been exaggerated, and he makes the following observations founded on his own experience :—

> Owing to the abundance of magnetic ironstone all over South Africa (and the name "Rooi-kop," "red-head," probably indicates its presence near Stormberg), compass bearings are liable to be all over the place, especially at night, when it is impossible to know how near one may be to magnetic rocks. At Chieveley one day I was taking some bearings which made Colenso lie due east instead of north, north for the nonce happening to be a large stone a yard or two away.

Advanced Class on Practical Electrical Measurements at University College, London.—The lectures and practical demonstrations on advanced electrical measurements being given this winter on Monday evenings at 7 p.m., in the Pender Electrical Laboratory, University College, Gower-street, will be resumed next Monday evening, January 22nd. The class is being conducted by arrangement with the Technical Education Board of the London County Council, and is intended only for those who are practically engaged

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during the day in electrical or engineering work. The subjects which will be treated during the remainder of the course (ten lectures) are the photometry of arc and incandescent lamps and alternating-current measurements. The Pender Laboratory has just been provided with one of Mr. Duddell's improved oscillographs, made by the Cambridge Instrument Making Co.

"Centralblatt für Accumulatoren und Elementenkunde."—This is the name of a new bi-monthly journal, edited by Dr. Franz Peters, of Charlottenburg, and published by Wilhelm Knapp, at Halle. The periodical is devoted to matters pertaining to secondary and primary batteries and their accessories, and will no doubt prove invaluable to manufacturers of these apparatus and to others interested in this branch of electrochemistry. The first number, which has just come to hand, contains the first instalments of two serial articles, one on standard cells, by Prof. W. Jaeger, who is one of the first authorities on this subject; and the other an account by Dr. L. Höppner of a type of cell especially intended for traction work. There are some shorter articles and reviews, and several pages of abstracts from articles in contemporaries and from patent specifications, together with miscellaneous items of news. The subscription price of the journal for England is M3·50 quarterly, post free.

The Institution Building Fund.—At the last meeting of the Institution of Electrical Engineers, the President announced that a letter had been addressed to him by three of the members of the Institution, and he believed he was right in saying that it was the result of an appeal which he made in his presidential address. The letter was read to the following effect: "In consequence of successful litigation in connection with the copyright of our catalogue, we, the undersigned, have been awarded nominal damages to the amount of 100 guineas. Having, therefore, in our minds your appeal for the furtherance of the building fund, we have much pleasure in handing that cheque to you for this purpose. Though not a very large amount, we hope that this action on the part of your old pupils will serve as an example to others in the electrical trade, who, instead of squandering money in costly and unprofitable litigation, might do a great deal of good to the electrical profession generally and to the Institution in particular.—Signed, G. Binswanger Byng, Max. Byng, and Hugo Hirst."

The Institution of Electrical Engineers' Wiring Rules.—We have received from the secretary of the Institution of Electrical Engineers a copy of a circular, with a list of questions, that is now being sent out to all those who replied favourably to a notice previously issued on the same subject. We understand that a similar circular will, on application to the Secretary, be sent to any electrical engineer who may be willing to assist the Institution in the attempt to promote uniformity in wiring rules. The following are the questions embodied in the circular:—

1. Do you consider that regulations of some kind are necessary to ensure safe and durable wiring?
2. Presuming that you consider that there should be one set of standard regulations for ordinary risks for the United Kingdom, do you think that those which have been issued by the Institution cover sufficient ground; if not, in what direction do you suggest that they should be added to? Please give the suggested additions in the form you consider they should take.
3. Do you consider that the Institution regulations cover too much ground? If so, which portions should be omitted? Please give your reasons for suggesting their omission.
4. Do you agree with the general arrangement of the Institution rules?
5. Do you consider that any one regulation should be altered? If so, please say on what ground, and suggest in what way it can be improved.

Ether and Atoms.—A lecture on the above subject was given by Prof. J. A. Fleming, F.R.S., on Monday evening last, at the London Institution. The lecturer pointed out that among the greatest advances of physical science in the nineteenth century one of the most far-reaching was the conception of an all-pervading ether filling all space. Assuming its existence, Maxwell proved, in his epoch-making Paper of 1864, the existence of electromagnetic waves, a phenomenon which was confirmed experimentally by Hertz in 1879, and by a large number of physicists working in every part of the world since that date. Hertz's experiments, and the phenomenon of "coherence" of metallic films, discovered first by Hughes in 1879 and subsequently by Branly, together with its application in wireless telegraphy, were then described and explained. Referring to the constitution of the ether, Prof. Fleming said that its most characteristic property was its power of storing immense quantities of energy. He next mentioned that Lord Kelvin had been able to obtain some idea of the size of the atoms, and referred also to the now-accepted kinetic theory of gases, due in the first instance to Clausius, and amplified and extended later by Maxwell. The recent work of Prof. J. J. Thomson was next mentioned, as pointing to the existence of sub atomic matter, or of atoms a thousand times smaller than the hydrogen atom.

Northern Society of Electrical Engineers.—At a special meeting of the members, held in Manchester on Wednesday evening, the following additions to the rules were adopted unanimously:—

[*To be added to objects of the Society*]: 4. In case the Society shall be discontinued or dissolved, or shall be absorbed by or amalgamated with any other institute or society, to dispose of the funds of the Society as the council may determine.

[*New Rule, XXIXa, to be added*]: The council may at any time at which they may think the same desirable arrange for the amalgamation or absorption of the Society with or by any other society or institution having similar or kindred objects on such terms and conditions as they may think, and may transfer to such society or institution the whole or any part of the funds of the Society, provided that it is made a term of such amalgamation or absorption that the members of the Society as enumerated in Rule IV. may join the other society or institution in the various grades for which they are respectively qualified without payment of any entrance fees. Provided that such amalgamation or absorption shall not be carried into effect without the proposal being approved in writing by a majority of the members of this Society. On such amalgamation or absorption being effected in manner aforesaid, and notice of the same, together with a copy of the terms and conditions subject to which the amalgamation or absorption takes place, being sent to every member of the Society as enumerated in Rule IV., the Society shall be considered as dissolved and be at an end.

In proposing this addition to the rules, the council possibly had in view an "amalgamation or absorption" with the Institution of Electrical Engineers, under the new rules for local centres which the Institution passed a year ago.

MEETINGS OF SCIENTIFIC AND ENGINEERING SOCIETIES, &c.

(TO-DAY) FRIDAY, January 19th.

North-East Coast Institution of Engineers and Shipbuilders.

7.30 p.m. Third General Meeting in the Lecture Hall of the Literary and Philosophical Society, Westgate-road, Newcastle-on-Tyne. Amongst the items on the Agenda are the following: The discussion on Mr. C. H. Innes's Paper on "Screw Fans" will be resumed and closed, and a Paper on "Receiver Drop in Multiple Expansion Engines" will be read by Prof. R. L. Weighton.

Royal Institution.

9 p.m. Evening Discourse on "Flight," by the Right Hon. Lord Rayleigh, F.R.S.

THURSDAY, January 25th.

Institution of Electrical Engineers.

8 p.m. Ordinary General Meeting. Adjourned discussion on the report of the Swiss Visit Committee, and, if time permits, a paper will be read by S. Cowper-Cobs on "An Electrolytic Centrifugal Process for the Production of Copper Tubes."

FRIDAY, January 26th.

Physical Society.

5 p.m. Meeting in the Rooms of the Chemical Society, Burlington House. Papers to be read: (1) "Some Developments in the Use of Price's Guard Wire in Insulation Tests," by Prof. Ayrton and Mr. Mather; (2) "Reflection and Transmission of Electric Waves along Wires," by Dr. E. Barton and L. Lownds; (3) "The Frequency of the Transverse Vibrations of a Stretched India-Rubber Cord," by T. J. Barker.

Institution of Mechanical Engineers.

8 p.m. Annual General Meeting. The following Paper will be read and discussed: "Water Meters of the Present Day," by W. Schönheyder.

Royal Institution.

9 p.m. Evening discourse by the Hon. C. H. Parsons, F.R.S., on "Motive Power—High-Speed Navigation—Steam Turbines."

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CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

Death from Industrial Currents.—R. H. Cunningham combats the idea that cases of syncope from commercially-used currents can be treated by artificial respiration. The organ most vitally affected is the heart, and that is not totally paralysed or killed by disruptive action, but is put into a state of fibrillar contraction. This contraction reduces the pressure of the blood throughout the system, and the nervous system is affected, not instantaneously but gradually, by the total anæmia following a sudden arrest of the circulation. In rare instances, where an electric current traverses only the cerebro-cervical portion of the nervous system in considerable intensity and for a considerable length of time, it may kill by asphyxia. Industrial currents are practically non-lethal to frogs and turtles, as the condition of fibrillation quickly and spontaneously disappears from their hearts after the current has ceased to pass. But such recovery is much more difficult in dogs, and probably also in the human being. The author has worked out an elaborate method of artificially restoring the circulation by the injection of defibrinated blood, which is successful in the case of dogs, but must be applied immediately. The net result of the author's researches is that artificial respiration is ineffective, and the only hope lies in spontaneous recovery.

[R. H. Cunningham, *New York Med. Journal*, 70, 1899.]

Ressitance of Iron Wires.—The abnormally large resistance offered by iron wires to alternating currents has been a matter of common observation for many years. It is due to what is called the "throttling effect," which prevents an alternating current from penetrating completely to the centre of the wire, and which is exaggerated in iron by its high permeability and the change of the latter with the current strength. The laws of this change are at present unknown, and E. Merritt has therefore instituted some experiments calculated to shed light upon them. In every case the ratio of the alternate-current resistance to the direct-current resistance of the same wire was determined. This ratio gave the throttling effect, and the method also eliminated any secondary effect due to heating. The results were in accordance with what might have been anticipated from the known properties of iron. For small currents the magnetisation is small, and the behaviour of the iron wire is not very different from that of non-magnetic metals. This throttling effect is largest where there is a maximum of permeability; but with still stronger currents the wire becomes magnetically saturated from the surface inwards, and when the core is saturated also the difference between the two types of resistance vanishes and the wire again behaves like an ordinary wire. The author's verification is, however, only qualitative as yet.

[E. Merritt, *Phys. Review*, Nov.-Dec., 1899.]

Resistivity of Pure Nickel.—Nickel is not easily obtained in a state fit for resistance measurements, owing to its great brittleness when obtained from the carbonyl. J. A. Fleming has, however, made some successful experiments on a specimen of pure nickel prepared electrolytically from a hot solution of carefully purified nickelous chloride by J. W. Swan. It was annealed by heating in an atmosphere of hydrogen after having been drawn into wire through a die. The nickel wire so prepared and annealed is as soft as silver wire. It was soldered to thick copper leading-in wires, and wound on a frame of a kind suitable for immersion in liquid air. The volume resistivity was found to be 1,444 C.G.S. units at −182·5deg., 4,251 at −78·2deg., 6935 at 0deg., and 10,951 units at 94·44deg. It thus appears that this electrolytic nickel has a much lower resistivity than that employed by Matthiessen for his tests 35 years ago, which had a volume resistivity at 0deg. of some 12,000 units. Moreover, the temperature coefficient of the author's nickel is the same as that found by Fleming and Dewar in 1893. Matthiessen's nickel was probably not pure, and it is strange that his figure should nevertheless have been adopted all these years as the standard value for pure nickel.

[J. A. Fleming, *Proc. Roy. Soc.*, Dec. 14, 1899.]

Magnetic Qualities of Building Brick.—The magnetic disturbances in physical laboratories have in some cases been traced to the brickwork of the walls and piers of the building. That burnt clay is permanently magnetic was shown some time ago by Folgheraiter, who was able to form an idea of the magnetic dip in Italy over 2,000 years ago from the distribution of magnetism in some Tuscan vases. O. A. Gage and H. E. Lawrence have examined some 30 varieties of building brick from the factories of the northern and eastern States of America. The greater number were of the pressed-brick variety, though specimens of the ordinary red variety were included. All of them except one, which was nearly white, were found to possess some amount of permanent magnetisation. The moments were found to vary in the course of a few months, some increasing and others decreasing. Assuming that a steel magnet has 0·325 C.G.S. units to the cubic millimetre, the brick showing the strongest magnetisation was equivalent to a steel magnet 9·7mm. long and 1mm. in diameter. Heating the bricks brought about a great reduction of the magnetisation, but cooling invariably restored it. The author attributes the magnetism to magnetic oxide of iron formed during baking and influenced by the earth's field. This is confirmed by the fact that the poles are always on the faces and sides, and not at the ends.

[Gage and Lawrence, *Phys. Rev.*, Nov.-Dec., 1899.]

Frequency Indicator.—A simple and serviceable frequency indicator, devoid of any mechanism, cannot but be a useful adjunct to the equipment of a central station. What claims to be such has been designed by E. Stöckhardt. It consists essentially of a tuning fork vibrating in unison with the current under investigation. The fork is tuned to the current by means of two weights, which are displaced along the prongs and pressed against them by metallic springs. The displacement is read off on an empirical scale giving the frequency direct. The range of the instrument is increased by the fact that it will resound to certain multiples of the frequency by means of its overtones. This advantage is, however, attended by the drawback that the value indicated is not necessarily of the correct order. It is therefore necessary to know the approximate frequency, say within 50 per cent. The definition is clear enough, and the tests show that an accuracy of considerably less than 1 per cent. can be relied upon. Nor does the form of the current curve seem to interfere, for the instrument resounded equally well to the Dresden city mains, to an old Siemens alternator, and a small Siemens rotatory current generator. The manipulation of the instrument is ideally simple.

[E. Stöckhardt, *Elektrotechn. Zschr.*, Dec. 14, 1899.]

Hall Effect at Low Temperatures.—E. van Everdingen has continued his experiments on the Hall effect and the properties of bismuth at low temperatures after the work of the Leiden cryogenic laboratory had been temporarily stopped by the Government on account of its alleged danger. Experiments have now been carried out at −90deg., the temperature of boiling nitrous oxide, and at 15deg. for comparison. The lowering of the temperature has the effect in all cases of increasing the Hall effect, especially in a weak field of 1,300 units, where it is nearly doubled. Indeed, the value in that field, 21·1, exceeds by far the highest value formerly obtained. The question whether a maximum Hall effect exists anywhere at a low temperature could of course not be determined by two measurements, but the rapid increase points to the contrary. As regards the resistance of bismuth, its alteration by a magnetic field depends upon the angle which the lines of force make with the crystallographic axis. Thus, the percentage increase of resistance in a field of 2,650 units is 1·3 at 27deg. in one direction, and 3·2 in a direction perpendicular to it. At −90deg. the figures are 2·8 and 8·7 respectively. This should be remembered in measuring resistances by bismuth coils.

[E. van Everdingen, *Proc. Akad. Amsterdam*, Nov. 25, 1899.]

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THE PRODUCTION OF RAW MATERIALS FOR THE MANUFACTURE OF CALCIUM CARBIDE.

Some time ago we published an article dealing with the question of the state of division of the raw materials used for making calcium carbide which was found to give the most economical results. The tenour of that article was that on the whole the raw materials were better in the granulated state than in powder, and as a corollary of this that the comminuting machinery should be of a crushing or cracking description rather than designed for actual grinding. It will be seen that the matter is of much importance, because the cost of grinding is considerable and is attended by many inconveniences: if as good results in manufacture can be obtained with a coarser raw material, a substantial advantage will be secured. The question has now been investigated by Birger Carlson, who puts forward his views in a recent number of the *Zeitschrift für Elektrochemie*. On the whole, his conclusions bear out those which we have previously published, and are worthy of the attention of carbide manufacturers.

It is sometimes alleged that raw materials for carbide in a fine state of division require an amount of energy for bringing about their union which is smaller than that needed for treating coarser materials. This would be true if the substances to be united were themselves infusible and produced no fusible products. It is well known that, in the manufacture of a substance like Portland cement clinker, which under normal conditions never reaches a more than plastic state, fineness of grinding and intimacy of mixing of the raw materials are essential to success, but with calcium carbide things are on another footing The lime is fusible at the temperature of the arc, the carbon dissolves in the fused lime much as a metal may dissolve in an acid, and the product, calcium carbide, is liquid at a temperature considerably below that necessary for its formation. Therefore, if the raw materials are in fragments of any reasonably small size, their union will occur as completely as if they were finely powdered. Thus, on purely theoretical grounds one may conclude that no advantage is to be gained by fine grinding, and this conclusion may be confirmed by a consideration of certain practical details of working.

When the raw materials are finely ground they form a coating round the electrodes which is not readily permeable to gases. Seeing that the production of carbon monoxide is a natural part of the reaction, it is clear that this gas will be confined in the neighbourhood of the electrodes and will tend to form a hollow space round them. The walls of this cavity are exposed to the radiant heat from the arc which suffices to fuse the small particles of lime, these reacting partially with the carbon and yielding a semi-fused layer which may act as a bridge between the electrodes. This glazed envelope still further confines the carbon monoxide, and, when the pressure of the latter rises sufficiently, gives way suddenly, allowing a puff of carbon monoxide to escape to the flue carrying with it a quantity of the raw material as fine dust. Further, these semi explosive evolutions of carbon monoxide cause the formation of channels in the raw material, through which the carbon monoxide passes almost exclusively. The walls of these channels are subjected to the full temperature of the carbon monoxide as it passes from the arc, and become glazed. The carbon monoxide therefore, instead of serving to warm the general mass of the charge, is led away rapidly and at a high temperature through its self-formed channels, carrying with it a great quantity of useful heat. The formation and breaking down of these cavities and channels which tend to occur when the raw materials are finely powdered are the cause of another inconvenience. When a mass of raw material falls in on the collapse of the wall of the cavity, the resistance of the arc is altered and a sudden fluctuation of current occurs, a condition by no means desirable if the dynamos are running full load. The objectionable nature of this formation of cavities is recognised in some factories where the cavity is pierced at intervals with a rod so as to favour an even feeding of the raw material to the arc; but this is only partly effective, and is exceedingly disagreeable work.

These evils disappear when the raw materials are used, not as powder, but about the size of hazel nuts. No formation of cavities occurs, and the current is more nearly uniform: the carbon monoxide can flow out at all points at a low pressure and a low speed, giving up the greater part of its heat and escaping at a temperature not exceeding 1,000°C. to 1,100°C., as has been shown by actual measurement. Having regard to the fact that the temperature in the heart of the mass round the arc is about 3,000°C. to 4,000°C., this utilisation of heat from the escaping gases is fairly satisfactory. The thorough diffusion of the hot gases has the additional advantage that the raw materials before they reach the zone of fusion are substantially free from water and carbonic acid which they might accidentally contain. It is obvious also that with coarse raw materials the formation of dust is diminished and the various dust-catching devices needed when fine raw materials are used are done away with. As lime and coke dust are harmful to breathe, the workmen also benefit by the diminution of dust consequent on the use of coarse raw materials. There is another point of some moment—viz, that a charge of fine raw materials becomes segregated to some extent before it actually reaches the zone of fusion; a certain amount of carbon is carried away by the escaping gases more freely than is the powdered lime, and therefore it is necessary to compensate for this by making the mixture richer in coke, which is a dearer material than lime in most places where carbide works exist. This difficulty is particularly apparent when working in intermittent furnaces with fine raw materials, because the unused portion has been altered in composition, and must be mixed and corrected before it can be turned back for the next charge. No such troubles arise with coarse raw materials, and the residue from one charge can go back direct to be worked up for the next. That the difference is a serious one between the two processes is shown by the fact that with fine raw materials as much as 3,000 kilos are necessary for producing 1,000 kilos of carbide, as against about 1,700 kilos when coarse raw materials are employed. In an experimental run at the Deutsche Gold und Silber-Scheide-Anstalt at Frankfort 1,000 kilos of carbide were produced from 1,590 kilos of raw materials, which compares very well with the theoretical quantity—viz., 1,440 kilos. It might be thought that the advantages of the use of coarse raw materials are so noticeable that no one would use finely-ground stuff, but according to the author there are certain points to be observed, ignorance of which may make the use of coarse raw materials less successful. These may be regarded as working secrets, and are not further discussed in the Paper. The author considers that, whereas intermittent working with fine material can scarcely compete with continuous processes, yet that with coarse raw materials the conditions are reversed, and that the intermittent process, which in some respects is more rational, is thereby rehabilitated.

INDIARUBBER AS INSULATING MATERIAL FOR CABLES.

BY OSCAR SCHAEFER.

In an article on "Substitutes for Indiarubber," written by Mr. Terry and published in *The Electrician* of the 29th ult., some statements are made about the manufacture and durability of indiarubber insulated cables, which have suggested the following remarks to me:—

Manufacture of Indiarubber Cores.—There are three methods by which the indiarubber compounds can be put on the conductors. By the first and oldest, which is now only used in special cases, the indiarubber tape is lapped helically in successive layers round the conductor. By the second, first introduced by the late Sir William Siemens and now generally used, two tapes are passed parallel and with the conductor—one above and one below it—through circular shears, which press the indiarubber tightly on the conductor and cut off the superfluous material on both sides. Unless the indiarubber is too much loaded with minerals, the freshly-cut edges combine together and become so firmly united in the subse-

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quent process of vulcanisation that the seams are as solid and reliable as any other part of the insulation. To lessen the cost of manufacture, several wires are now mostly covered in one operation.

Although tolerably poor stuff can be put on the conductors by the second method, it still requires a somewhat better quality to make sound cores than the material which not only can but must be used for the third and *seamless* process. The machines used for the third method are vulgarly called "sausage machines," and were first put on the market about 15 years ago by French and American makers. The india-rubber compound, fed into these machines in strips, is propelled by a screw to a die, where it is—in a similar way as gutta-percha—pressed round the conductor, which passes through the hollow screw. At first sight—and especially for anybody not thoroughly conversant with the nature of india-rubber—this process looks very good and promising: its drawback lies, however, in the fact that good, strong, elastic rubbers like Para, and brands resembling Para, cannot—on account of their elasticity—be pressed through such machines, unless heated to such an extent that they perish. The only rubbers suitable for working in such machines are cheap, soft qualities. These rubbers can also be heavily loaded with minerals and still be worked in the screw machines. Several, and perhaps all, first-class makers of indiarubber insulated wires and cables tried these machines when they were first introduced, but gave up all idea of using them when they found that only such poor stuff could be worked on them.

So far, therefore, from this seamless method of manufacture being an advance on the old methods, as is suggested by Mr. Terry, it is, on the contrary, a sure sign that the maker who uses it employs inferior material, and buyers should abstain from using cores made on such machines. A foreign Government which had formerly large supplies of first-class rubber insulated cables from the best English makers, was offered about eight or nine years ago similar cables at a great reduction in price from a local manufacturer, who had only recently commenced making indiarubber wires. The samples submitted were made on a screw machine, but the Government decided—in spite of repeated warnings by its old contractors, who were perhaps considered to be biassed—to order large quantities of these cheaper cables. In a very short time these cables, which were kept in suitable store-rooms and had never been used, became bad, the so-called indiarubber being perfectly brittle and falling off in pieces; whereas the cables which had formerly been supplied by English makers did not in one single instance become bad after many years' storage.

St Petersburg Cables.—The statement of Mr. Terry's German informant, that indiarubber insulated cables have lasted 14 years in St. Petersburg, contains nothing extraordinary; every manufacturer who is established long enough could refer Mr. Terry to some indiarubber cables of his own make which have lasted quite as long, or longer. The statement would have been more valuable if a description had been given of the cables and of the conditions under which they are used. The cables in question, or at any rate their cores, were probably made in England, as I am almost sure that no indiarubber insulated cores were made in Germany 14 years ago.

Land Cables and Wires.—The failures of indiarubber insulated electric light cables which have occurred in a number of towns cannot be all due to bad material or bad workmanship, as some of the best and oldest English firms, with a world-wide reputation for their produce, are concerned in the matter, who cannot be suspected of jeopardising their name for the sake of a few orders. In some cases inferior material has doubtless been used, and in others manufacturers had not yet acquired sufficient experience to enable them to produce good cores with good material.

The principal cause of the failures lies, however, in the faulty use that has been made of indiarubber insulated cables. If such cables, covered only with a tape and braiding, are drawn in underground pipes, where they are surrounded with gas and continually damp, if not wet, the indiarubber must deteriorate and develop faults. A striking proof of this was twice obtained at Bradford, where the entrance of sea-water into the pipes accelerated the process of destruction. Iron-armoured indiarubber insulated cables which are buried in the ground must be destroyed in the same way, and this has happened in the few cases in which such cables have been employed. Indiarubber insulated cables should not be used underground, in pipes or without pipes, or in other places where they are exposed to the action of gas or moisture, without a covering which protects them against such influences.

Messrs. Siemens Bros. made, many years ago, a submarine telegraph core, insulated with indiarubber and then covered with gutta percha; and Mr. Clouth, of Cologne, lately adopted this construction for a high-tension cable across the German North-East Canal. Although constructions like this may answer under water, they would not do for street work, the best protection for cables in street work being a lead casing. Lead-cased indiarubber insulated cables will of course in many cases be dearer than cables with an insulation of impregnated yarn or paper; but indiarubber offers so many advantages that I am convinced that indiarubber insulated lead-cased cables will be largely used in future for high-tension and especially for extra high-tension work.

To obtain all possible advantage from a lead casing on indiarubber cables, it is necessary that the lead lies tightly on the indiarubber or on the tape surrounding it. In multiple-core cables each core should have its own covering of lead, as otherwise the fibrous worming and serving yarns are liable to get soaked with moisture at the ends or at faults in the lead. I have made and laid large quantities of indiarubber insulated cables for high-tension and extra high-tension, both concentric and stranded, the latter cables having in the earlier cases a lead covering over the stranded cores, and in the more recent cases a lead casing over each core. These cables have been used for street work and in mines, and although the time during which they have been at work exceeds in no case six years, and it is therefore too early to speak of results, it augurs well that I have never had a single mishap. To sum up:—

The manufacture of seamless indiarubber wires is neither new nor to be recommended—at least, not to users.

The failure of underground indiarubber cables in England is not necessarily due to bad material or bad workmanship.

Indiarubber insulated cables or wires should not be used underground, in mines, or in other places where they are exposed to gas, stagnant air, or moisture, without being cased in lead.

A NEW AMERICAN TRACTION POWER STATION. *

The foundations of the new Main power station of the Third Avenue Railroad Co, New York, which, when completed, will rank as the largest power station in the world, having a maximum capacity of 100,000 H.P., have just been laid at 216th-street and Ninth-avenue, New York, but a short distance from where the Third Avenue Railway Co. will commence electrical construction. Although somewhat north of the present centre of distribution of the company's lines, it will be contiguous to the Union Railway system, and the use of three-phase currents for electrical distribution will necessitate feeders of but comparatively small size. The site selected allows more freedom in station design to secure the best results than would have been possible at a site farther down town. The Harlem river is close at hand for condensing purposes, while fuel and supplies to the station can be brought directly to it by water, or to within a short distance by the New York Central Railroad. From this station feeders will be led to five or more transformer stations, the locations of which have not yet been definitely decided upon. There will also be an auxiliary storage battery station at Sixty-sixth-street and Tenth-avenue.

After due competition, the contracts were awarded to the Westinghouse Electric and Manufacturing Co, an organisation well adapted for such an undertaking, on account of the number of specialists actively associated with it.

The power station will contain 16 main generating units, aggregating 72,000 H.P. as usually rated, and about 100,000 H.P. maximum. Careful grouping affords ample space for all the apparatus, and excellent provision is made for light, ventilation, and the other details necessary for producing the best operative results. In the

* Abstracted from the *Street Railway Journal*.

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following outline of the engineering and mechanical features of this plant attention is drawn, not only to the quality and amount of machinery, but to the system as a whole, its completeness, and the engineering relation of the various parts.

The general plan involves a division of the plant into four sections of four power units each. Each section is served with steam by a double-decked battery of boilers occupying one quarter of the boiler house. Each quarter, in turn, has its independent flues, economisers, stack and auxiliary mechanical draught. From each section, also, a main exhaust leads to one of the four condensers. Equalising flues are provided to allow each stack, with the aid of mechanical draught, to relay the other stack on the same side of the house. The steam piping constructed upon the equalising main system, is so connected as to allow each section to relay each of the other three, while the four condensers are so multiplied together in their connections as to work as one unit, three having the requisite capacity to admit of one being cut out. Thus it is one homogeneous plant, yet four plants. The main aisles of engine and boiler rooms are intersected by a wide transverse aisle to gain ample room for the concentration of auxiliary apparatus and connections at the centre of the plant. The switchboards are carried upon elevated structures along the side walls, about 80ft. in length on each side, and their galleries connect to the engine galleries and to a transverse bridge spanning the engine room in the middle. All the above main features, together with their attendant auxiliaries, such as exciters and exciter engines, independent lighting plant, circulating pumps and engines, air pumps, boiler feed pumps, and feed-water system, feed-water heaters, oil systems, &c., are carefully worked out upon a definite system of arrangement, which is characterised by a simplicity the importance of which cannot be over-estimated. Compactness is thus gained without crowding, and completeness without complexity.

The engineering structure and architectural exterior of this building are adapted to the plant in a greater measure than is usual in such undertakings. It covers the entire distance between 216th and 218th-streets, on the east side of Ninth-avenue, and extends back about 250ft. to the dock on the Harlem river.

Structurally this building must be classed as belonging to the skeleton construction type. The masonry and steel work have been designed so as to make each part as efficient as circumstances permit, the walls carrying their own dead load up to the height of the second floor line, but being supported by the wall columns from the effect of exterior forces such as wind pressures. All portions of the building have been designed to secure a maximum of light and ventilation, the light openings in engine room amounting to 1 sq. ft. for each 1·8 sq. ft. of floor space. The framing of the coal pocket and its supports is a model of engineering strength and skill, while throughout the entire design the most painstaking care has been given to provide for every point of strain attachment, for the proper distribution of weight, and for the effects of machinery in motion. An excavation, 350ft. long, on Ninth-avenue, 270ft. in width and 14ft. in depth, has already been prepared. In this excavation some 15,000 to 16,000 oak piles, 40ft. long and spaced about 2ft. 4in. centres, have been driven. The soil at the site is a very fine, sharp sand, and owing to this circumstance the piles were driven by the aid of jets of water, a method common in such bottom. The water is conveyed to the point of use in pipes under pressure, and these pipes are thrust down alongside the pile as it is being driven, loosening the sand so that driving is rendered comparatively easy. The operation occupies about 10 minutes for each pile.

Resting upon the piles is the concrete foundation, which is from 7ft. 6in. to 8ft. in thickness, and extends over the entire surface of the piles. The concrete is composed of one part Portland cement, two of sand, and four of stone. The bearing weight on the concrete foundation will be from 2 to 15 tons per sq. ft.

The basement floor line is placed at a grade amply above the highest tide ever recorded, to ensure absolute dryness at all times. Below this floor line, in the concrete foundation, tunnels will be built for the intake and overflow water for condensation, the former being brought through large cast-iron pipes to four large centrifugal circulating pumps, and the latter flowing out in a covered channel built in the concrete itself. The intakes are brought to the suction wells immediately outside the building. They approach from the extreme corners of the property, and are thus kept as far away from the warm overflow as possible, the latter flowing into the centre of the slip as a precaution against the formation of ice in the coldest winter weather. All the floor drains are also embedded in this foundation.

In the basement space has been provided for a machine shop for light repair work, and there is ample accommodation of lockers and toilet rooms for the power house employés. Most of the auxiliary apparatus is to be placed in the boiler house basement, while the space around the main engine foundations is reserved for the main steam and vacuum connections, and for other piping systems. The engine room floor and the first floor or boiler room are on the same level, which is 15ft. above the basement floor. Above the second floor boilers, supported on a series of columns rising through the boiler house, is the coal pocket of large capacity, extending the full length of the building, from which coal is fed by gravity to the furnaces, as described elsewhere. An ample equipment of stairs, ladders, and runways will provide ready access to all machinery and apparatus, while an elevator running from the basement to the coal pocket will serve the various floors of the boiler plant, for convenience in handling apparatus and other materials of moderate weight.

Two 50-ton electric travelling cranes will span the engine room. Each of these cranes will have a main hoist of 50 tons, with an auxiliary hoist of 15 tons for handling small parts of apparatus at high speed. The principal features of the steam plant are in outline as follows:—

I. *Engines.*—These are under construction at the works of the Westinghouse Machine Co., and are of the vertical cross-compound condensing type, with the generators mounted on the shaft between the cylinders They are of 4,500 H P. each, at 75 revs. per min., with a maximum capacity of about 7,000 H.P. The cylinders are 46in. and 86in. × 60in., and will be mounted on very heavy rectangular section housings, supported by box-type bedplates.

The cylinder heads will be of the box pattern, carrying the steam and exhaust valves and passages. The pistons and followers will be built up of cast steel, and steel plates with cast-iron wearing and packing rings. The piston rods will be of open hearth steel, 9in. and 10in. in diameter, fitted with double split metallic packing.

The valves will be of the rolling type, double ported, supported by ample bearings and intermediate bridges. They will be operated by releasing-valve gear, and designed to permit carrying steam to three-quarter stroke, with rapid release at this extended cut-off. The exhaust and steam valves will be driven by separate eccentrics on both high and low cylinders, and provision made for disconnection of wrist plates, for hand operation by means of a steam or hydraulic cylinder.

The governor will be of the heavy weighted pendulum type, connected to both high and low pressure gears with hand adjustment; also with a device for adjusting the speed from the switchboard. The cross-heads will be of cast steel, turned type, with wedge adjusted babbitt-faced shoes, and fitted with 14in. crank pins. The connecting rods will be 12ft. 6in. long from centre to centre, of open hearth steel, with solid ends, fitted with bronze cross-head pin boxes and babbitt-lined cast-iron crank pin boxes. The eccentrics will be of cast iron, split and fitted with scraped babbitt-lined cast-iron straps, all enclosed in sheet steel casings, provided with doors for access.

The main shaft journals will be 60in long, the lower shells of the ball and socket type bearing on the bedplate about one-third of their length, and will be fitted for water circulation. The caps will be in two pieces. The shells will be removable by raising the shaft ¼in. The cranks will be overhung, of the fantail type and of cast steel, bored for a 30in. fit 19in. long, and forced in place by hydraulic pressure. The shaft will have a maximum diameter of 39in. and a length of about 27ft.

The receiver will contain a reheater of the type in which the live steam circulates around the reheater pipes. It will be of boiler steel, with double riveted flanged heads, properly covered and lagged. It will be carried close to the frame upon brackets. The flywheel will be of the built up type, some 28ft. in diameter, composed of a cast-iron centre, cast steel segments, properly linked together and bound by steel reinforcing plates. The wheel will be directly attached to the revolving element of the generator. The exhaust connection will be 30in., while the steam connection will be 14in., fitted with a semi-balanced throttle with pilot valve, also a balanced safety stop valve arranged to shut off automatically at a predetermined increase of speed; it will also be operative from any designated point. Two galleries will be provided; one level with the top of the housings, from which a stairway leads to the upper one on a level with the lower side of cylinder heads. The upper gallery is connected across from high to low-pressure side, and from engine to engine. Indicator motion, oil shields, oil drains, and various oiling devices are supplied. These engines are, in general type and detailed construction, of plain, substantial character, very heavy and designed with special care and reference to multiple operation under the heavy variable loads of street railway service and emergencies.

II. *Boilers.*—The boiler equipment consists of 60 Babcock and Wilcox water-tube boilers of 520 H.P. each, set in batteries, with the upper tier corresponding with the lower in setting and arrangement. They are of the standard construction usual to such boilers, fitted with forged headers, and adapted for 200lb. working pressure. The boilers are hung from steel beams, supported by and forming part of the building structure, not only independent of the brickwork, but of the floors on which they appear to rest. All fittings and fixtures are of the highest class, and the settings of the most substantial design and quality.

III. *Mechanical Stokers.*—The boilers are to be equipped with the Roney mechanical stoker and smokeless furnace, capable of burning either hard or soft coal, separately or mixed, as may be desired, thus relieving the plant from troubles incident to changes in the relative

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market prices of the two kinds of coal, and in large measure preventing interference in the operation of the plant by strikes either in the mines or on transportation lines. It also enables coal to be dumped into the pocket indiscriminately, so that hard and soft coal may be piled together and be burned by the stokers as it is drawn from the pocket. The stokers are of the same type as those now under construction for the Metropolitan Street Railway and the Manhattan Elevated Railway, of New York.

In a power plant of this size, the number of men that would be required to operate flat grates, the rapidity with which changes of load come upon the station, and the large quantities of coal to be handled, almost preclude the use of anything but mechanical firing. In addition to the large savings incident to more perfect combustion, the stokers not only will save their cost in wages of firemen in a few months' time, but have an exceptional value in connection with decreasing the likelihood of labour troubles.

IV. *Condensing Plant.*—The subject of condensing has received extended consideration and investigation in the design of this power station. After much consideration it was decided to adopt a central elevated jet plant, comprising the essential features of a central surface condensing system, except such as pertained strictly to the surface condensers, and so arranged as to admit of the substitution of surface condensation at such time as it may be desired to reclaim the feed water, which in this plant will be worth upwards of one hundred thousand dollars per year. The large exhaust trunks, some 54in. in diameter, lead from the four sections, each serving four engines. Provision is made for free exhaust through a smaller auxiliary trunk, for each pair of sections, carried through the roof independently. The main trunks lead to their respective elevated jet condensers of the Worthington type, and are so multiplied together as to enable any three to carry the full load while one is cut out for cleaning or repair, or any one may be cut out singly, to prevent abnormal leakage on any trunk from affecting the vacuum on the others. The condensers are operated on the dry air system, the injection water being handled by four large centrifugal pumps operated by Westinghouse compound engines, which serve the condenser heads at an elevation of about 48ft. The water passes through elevated air coolers, where it surrounds brass pipes, in which the air is cooled until its volume is reduced about one-half; it is then exhausted and the vacuum maintained by close clearance air pumps of the flywheel type, with positively actuated valves.

This system, whether it be of the surface or jet type, when properly applied to a station of such proportions, which requires such large quantities of steam and water to be manipulated, affords special advantages in simplicity and economy, as well as in flexibility of operation. A central condensing plant possesses many of the qualities that a large centralised power plant has over numerous small isolated plants. It includes various features, of detail design, essential to its application on so extended a scale, and which have been worked out for this installation. These cannot conveniently be described in the present article.

V. *Coal Handling Machinery and Coal Pocket.*—The coal handling machinery is to consist of an elevated unloading plant on the dock, with power shovel and hoisting machinery, which will discharge the coal into a hopper on the upper floor of the tower. From this point the coal will be spouted to two crushers on the lower floor, they discharging in turn by gravity to the conveyers. From the crushers the coal is to be taken by conveying and elevating machinery of the wheel and bucket type, and deposited in the coal bunkers above the boilers. From the bunkers it will feed by gravity to the stokers. Coal conveyers from the unloading plant on the wharf to the boiler house will be worked by electric motors, and are also arranged to convey the ashes. The coal bin extends the entire length of the boiler house, and is of masonry and steel construction, the beams being protected from heat due to possible internal fires by the concrete bottom. The pocket has a storage capacity of 12,000 tons of coal, and is so arranged that the coal in storage will be constantly in motion, due to drawing by gravity from the bottom; and in case of fire the tight masonry and beam construction, of which the bottom of the pocket is composed, will enable water to be freely used without interrupting the operation of the boilers. The coal chutes in the bottom of the coal bin are over the centre of the upper fire room, 16 outlets being provided.

VI. *Draught Plant.*—This will consist of four stacks, each 12½ft. long and 98ft. high, and eight large slow-speed exhaust fans for producing draught in case of overloads. Each fan is capable of producing draught for an installation of 4,000 H.P. of boilers at nominal rating, and equal to that of a stack 500ft. high, with proper flue and with all boilers and economisers in service.

VII. *Fuel Economisers.*—The economisers are of the improved high-pressure type, aggregating 9,600 pipes, being 16 in number, each containing 600 tubes, and having a total surface of 96,000 sq. ft. Self-acting scrapers are to be provided for cleaning the exterior surface of tubes, and are to be actuated by an automatic scraper gear, driven from the fan shafts.

These economisers are to be capable of raising the temperature of the feed water 140°F. from an initial temperature of 105°F., when all the boilers are operating at or above their rating. They will take from the waste gases an amount of heat which represents from 10 per cent. to 15 per cent. of the coal burned on the grates, the amount varying with the amount of load, the rate of combustion, and other things which vary from time to time. It is estimated that the first cost and operating expenses of the economisers and mechanical draught apparatus shows an annual saving to the Third Avenue Railroad Co. of some $65,000, representing 75 per cent. on the investment.

VIII. *Boiler Feed System.*—The boiler feed pumps are to be of the H. R. Worthington make, five in number, of heavy construction and special design, having compound steam ends and outside packed plungers in "pot valve" or "pressure pattern" water ends. The primary heaters are to be four in number, of the closed type, and each of 6,000 H.P. rated capacity. The closed auxiliary feed-water heaters will be of suitable size to completely utilise the heat of the exhaust of the steam auxiliaries.

The feed water mains are to be in duplicate, except the branches to the individual economisers, to the auxiliary heaters, and to the boilers. The water will be carried to the pumps in a duplicate suction main, each branch being of ample capacity for the whole installation. The discharge mains from the pumps will be in duplicate, and will be carried to the primary heaters, where inlet connections from each main will be made to each heater.

The discharge from the primary heaters will be in duplicate, making separate connections to duplicate intermediate headers, which will be carried full size entirely around the boiler house, being suspended from the floor which carries the upper tier of boilers. The mains will also be provided with stop valves, so that they may be divided into sections. Individual connections will be made from each of these mains to a branch leading to each economiser, and there will be provided by-passes connecting these mains to the discharge mains from the pumps, cutting out all the primary heaters. Feed water from the primary heaters will discharge through the auxiliary heaters and deliver to each of these mains.

The discharge from each economiser will connect by a single branch to each line of a duplicate high-temperature main, which will extend full size entirely around the boiler house, and will be suspended immediately under the fronts of the upper tier of boilers. By-passes will be provided from the intermediate mains, connecting them directly to the high-temperature mains, so that water may pass from one to the other without going through the economisers. These by-passes will be provided with automatic valves to compensate for changes in resistance due to cutting off economisers. This main will also be provided with cut-off valves, so that it may be used in two sections.

IX. *Oiling Systems.*—An oiling system of the gravity flow type is to be installed, with full complement of flow pipes to take lubricating oils from the two central elevated storage tanks to the bearings of the main generators, and return the dirty oil therefrom to two central filter plants, where it is to be cleansed and returned by small pumps to the storage reservoirs. The filters are to be of the double gravity type, wherein the oil settles by gravity through bags of close-woven fabrics into tanks of sufficient depth to contain about 15in. of water in the bottom beneath the oil. The bags will remove the larger particles of dirt, while the smaller abraded materials will fall by gravity through the water and be retained on the bottom of the tank. Filters are to be so arranged that they may be cleaned without interrupting the service. The oil pumps will be in duplicate, there being two complete systems, each serving one-half of the plant.

The cylinder oil is to be brought to the lubricators on the engines by a system of piping from a tank well elevated in a warm place in the boiler house. This will enable the lubricators to be filled by simply draining the lubricating oil through a drip pipe which will be provided for the purpose, and then allowing the cylinder oil to flow into the lubricator tank or receiver, thus avoiding the numerous troubles incident to attempting to feed continuously under pressure. A closed tank and a connection with the air cleaning system are to be provided for forcing the cylinder oil up to the supply tank, the oil flowing from the barrels in which it will arrive into this closed tank by gravity.

Much attention has been given to the oiling system, to save oil, labour, and inconvenience. The amount of oil used in so large a station is a considerable item of expense, and it is one of the most fruitful causes of waste. In some stations the oil bill has been reduced from 70 per cent. to 90 per cent. by good management and skilful arrangement. The oiling system for the Third Avenue Railroad power house will be divided into two portions—first, that which handles the lubricating oils from storage tanks to the bearings, and returns the dirty oil to two central filtering plants, where it will be cleansed and returned by small pumps to the storage reservoirs. The second portion will handle the cylinder oil by gravity to the cylinder lubricators. With this oiling system the difficulties inherent in this department of the power house will be reduced to a minimum.

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THE INCREASE IN RESISTANCE OF CYLINDRICAL CONDUCTORS CARRYING AN ALTERNATING CURRENT.*

When an alternating current traverses a conductor the energy spent in the conductor itself is greater than for a continuous current of equal intensity. Formulæ for calculating the increase in the resistance have been given by Maxwell, Rayleigh, Kelvin, and others, but these all involve the specific resistance of the material in the calculations. The following convenient method of calculation, due to M. A. Potier, possesses the advantage of introducing terms which are directly measurable. If R_a = apparent resistance of wire or alternating currents, R_c = resistance for continuous currents, then M. Potier's equation becomes

$$R_a = kR_c$$

where k is a factor obtained from the table appended below:—

$a=\frac{\omega}{\left(\frac{R}{l}\right)}10^{-4}$.	$b=10^4\left(\frac{R}{l}\right)T$.	k.
1	6·2831	1·078
2	3·1416	1·265
3	2·0944	1·479
4	1·5708	1·678
5	1·2566	1·853
6	1·0472	2·007
7	0·8976	2·146
8	0·7854	2·274
9	0·6981	2·394
10	0·6283	2·507
16	0·4488	3·095
20	0·3142	3·415
25	0·2513	3·735

In the above table ω represents the "pulsation" of the alternating current $\left(=\frac{2\pi}{T}\right)$, R/l represents the resistance per kilometre length in ohms.

For values of A greater than 25 we get practically

$$k = 0{\cdot}25 + \sqrt{a/2}.$$

For values less than 1

$$k = 1 + \frac{a^2}{12} - \frac{a^4}{180}.$$

BOOKS RECEIVED.

(Copies of any of the undermentioned works can be had from *The Electrician* office post free, on receipt of published price.)

"The Official Gazette of the United States Patent Office." No. 1 Vol. XC. Published by authority of Congress. (Washington: Government Printing Office)

"Pyrography and Wood Roasting," by T. Bolas and C. G. Leland. (London: Dawbarn and Ward.) 6d.

ELECTRICITY WORKS ACCOUNTS.

Blackburn Municipal Electric Supply Works.

Our first analysis this week records the results of working during the year ended March 25, 1899, of the Blackburn municipal undertaking. Making allowance for the fact that the previous accounts were for a period of 15 months, and therefore included an abnormal proportion of winter load, the accounts now dealt with show very satisfactory progress. During the year the 125 new consumers secured have raised the lamp connections from the equivalent of 25,000 8 c.p. lamps to 31,000, or 24 per cent.

The output at 368,087 units sold represents an excellent advance—even on the output of the preceding period of 15 months.

The aggregate costs have fallen 0·08d. in consequence of a substantial reduction in the management charges, although the works costs indicate a rise. The two items of generating costs, "fuel" and "repairs and maintenance"—especially the latter—have considerably increased.

In view of the moderate average total revenue received, the working profit of £2,917 is satisfactory; and although a deficit is the net result of the year's operations, yet it must be remembered that a total of £2,993 was paid into the reserve and sinking funds, as against £2,328 for the preceding 15 months.

We should like to see the total costs figure at Blackburn slightly lower, but although, conjoined with an output of 368,087 units sold, the present figure seems high, yet the low load factor of only 7·5 per cent. must be held accountable for the impossibility of very material improvement in the cost sheet.

Lancaster Municipal Electric Supply Works.

The results of the working of the Lancaster undertaking during the year ended May 25 last are excellent. From our table it will be seen that the output has made an advance of from 147,175 units sold to 204,686, an increase of no less than 39 per cent. The lamp connections also show a healthy rise of over 45 per cent.

Thanks to reductions in the works costs, and in the management and property charges, the already low total costs of 1897 have been materially reduced, and now stand at the highly satisfactory figure of 2·01d. per unit. Considering the very moderate output, and that the load-factor at 9·36 per cent. is decidedly below the average, this result is to be highly commended. Looking down the generating items, those of wages and repairs and maintenance at the station attract our notice as being very low at the output. The fuel charge at 0·63d. is, we should say, quite within what might have been expected, while the item of oil, waste, &c., appears normal. Management charges having fallen, are now quite 0·3d. below the average at the output. The year's working profit amounted to £2,419, representing 9·18 per cent. of the mean capital expended: £277 was placed in the sinking fund, and £200 forms a nucleus for a depreciation fund. Interest charges account for another £750, and there is thus left available as net profit £1,191, which has been carried to the district fund.

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

Aberdeen (Municipal)	Jan. 12, 1900	Lancaster (Municipal)	Oct. 21, 1898
Ayr (Municipal)	Sept. 22, 1899	Leeds (Municipal)	Dec. 1, 1899
Bedford (Municipal)	May 19, ,,	Leicester (Municipal)	Jan. 20, ,,
Belfast (Municipal)	Sept. 15, ,,	Leyton (Municipal)	Sept. 8, ,,
Birmingham (Company)	Sept. 15, ,,	Liverpool (Municipal)	June 9, ,,
Blackpool (Municipal)	Sept. 29, ,,	Manchester (Municipal)	Aug. 11, ,,
Bournemouth (Company)	April 28, ,,	Newcastle and District (Co.)	Oct. 6, ,,
Bolton (Municipal)	Nov. 24, ,,	Newcastle-upon-Tyne (Co.)	April 11, ,,
Bradford (Municipal)	April 14, ,,	Newport (Mon.) (Municipal)	Dec. 15, ,,
Brighton (Municipal)	May 12, ,,	Northampton (Company)	Oct. 20, ,,
Bristol (Municipal)	July 14, ,,	Norwich (Company)	Nov. 17, ,,
Burnley (Municipal)	Aug. 25, ,,	Notting Hill (Company)	Mar. 17, ,,
Burton-upon-Trent (Mun.)	April 21, ,,	Nottingham (Municipal)	July 21, ,,
Bury (Municipal)	Sept. 22, ,,	Oldham (Municipal)	Dec. 1, ,,
Cambridge (Company)	Mar. 10, ,,	Oxford (Company)	May 19, ,,
Cardiff (Municipal)	Dec. 15, ,,	Pontypool (Company)	May 5, ,,
Charing Cross (Company)	Mar. 17, ,,	Portsmouth (Municipal)	July 14, ,,
Chelsea (Company)	Mar. 31, ,,	Prescot (Company)	Dec. 8, ,,
Cheltenham (Municipal)	Nov. 10, ,,	Preston (Company)	Sept. 29, ,,
Chester (Municipal)	June 23, ,,	Reading (Company)	Oct. 13, ,,
City of London (Company)	May 12, ,,	Richmond (Company)	Oct. 13, ,,
Clerkenwell (Company)	Aug. 18, ,,	Scarborough (Company)	Nov. 3, ,,
Derby (Municipal)	Dec. 9, 1898	St. Helens (Municipal)	Dec. 8, ,,
Dewsbury (Municipal)	Nov. 24, 1899	St. James' & Pall Mall (Co.)	Feb. 24, ,,
Dover (Company)	June 2, ,,	St. Pancras (Vestry)	May 26, ,,
Dundee (Municipal)	Jan. 12, 1900	Sheffield (Municipal)	Dec. 29, ,,
Eastbourne (Company)	July 22, 1898	Shoreditch (Vestry)	Oct. 27, ,,
Edinburgh (Municipal)	Nov. 17, 1899	Southampton (Municipal)	Nov. 10, ,,
Exeter (Municipal)	Aug. 5, 1898	Southport (Municipal)	July 7, ,,
Glasgow (Municipal)	Sept. 1, 1899	South Shields (Municipal)	July 7, ,,
Guildford (Company)	May 5, ,,	Stafford (Municipal)	Dec. 29, ,,
Halifax (Municipal)	July 21, ,,	Sunderland (Municipal)	July 28, ,,
Hammersmith (Vestry)	May 26, ,,	Taunton (Municipal)	June 16, ,,
Hampstead (Vestry)	Aug. 25, ,,	Tunbridge Wells (Mun.)	Sept. 1, ,,
Hanley (Municipal)	April 28, ,,	Wakefield (Municipal)	Dec. 1, ,,
Harrogate (Municipal)	Oct. 20, ,,	Walsall (Municipal)	June 23, ,,
Harrow (Company)	June 16, ,,	Wandsworth (Company)	Aug. 19, ,,
Hast'gs & St. Leonards (Co.)	April 29, 1893	Westminster (Company)	Feb. 24, ,,
H'use-to-H'useCo. (K'ns'gt'n)	Mar. 31, 1899	Whitehaven (Municipal)	July 28, ,,
Hove (Company)	Mar. 10, ,,	Windsor (Company)	Dec. 22, ,,
Huddersfield (Municipal)	Oct. 6, ,,	Woking (Company)	Dec. 22, ,,
Islington (Vestry)	Oct. 27, ,,	Wolverhampton (Municipal)	June 30, ,,
Kens'gton & Knightsbr' (Co.)	Mar. 3, ,,	Woolwich (Company)	Jan. 13, ,,
Kingston-upon-Hull (Mun.)	June 9, ,,	Worcester (Municipal)	April 7, ,,
Kingston-on-Thames (Mun.)	April 21, ,,	Yarmouth (Municipal)	Nov. 3, ,,

* From *L'Industrie Electrique*.

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	BLACKBURN.		LANCASTER.	
Undertaking Worked by	Blackburn Corporation.		Lancaster Corporation.	
Date of Commencement of Supply	Feb. 18, 1895.	[sta. & house trans. for outer area.	April, 1894.	
System of Supply	Con.-curr. 3-w. to centr'l area; alt.-curr. by trans. sub		Three-wire continuous current.	
Chief Engineer	A. S. Giles.		C. M. Johnston.	

YEAR ENDED	MAR. 25, 1898.*		MAR. 25, 1899.		MAY 25, 1898.		MAY 25, 1899.	
QUANTITIES—								
Units generated	358,891		470,716		162,806		220,329	
„ SOLD (TOTAL)	300,203		388,087		147,175		204,686	
„ sold to consumers	241,567		297,963		120,423		177,014	
„ sold for public lighting, &c.	58,433		70,124		26,752		27,672	
„ used on works	13,485		26,480		3,344		5,261	
UNITS SOLD PER 8 C.P. LAMP CAPACITY	14·2		15·1		19·63		15·6	
Maximum supply demanded	277 kilowatts		560 kilowatts		190 kilowatts		250 kilowatts	
Number of public lamps	24 arc, 34 glow		74 arc, 34 glow		20 arc		23 arc, 46 (16-c.p.) glow	
Number of consumers	320		445		—		363	
Connections to mains in 8-c.p. lamps	25,000		31,000		12,256		17,807	
CAPACITY OF PLANT IN 8-C.P. LAMPS	21,100		34,800		7,500		13,100	
CAPACITY OF PLANT IN KILOWATTS	675		1,115		240		420	
CAPITAL—	Total.	Per kilowatt capacity.	Total.	Per kilowatt capacity.	Total.	Per kilowatt capacity.	Total.	Per kilowatt capacity.
AUTHORISED (TOTAL)	£60,000	£89·0	£68,000	£61·0	—	—	—	—
Share	—	—	—	—	—	—	—	—
Loan (including Debenture charges)	60,000	89·0	68,000	61·0	—	—	—	—
RECEIVED (TOTAL)	43,371[a]	64·3	65,077[e]	58·4	£25,083	£104·5	£25,000	£59·5
Share	—	—	—	—	—	—	—	—
Loan (including Debenture charges)	43,343	64·2	65,033	58·3	25,086	104·5	25,000	59·5
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	16,657	24·7	2,967	2·66	—	—	—	—
Share (unissued)	—	—	—	—	—	—	—	—
Share (uncalled)	—	—	—	—	—	—	—	—
Loan (including Debentures)	16,657	24·7	2,967	2·65	—	—	—	—
REPAID (TOTAL)	2,700	4·0	2,700	2·42	—	—	—	—
RESERVE OR SINKING FUND	13	0·019	1,347	1·21	831	3·46	1,160	2·76
DEPRECIATION FUND	—	—	—	—	—	—	200	0·48
EXPENDED (TOTAL)	50,540	74·9	81,436	73·0	24,298	101·2	28,633	68·3
Lands and buildings	4,360	6·46	8,691	7·71	3,490	14·5	3,497	8·33
Plant	23,374	34·6	41,568[f]	37·3	10,127[a]	42·2	12,948[d]	30·8
Mains	21,128	31·3	29,882	26·8	10,142	42·3	11,764	28·0
Miscellaneous	1,718	2·55	1,395	1·25	539	2·25	452	0·103
BALANCE OF CAPITAL ACCOUNT	−7,169[b]	−1·06	−16,359[b]	−14·7	789	3·29	−3,663[c]	−8·72
REVENUE—	Total.	Per unit sold	Total.	Per unit sold	Total.	Per unit sold	Total.	Per unit sold
TOTAL	£6,011	4·804d.	£7,113	4·638d.	£2,921	4·760d.	£4,133	4·843d.
Revenue from supply	3,848	3·076d.	5,137	3·347d.	2,381	3·880d.	3,470	4·070d.
„ meters, &c.	160	0·128d.	196	0·128d.	1	0·002d.	1	0·001d.
„ public lighting	1,600	1·279d.	1,078	0·703d.	505	0·823d.	530	0·621d.
„ sale of lamps, &c.	400	0·320d.	651	0·425d.	21	0·034d.	94	0·110d.
„ miscellaneous sources	3	0·002d.	52	0·034d.	13	0·021d.	38	0·045d.
EXPENDITURE OUT OF REVENUE—								
TOTAL COSTS	£3,498	2·796d.	£4,166	2·716d.	£1,353	2·210d.	£1,715	2·011d.
WORKS COSTS	2,191	1·751d.	3,138	2·046d.	1,065	1·735d.	1,351	1·584d.
Generation of electricity	*1,805*	*1·443d.*	*2,499*	*1·629d.*	*952*	*1·553d.*	*1,203*	*1·411d.*
Fuel (including cartage, &c.)	720	0·576d.	1,070	0·698d.	429	0·700d.	540	0·633d.
Oil, waste, water, stores	300	0·240d.	335	0·219d.	100	0·163d.	153	0·179d.
Wages at station	686	0·548d.	764	0·498d.	371	0·605d.	421	0·494d.
Repairs and maintenance at station	100	0·080d.	330	0·215d.	52	0·085d.	90	0·106d.
Distribution of electricity	*25*	*0·020d.*	*45*	*0·029d.*	*44*	*0·072d.*	*57*	*0·067d.*
Wages, &c.	25	0·020d.	45	0·029d.	9	0·015d.	12	0·014d.
Repairs, renewals of mains, &c.					35	0·057d.	45	0·053d.
Public lighting	*361[g]*	*0·289d.*	*594[g]*	*0·387d.*	*69*	*0·113d.*	*91*	*0·107d.*
Attendance	361[g]	0·289d.	594[g]	0·387d.	69	0·113d.	91	0·107d.
Renewals								
MANAGEMENT AND PROPERTY CHARGES	1,307	1·045d.	1,028	0·670d.	291	0·474d.	364	0·427d.
Royalties	—	—	—	—	—	—	—	—
Rent, rates, taxes	*193[e]*	*0·154d.*	*254*	*0·166d.*	*84*	*0·137d.*	*97*	*0·114d.*
Management	*1,114*	*0·890d.*	*774*	*0·505d.*	*207*	*0·338d.*	*267*	*0·313d.*
Salaries	855	0·684d.	578	0·377d.	123	0·201d.	148	0·174d.
Stationery, &c.	43	0·034d.	40	0·026d.	16	0·026d.	32	0·038d.
Establishment charges	120	0·096d.	156	0·102d.	51	0·033d.	66	0·077d.
Law charges, &c.	96[e]	0·077d.	—	—	17[b]	0·028d.	21[f]	0·025d.
FINANCIAL RESULTS—	Total.	% to mean cap. exp'nded	Total.	% to mean cap. exp'nded	Total.	% to mean cap. exp'nded	Total.	% to mean cap. exp'nded
WORKING PROFIT FOR YEAR	£2,512	5·83%	£2,947	4·47%	£1,564	6·62%	£2,419	9·13%
Sum carried to Depreciation Fund	—	—	—	—	—	—	200	0·755%
Sum carried to Reserve or Sinking Fund	931	2·17%	1,334	2·02%	277	1·17%	277	1·05%
Net interest on loans (incl. Debenture charges)	1,397	3·26%	1,659	2·51%	689	2·91%	750	2·83%
BALANCE FROM LAST ACCOUNT	−1,870	−4·36%	−1,687	−2·56%	—	—	—	—
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	—	—	—	—	598[c]	2·53%	1,191[c]	4·50%
Deficit	*1,687*	*3·94%*	*1,732*	*2·63%*	—	—	—	—
ORDINARY DIVIDEND PAID	—	—	—	—	—	—	—	—
PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE	58·2%		58·6%		46·4%		41·5%	
Expenditure per kilowatt capacity	£5. 3s. 8d.		£3. 14s. 9d.		£5. 13s. 0d.		£4. 1s. 7d.	
REVENUE PER KILOWATT CAPACITY	£8. 18s. 0d.		£6. 7s. 7d.		£12. 3s. 6d.		£9. 16s. 10d.	
Expenditure per 8-c. lamp capacity	3s. 3¾d.		2s. 4¾d.		3s. 7½d.		2s. 7½d.	
REVENUE PER 8-C.P. LAMP CAPACITY	5s. 8½d.		4s. 1d.		7s. 9½d.		6s. 3½d.	
REVENUE PER 8-C.P. LAMP CONNECTED	4s. 9½d.		4s. 7d.		4s. 9½d.		4s. 7½d.	
Price charged for lighting, per unit	6d. to 3d.[d]		6d. to 3d.[d]		5d.		4½d.	
Price charged for power, per unit	2½d.		2½d. to 1½d.		4d.		3d.	
Price charged for public lighting	6d. to 3d. per unit		2½d. per unit		4d. per unit		£20 per lamp per ann.	

BLACKBURN.—REMARKS—* For period of 15 months ended March 25, 1898. *a* Includes £23 interest on cost of services. *b* Over-expended. *c* To insurance. *d* Maximum demand system (one hour). *e* Includes £44 received as interest on cost of services. *f* Inclusive of £7,491 on traction plant, £3,676 on condensing plant and reservoirs, and £2,764 on accumulators at generating and distributing stations. *g* Being to "Lamps, carbons, and fittings"—whether public or private not stated.

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Published every Friday, Price Sixpence; Post Free, Sixpence-Halfpenny
Editorial, Publishing and Printing Offices,
1, 2 & 3, SALISBURY COURT, FLEET ST., LONDON,
Telephone: 949 Holborn. *Telegrams:* "ELECTRICIAN NEWSPAPER LONDON."

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MUNICIPAL MONOPOLY.

The fate of the General Power Distributing Co.'s bill last session has by no means ended the controversy between local authorities and companies desiring to distribute electrical power on a large scale. We have already referred to the large number of "electricity in bulk" schemes which are to be brought before Parliament in the coming session. While one or two of these are for districts in which practically no public electricity supply has been in existence hitherto, and others are destined to supplement fully-loaded stations from which their promoters are already supplying electrical power, a number of the bills seek to acquire powers in areas parts of which are already occupied by municipally-controlled concerns. The two of this latter class which will probably meet with most opposition are those whose fields of operations are in South Lancashire and South Wales respectively. The Lancashire Electric Power Co.'s bill, it will be remembered, was thrown out last session through non-compliance with the Standing Orders; but it is now brought forward again by a strong board of promoters intimately connected with the electrical industry, among the names of the first directors being G. B. SAMUELSON, R. P. SELLON, and W. P. J. FAWCUS. This company, whose share capital is to be £3,000,000, with borrowing powers of £1,000,000, has chosen the area in South Lancashire bounded by the river Ribble, an area which includes no less than 19 towns owning electricity supply works in operation or in course of erection, in addition to two towns in which companies are running electricity works. Among the 19 towns first mentioned are Manchester, Salford, Liverpool, Oldham, Bolton, and St. Helens, so that energetic opposition may be expected. House-to-house distribution is not contemplated by the company, but merely the delivery of electrical energy "in bulk." Exclusive rights to supply electricity within the area in question are of course not asked for, nor any protection from future competition. Among the promoters of the Welsh scheme are Mr. E. W. RICHARDS and Mr. MARK ROBINSON. The capital of this company has been fixed at £1,000,000 of which £250,000 is debenture capital. The area which it is sought to cover is 1,050 square miles, it being proposed to erect generating stations at Neath, Pontypridd, and Pontypool for the supply of electricity throughout the whole of Glamorgan and the part of Monmouthshire to the west of the river Usk. In this district

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there are three small company stations, two municipal stations (Cardiff and Newport), and one municipal station in process of erection (Swansea), the total area over which the existing works supply electrical energy being about 16½ square miles. A maximum charge of 4d. per unit for an intermittent supply and 2d. per unit for a regular supply is laid down, and a sliding scale limiting the profits distributed in accordance with the cost charged per unit—as in the case of the gas companies—the latter being also a feature of the Lancashire bill. To conciliate the local authorities, a provision is added that, within local authorities' areas of supply, the company is only to supply wholesale unless with the consent of the local authority, a wholesale consumer being defined as one who takes not less than 20,000 Board of Trade units per annum. The 42 years purchase clause from the Electric Lighting Acts is also included.

In considering the likelihood of these and similar bills becoming law, a result greatly to be hoped for, by reason of the impetus they will give to the electrical manufacturing industry, the matter may be looked at from two points of view—viz., by examining the extent to which the passing of such bills as these will affect the business of municipal electric supply; and by considering the cause of the combined and effective opposition to the General Power Distributing Co.'s bill last session. It may be mentioned incidentally that this latter company is following the example of the Midland Electric Corporation for Power Distribution, and, having abandoned its attempt to obtain powers by special Act of Parliament, it is at present quietly proceeding by provisional orders. It has been seen that the companies now seeking parliamentary powers under special Acts have given up the idea of supplying electricity to individual consumers, but propose to confine themselves to wholesale supply. Thus, so long as no retailers are permitted to compete with the local authority, the only manner in which competition can be set up between them and the new wholesale companies is in the business of supply to large consumers, such as tramway companies, ironworks, factories, &c. To supply such consumers, local authorities would have to erect additional plant and mains, and possibly additional works, as in most cases their existing works are already fully loaded; and, moreover these corporations, being only empowered to supply within a limited area, would not find it possible to supply as cheaply as the company, which can include in its district a far greater number of such large consumers than could the local authority. Thus, so far as concerns wholesale supply, the only rivalry would be with a potential extension of the trading of the local authority in question in a direction in which it could not produce as cheaply as an independent company. In the case of retail supply, the local authorities where they were at work would still be carrying on their house-to-house distribution unhampered by competition (or even assisted by cheap supply "in bulk" from the company), so long as the Board of Trade continues its policy of granting no provisional order to another retailer when a local authority already occupies the field. But even if a second retailer were licensed, would not the competition on equal terms be a just one? From a trading point of view it would have the same justification as competitive telephony, without its technical difficulty of compulsory intercommunication between the two rival concerns.

Local authorities, therefore, having nothing to fear from the companies so far as competition is concerned, the question naturally arises: Will they renew their opposition to the companies' bills? And if so, why? For an answer to this we must turn to the debate on the second reading of the General Power Distributing Co.'s bill last March. Mr. Stuart Wortley moved the rejection of the bill, on the ground that Parliament had never allowed private undertakings to compete with local authorities in the supply of electric current. Mr. Davenport, in order to obtain the passage of the bill, undertook that an amendment would be accepted prohibiting the supply by the company of any municipal borough within the area of the bill. Mr. Wortley thereupon expressed himself satisfied with this concession, but Sir J. Woodhouse, the spokesman for the Association of Municipal Corporations, said that the association would continue to oppose it on account of the Great Principle which underlay the bill. This position taken up by the association in question influenced the voting, for, in spite of the announcement of the mover of the rejection that he was satisfied in withdrawing his opposition, the bill was defeated by 164 votes to 132. Thus, the bills coming up for consideration this year are likely to be received with a similar opposition on behalf of the upholders of municipal trading rights, as determined as it is illogical; for a Great Principle once duly rooted in the mind of a municipal magnate is hard to dislodge, and the municipal magnate has great influence on the voting power of the constituency. It is to be hoped, therefore, that not only the electrical world but the whole commercial world will combine to resist this pertinacious obstruction on the part of municipal traders. By all means let them endeavour to safeguard their own interests where they are unfairly threatened, but do not let them oppose the progress of the engineering industry by preventing private enterprise from undertaking work which others can do better than themselves. We have purposely avoided on this occasion, entering into the merits and demerits, from a commercial or engineering point of view, of the various schemes themselves. Some there may be—even among those we have referred to in this article—whose chance of financial success is small, and we have on a previous occasion warned our readers that every "in bulk" scheme is not of necessity a wise one. But let each scheme be considered on its merits, instead of being opposed by a blind opposition based on the narrow principle of conserving and extending municipal trading privileges at all costs.

REVIEWS.

(Copies of any of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price.)

The Commercial and Business Aspects of Municipal Electricity Supply. By Alfred H. Gibbings. (Bradford: 1899. Published by the Author.) 15s.

There are many electrical engineers fully qualified, so far as engineering ability is concerned, to take charge of the electricity supply works of a municipality, who yet lack that commercial and business knowledge essential to the management of such an undertaking. Those engineers who turn to Mr. Gibbings' book in the hope that it will enlighten them on matters of municipal finance and business methods will be disappointed, although they will find much in the volume of interest and utility upon miscellaneous points. On the other hand, members of municipal electricity committees, to whom principally the book is dedicated, should find it of great service to them; and the prolixity of Mr. Gibbings' writing, no doubt somewhat troublesome to the engineer reader who can devote but little time to literature of any sort, will be duly appreciated by the town councillor. As an instance of Mr. Gibbings' most impressive manner, we may quote the following:—

In these days of frequent change of habitation, of continual transfer of ownership of property, and of the keenest competitions in business, the ordinary householder does not feel inclined to hurriedly invest money in what is not likely to prove some sort of asset. The necessary wiring for

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an electric light installation, like house decoration and some other things, are certainly not "assets," nor are they in any sense portable property. The expense of such paraphernalia is always incurred more or less b·gru·gingly, and with the majority of middle-class householders there is usually a very decided limit to the outlay of money for what may truly be called expensive luxuries. On the other hand, it is a tempting offer which it is difficult to resist when any such modern improvements are to be obtained on "easy terms" involving no immediate outlay and perhaps only a nominal rent per annum. It is true that the bill for electricity will in many cases exceed that which has been heretofore expended for gas or oil, but the consumer will not mind this.

Electricity has already a good foothold, and the broad general recommendations in its favour are already well known. In most towns, even at the present time, the householder has become acquainted with, if not actually used to, the advantages of the electric light in his business office or premises, in the restaurant, the club, and the theatre. In his own house, however, he has still to put up with an inferior method of illumination, which is harmful, unpleasant, and unsatisfactory. Free wiring is therefore decidedly a boon; there is a demand for it already, and if it once becomes established within any area of electricity supply, the ratepayer in his suburban home will very speedily enjoy the same privilege as he now possibly does in his town office.

The book will constitute a generous education to such readers, as it will enlighten them on technical matters just sufficiently, without burdening their minds with matters of detail outside their province. Thus, the various systems of charging are lucidly described, and their *pros* and *cons* discussed at length; and the questions of "free" wiring and lamp distribution, hiring of motors, prepayment meters, &c., are equally dealt with. Portions of this book have appeared in a series of articles by Mr. Gibbings in the columns of *The Electrician*. The volume is well printed on highly-glazed paper—which is rather troublesome to the eyes—and is bound in a serviceable half-leather cover. The title page is preceded by 20 pages of advertisements, which, although well printed and interesting to read, should not occupy such a position in a book of this character.

Regelung der Motoren elektrischer Bahnen. By Dr. Gustav Rasch. (Berlin: Julius Springer. 1899.) 4 marks.

Most students of electric traction would probably consider that all there was to say on the subject of the regulation of electric railway motors could be disposed of by accurate descriptions of the leading types of controllers. Dr. Rasch in the 140 pages of this book deals with the matter theoretically, however, and makes the most of it in his thorough treatment. The addition of actual working drawings of controllers, showing the actual details of their construction, with instructions for designing their electrical and mechanical parts, would make the book complete.

NOTES ON THE ADHESION OF ELECTRO-DEPOSITED ZINC TO STEEL.

BY SHERARD COWPER-COLES.

The following experiments were made to test the adhesion of electro-deposited zinc under varying conditions. A number of specimen plates of mild Siemens-Martin steel were boiled in a hot solution of caustic soda to remove the grease, and pickled in a 1 per cent. solution of sulphuric acid, and scoured with sand. The plates were then coated with zinc at current densities varying from 15 to 80 amperes, advancing 5 amperes at a time. The electrolyte contained 35oz. of zinc sulphate per gallon, the acidity being about 0·2oz. per gallon of free sulphuric acid. In all cases the plates were left in the zincing solution for a sufficient time to allow a calcu'ated deposit of 1¼oz. per square foot. The plates were then removed, washed and dried and cut into three parts, which were subjected to the following after-treatment. One portion was placed in the receiver of an air-pump and kept in a vacuum for half an hour, the second part was placed in an hydraulic pressure cylinder and subjected to a pressure of 1 ton per square inch for five minutes in a saturated solution of zinc sulphate, the third part being kept as a witness or reference. All three portions of the plate were then bent back on themselves, and the zinc coatings were found not to be adhesive.

Another set of plates was then prepared in precisely the same manner as that already described, with the exception that before galvanising they were placed in the zincing bath, and the current caused to flow in the opposite direction to that required to deposit zinc upon them for a period of 2½ minutes. The current was then reversed, and the zinc deposited on the plates until a calculated weight of 1¼oz. was obtained. They were then removed, washed and dried and subjected to the same bending tests as the previous set, when all the zinc deposits were found to be adhesive. In nearly every case the plates could be broken without any sign of the zinc parting from the steel.

As far as the general appearance of the electro-deposits of the zinc was concerned, there was very little differenc between them.

Another set of experiments was made to determine the cause of the non-adhesion of zinc deposited on iron from neutral solutions of zinc sulphate. In all cases a current density of 15 amperes per square foot was employed, and the current passed for 30 minutes, which is equivalent to a deposit of 0·32oz. per square foot. Photo-micrographs were then taken of the iron surface prepared for the deposit, also of the deposit of zinc and the iron plate after the removal of the zinc by means of a copper sulphate solution. The results obtained from a solution containing 1/10oz. per gallon free acid (H_2SO_4) showed that the deposit was adhesive, but less uniform than that obtained from a neutral solution. The results obtained when the iron was flashed for a few seconds in a neutral solution, and deposition continued in a solution containing 1/10oz. per gallon free acid, showed that the deposit of zinc was non-adhesive, but otherwise satisfactory. In another series the iron was flashed in a solution containing 1/10oz. free acid, and deposition continued in a neutral solution.

The deposits obtained from neutral solutions were smoother and more even than those obtained from solutions containing 1/10oz. per gallon free acid, but were non-adhesive, while the latter were perfectly adhesive. The object of the last two experiments was to determine if the flashing of iron in various solutions affects the adhesive properties of the deposit when the final deposition is carried on in some other solution, and the results obtained show that the adhesion or non-adhesion depends on this flashing. The cause of the stripping of zinc deposited from neutral solutions is probably due to the formation of a film of oxide on the iron plate when it is first immersed in the electrolyte. The iron and zinc not being in metallic contact, are easily separated, and the microphotographs bear out this view. The best deposits of zinc could probably be obtained by using neutral zincing solutions, and, after placing the cathode in the bath, momentarily reversing the current, so as to remove the film of oxide formed and thus secure an adherent deposit.

ELECTROLYTIC MECHANISM OF THE VOLTAIC CELL.*

BY W. R. COOPER, B.SC.

We know that in a voltaic cell a certain decomposition takes place within the electrolyte itself, and that certain compounds are formed, but how shall we imagine conduction to be carried out? What, in fact, is the mechanism of conduction?

In an article published in *The Electrician*, Vol. XLIII., p. 703, an account was given of the theory of Grotthus. This theory is in accordance with the broad facts of electrolysis, but in the following respects it has been found wanting:—

1. *Limiting E.M.F. Necessary for Decomposition.*—We should expect the E.M.F. to exceed a certain limiting value, according to this theory, before electrolytic decomposition could take place. But in certain cases this is not found to be so. For example, the application of the smallest E.M.F. to two copper plates immersed in the solution of a copper salt will cause a current to flow. If we suppose conduction to take place by means of Grotthus chains, we should expect no current to flow until the applied E.M.F. is equivalent to the heat of the formation of the compound in solution. It would then be capable of decomposing a molecule in the chain, and

* From a book on "Primary Batteries," shortly to be published by *The Electrician* Printing and Publishing Co. All rights reserved.

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recompositions and decompositions would follow according to the hypothesis. That no such limiting E.M.F. is found to be necessary has been explained by saying that the energy required for any decomposition is returned to the circuit by the immediate recomposition which follows, as already explained. Such a statement, however, leads to a second difficulty, viz.:—

2. *Violation of the Second Law of Thermo-Dynamics.*—The recomposition which follows a decomposition no doubt returns energy to the circuit, and in this way the *total* energy expended in a given time might be nil. But we cannot admit that a decomposition can be due to a subsequent recomposition, or that work can be done by energy which is given to the system after the work which it accomplishes is complete. Such a statement would be a direct contradiction of the second law of thermodynamics, which practically affirms that energy in a state of rest cannot of itself become active.

3. *Replacement of a Bound by a Free Ion.*—It is sometimes objected that the successive decompositions in a Grotthus chain take place through the replacement of a combined ion by a free ion, and that there is no reason why such a replacement should take place. That is no doubt the case if each ion is looked upon as really free after the decomposition of its molecule. But in reality the ions cannot very well be regarded in such a light, as they are under the influence of electric forces throughout.

4. *Migration of the Ions.*—When electrolysis takes place the ions move towards their respective electrodes, bearing their charges with them. In a Grotthus chain we have the equivalent of two streams of ions, moving in opposite directions and apparently with the same velocity. Now, if a

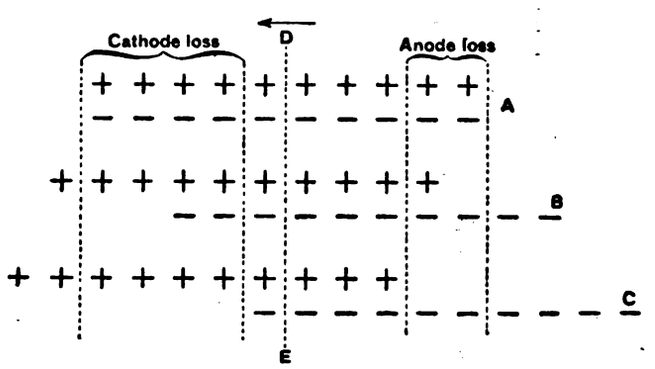

Fig. 1.—Migration of the Ions.

current is passed through a solution of copper sulphate by means of platinum electrodes, it is found that more copper sulphate is lost about the cathode than about the anode. This phenomenon, which is a very general one in electrolysis, was explained by Hittorf on the assumption that the velocities of the two ions are different. In the case of copper sulphate, for example, if the Cu ion travels more slowly than the SO_4, the effect would be equivalent to a bodily transfer of $CuSO_4$ towards the anode, and would account for the observed phenomenon. These apparently unequal migration velocities, as they are called, are generally considered as evidence against the theory of Grotthus.

The migration of the ions will be more readily understood by referring to Fig. 1. Here each positive ion is represented by a plus sign and each negative ion by a minus sign.

At the start each positive ion has a negative one alongside it, as indicated on the line A. Suppose the negative ions to move twice as fast as the positive. Then, when three ions have been deposited, the positive ions have moved one space to the left and the negative ions two spaces to the right, as indicated on line B. Line C shows the state of things when six ions have been liberated. Now, if we imagine the cell to be divided into anode and cathode compartments by the line DE, we see that the loss at the cathode is double that at the anode, just as the velocity of the anion is double that of the cathion. The ratio of the velocities is given by the ratio of the losses of the compound in the neighbourhood of the two electrodes.

Such losses might, however, be accounted for by supposing that the ions, although moving with equal velocities, are often complex, carrying molecules of the solution along with them. It is also not impossible to imagine unequal velocities of the ions in a Grotthus chain. After the recomposition of a molecule has taken place in a chain of this kind, it will be noticed, according to the usual representation, that the molecule is facing the electrodes in the wrong way. It is therefore necessary for a rotation to take place. The two ions will rotate about their centre of mass, and, if their masses are not equal, it follows that the motion of one ion in one direction will be greater than that of the other ion in the opposite direction. Consequently the ionic velocities will be different, and the observed concentration-changes will follow as a matter of course.

Modification of Clausius.

Owing to the somewhat unsatisfactory nature of the Grotthus hypothesis, Clausius introduced the idea that the ions of any molecule are not always linked to one another, but that they are continually exchanging partners, as it were, with the ions of the other molecules. For example, in a solution of sodium chloride the sodium and chlorine of any molecule do not for long remain attached to one another; the sodium changes place with the sodium of a second molecule and the chlorine may change place with the chlorine of a third molecule. This interchange is continually going on, so that a certain number of free ions are always in solution. In the ordinary state of things the direction of motion of the free ions is in no definite direction. But as soon as an E.M.F., however small, is applied at the electrodes, the free ions move along the lines of force and collect at the electrodes, where they will separate if the E.M.F. is sufficient to overcome the polarisation and prevent recombination. Voltaic action is also readily explained, in the manner suggested by Helmholtz, if we assume that each metal (or electrode) has a specific attraction for electricity, and consequently for the ionic charges. Thus it would be assumed that zinc attracts a negative charge more powerfully, and a positive charge less forcibly, than does copper. Consequently, when plates of copper and zinc are placed in sulphuric acid, there is a resultant attraction of the positive hydrogen towards the copper and an attraction of the negative SO_4 towards the zinc. As the ions interchange they will be drawn, under the influence of these forces, to one or other of the attracting plates, where they will be deposited. On open circuit, however, such deposition will soon cease, because each plate will become positively or negatively electrified, and the resulting electrostatic charge will repel those ions in solution which are of the same sign, and thus prevent their further deposition. In this way, the zinc will become negatively, and the copper positively, electrified. Since the ionic charges are large the amount of chemical action necessary to bring about this electrification is very minute; but upon closing the circuit chemical action continues, because the charges on the two plates neutralise each other, giving rise to a current, and more deposition can then take place. The simple Grotthus theory does not allow such a spontaneous electrification, but otherwise it permits an explanation on somewhat similar lines.

Ionisation Theory.

Clausius, as we have seen, assumed that a certain small proportion of ions were in the free state. In 1887 Arrhenius went a step further and asserted that practically *all* the molecules of an electrolyte in dilute aqueous solution are dissociated, or ionised, as it is called, into charged ions, any undissociated molecules being electrolytically inactive. Thus, when sodium chloride is dissolved in water the solution contains very few molecules, these being nearly all broken up into free Na and Cl. The solution does not look yellow or smell of chlorine because chlorine, as we know it, is Cl_2, not Cl, and for a similar reason the sodium ions do not decompose the water. But when the ions become deposited and separated from their charges, then they are transformed into the molecular condition to which we are accustomed. Nevertheless, the idea that a stable salt like sodium chloride should be resolved into its constituent atoms simply by dissolving in

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water is at first sight somewhat difficult to understand. On that account, and also because of the great importance of the theory, not only in electrolysis but also in primary cells, we shall do well to see upon what foundations it is based. These foundations are chiefly concerned with electrolytic conductivity, osmotic pressure, vapour pressures of solutions, and boiling points and freezing points of solutions. It would take too much space to consider the e subjects fully, and we shall therefore only attempt to give a very brief account of each, simply in its relation to solution and the theory of ionisation.

Electrolytic Conductivity.—Kohlrausch made a large number of measurements of the conductivity of electrolytic solutions. Specific conductivity, or the reciprocal of the resistance between opposite faces of a 1cm cube of the solution, gives very little insight into the question of variation of conductivity with concentration. If the conductivity depends upon the concentration of the solute rather than upon the solvent, the latter should be more or less eliminated from a statement of results from which a law of any kind is expected to follow. For this reason Kohlrausch made use of what is termed molecular conductivity, which is obtained numerically by multiplying the specific conductivity by the volume in cubic centimetres, containing 1 gramme molecule of the substance in solution. If a number of substances are taken and a solution of each is made up containing 1 gramme molecule per litre, the number of molecules in unit volume of each solution is the same, and the conductivities are therefore comparable. One litre is generally taken as the unit of volume in such measurements, and therefore, when a solution contains one gramme molecule per litre, the molecular conductivity is 1,000 times the specific conductivity. If a solution of this strength is diluted, the molecules become more separated, and the specific conductivity cannot be compared with that previously observed. But on multiplying this conductivity by the new volume, this separation of the molecules is compensated for, and we obtain a measurement of the molecular conductivity which is comparable with the previous value. If the specific conductivity varied inversely as the volume, the molecular conductivity would remain constant, but that is not the case.

Kohlrausch obtained two very remarkable results. The first may be stated as follows: The molecular conductivity of an electrolytic solution increases with the dilution and reaches a maximum value approximately corresponding with infinite dilution.

The following figures, which refer to a solution of potassium chloride and are due to Ostwald, afford an illustration of this fact:—

Gramme equivalents per litre.	Molecular conductivity.	Percentage of Molecules ionised.
3·0	879	68
1·0	977	75
0·5	1,018	78
0·1	1,113	86
0·03	1,178	90
0·01	1,219	94
0·006	1,235	95
0·001	1,268	98
0·0006	1,275	98
0·0001	1,285	99
Infinite dilution.	1,296	100

Here the molecular conductivity increases with the dilution, tending towards a maximum, which is reached when the dilution is infinite. If we regard molecular conductivity as a measure of ionisation, then this maximum corresponds with a state of complete ionisation; and the ratio of the molecular conductivity at any concentration to that at infinite dilution gives the percentage of molecules ionised at that concentration, as shown in the right-hand column of the above table.

Secondly, Kohlrausch found that a change of cathion produces a definite change of molecular conductivity independent of the anion in very dilute solution, and the same is true for a change of anion. For example, the difference in molecular conductivity between equi-molecular dilute solutions of KCl and NaCl is equal to the difference between solutions of KNO_3 and $NaNO_3$ of the same molecular concentration. From this it follows that the molecular conductivity at infinite dilution consists of the sum of two independent terms, which depend upon the anion and cathion respectively, and which must be equal to the ionic velocities. In the form of an equation we have

$$\mu_\infty = u + v,$$

in which μ_∞ is the molecular conductivity at infinite dilution, and u, v, the ionic velocities. The statement that the velocities of the ions are independent of one another is known as the law of Kohlrausch. Solutions of normal salts having two monovalent ions are found to obey this equation closely, but the molecular conductivities in the case of polyvalent ions are smaller than would be expected. It is therefore preferable to take Ostwald's modified form of the equation, and to include a constant a such that

$$\mu_\infty = a(u + v).$$

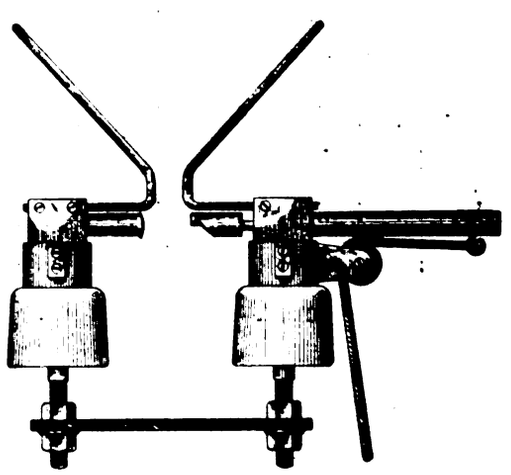
Under what may be regarded as normal conditions a is unity, and the equation reduces to the simpler form.

The above facts were known at the time that Arrhenius brought forward his theory, and they formed some foundation upon which to build it. If we accept the idea of independent ionic velocities, the entire independence of the ions themselves at once suggests itself. We will now pass on to work which was completed at a later date and which has served to strengthen and confirm the theory of ionisation.

(*To be continued.*)

A HIGH-PRESSURE SWITCH.

Below we illustrate a high-pressure switch designed by Herr Sprecher, and made at the Aarburg (Switzerland) electrical works. It is seen that the principle of the Siemens and Halske horn lightning protector is made use of to break the arc, two bent wires being



arranged immediately above the break and in connection with either side of the switch, so that the arc is guided upwards. The switch proper consists of a copper tube with several longitudinal slits into which a copper rod slides to make contact. A spring, not seen in the drawing, normally holds this rod at a distance from the tube, and the switch is put on by pulling the cord on the right. Each side is mounted on strong insulators, as seen. It is intended to employ this type of switch on circuits of 10,000 and 20,000 volts.

Output of Copper and Aluminium in United States during 1899.—The *Engineering and Mining Journal* of New York states that the output of copper, including that recovered as a by-product from copper sulphate, from the United States in 1899 was 264,586 tons, as against 239,330 tons during the corresponding period of 1898, showing an increase of 11 per cent. The price of copper during the same periods has shown very considerable increase, the average price having risen from $263.85 in 1898 to $388.84 in 1899. The growing demand for aluminium for electrical purposes, as also the high price of copper, are responsible for the increase in the output of aluminium from 2,322 tons in 1898 to 2,902 tons in 1899.

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INSTITUTION OF ELECTRICAL ENGINEERS.

The following is an abstract of the discussion which took place on the presentation of the report of the Swiss Visit Committee on the visit of the Institution of Electrical Engineers to Switzerland in September, 1899 :—

Thursday, January 11th.

Mr. R. E. B. CROMPTON, in opening the discussion, thought the Institution as a whole was to be congratulated, not only on the Swiss visit but on the very complete report that the committee had prepared on that visit. That report would have in the future extreme value, not only as a work of reference on account of the statistics it contained, but it would definitely state for the benefit of those who came after them exactly what was the state of the Swiss electrical engineering industry at the time of their visit. The tour, as far as he was personally concerned, commenced at Basle. They met at Basle and were introduced to what they saw on the screen—viz., a "common or garden" electric tramway. The only thing he could say in regard to this was that it was put down about three years ago by Messrs. Siemens and Halske, of Berlin. He had been laid up with a very bad toothache in a house within 20ft. of this tramway, and it had then been impressed upon him for the first time what a wonderful thing an electric tramway was or is—that was to say, cars passed at frequent intervals in front of the house in which he was passing a sleepless night, and he was not disturbed. Except for the hissing of the trolley wheel on the wire, he could not tell it was passing. Then they went to Rheinfelden. When they got there their individual idiosyncrasies began to develop themselves. As he had always, throughout his electrical career, followed Mr. Ferranti implicitly in everything he did, when Mr. Ferranti led the way on the bridge he was bound to follow him. Pointing to a view of one of the generators which was thrown on the screen, he said that was the first electric thing that met their eyes. There they saw Swiss practice; almost the first great development in which Swiss practice began to differ from English practice, and which was forced upon them by the necessity of mounting dynamos on the vertical shaft of a turbine. Swiss engineers had begun to do much work of that class—he thought he was correct in saying the first work of that class—which demanded large low-tension, continuous-current dynamos; and both Brown when he was at Oerlikon, and afterwards the Oerlikon people themselves had followed in the same line; and that vertical type, which they were so accustomed to in England, had become quite a common type in Switzerland. The first thing he noticed—and it was not in the way of criticism that he said this—was that the Swiss engineers were not afraid of a certain rise of temperature, a rise which would appal consulting engineers in this country, and they began to notice, when they opened a door of a power house, a puff of warm air was quite a familiar feature. But they really found out that the Swiss were right practically. The machines were quite efficient enough, and they certainly did not suffer from deterioration of the insulation due to overheating. After Rheinfelden they went through Messrs. Brown, Boveri and Co.'s works, but he would refer in detail to these later. During the several days' stay at Zurich they had a splendid opportunity of inspecting at their leisure the various great Swiss manufacturing electrical works. He would take this opportunity of calling their attention to the history of Swiss electrical engineering. Switzerland was a country where coal was dear, where water power was plentiful, and from the very first transmission of some sort of the power available had been practised. At Schaffhausen there had been wire rope transmission, and Mr. Sulzer had reminded him that as early as 1883 he had ordered from him (Mr. Crompton) a pair of dynamo machines for the purpose of attempting electrical transmission at this place: 65 per cent. efficiency had been obtained, and this was considered so satisfactory that he believed he (Mr. Crompton) was the humble means of inducing a good many people to take the matter up in Switzerland. At all events, Mr. C. E. L. Brown very shortly began to carry on work in the old machine tool factory at Oerlikon, and very rapidly made his name and fame at Oerlikon. Mr. Brown, before he started the works of Messrs. Brown, Boveri and Co., had been successively under the hands of the best engineers in Switzerland. The workmanship and mechanical training he had received at Messrs. Escher, Wyss and Co.'s works at Winterthur, and last, but not least, Messrs. Sulzer, had stamped Swiss electrical engineering with a finish and polish such as was possessed by no other class of electrical workmanship. He would call their attention to the wonderful winding in Messrs. Brown, Boveri and Co.'s shops. From beginning to end every class of winding must have been a revelation to English engineers, and although he did not want to be invidious, he always said—and he believed all English engineers thought the same—that if it was as good as the Swiss it was quite good enough. As regards the mechanical finish, they had had the example of such men as Sulzer before them. He had had the opportunity of a quiet inspection of Sulzer's works, and was never more interested in his life. He did not think it was possible that large engines several months in the shop could be finished without so much as a single scratch on them from beginning to end. Did they think that in any English engineering shop some labourer or apprentice would not have thrown something down and scratched that beautiful finish of these 1,000 H.P. engines? Would it have been possible in an English shop to have got the perfection and cleanliness and finish that they saw there? However, although they were so very perfect, they were not very rapid. Such work would always demand and bring a high price, and he thought it should be a powerful incentive to us in our branch of the mechanical engineering trade to work up to the same pitch and get that high finish and equally high price. This was what he envied in Sulzer. They had got such a name, and they got orders from all parts of the world at such high prices. Whether coupled to turbines direct or whether coupled to the Sulzer type of engine, the Swiss engineer was taught to believe that the highest development of steam machinery was a Sulzer engine. He built his dynamo to suit it, and consequently the Swiss dynamo had developed in the form of a large flywheel dynamo. They had their Sulzer: we had our Willans: men who thought out a difficult problem in a different manner, and profoundly influenced the early type of electrical engineering. But there was not now that divergence in practice that there was years ago. Swiss engineers began by a little lighting and a good deal of transmission of power. They were going on with a little lighting and a good deal of transmission. Therefore, having to deal with water power so much, they had become past masters in producing machinery for transmission to great distances. In this dark, fog-laden atmosphere the demand for light was very great indeed, and therefore we had become far more lighting engineers than they were. The result had shown itself practically in the wide differentiation in the kind of machinery turned out by both. The transmission of power forced the Swiss engineers to appreciate early the advantages of alternate current, particularly in its multiphase form, and as a result they saw Swiss shops filled with it. Therefore he was of opinion that, although the Swiss were ahead of us in that particular class, he did not think they could claim to be ahead, or even equal to us, in the production of our own class of machinery. The magnificent specimens that he had seen within the last few days at Manchester, for instance, of 2,500 H.P. continuous-current dynamos, certainly surpassed anything they saw in Switzerland in that line; and we could not shut our eyes to the fact that we have not only maintained our position in that part of the race, but we have bettered it. And this was due to the difference in the conditions under which we had had to work. But consider what an advantage in one respect the Swiss engineers had reaped from the conditions of things which forced them into high-pressure work. If electrical railways—not tramways—were to be worked at all; they were to be worked by high-pressure energy transformed; and what an easy thing it was for the Swiss to carry a little further what they had already done. He thought most of the members would agree with him about the unexpected simplicity and satisfactory design of the railways direct driven by multiphase currents. If anyone had been told years ago that a railway was going to be worked with a double trolley, and a considerable difference of potential between the two trolley wires in the air, and the return by the rail, they would have thought the complication too great. But he would ask them, looking at the lantern slide of the trolley construction on the Stänsstad-Engelberg line, where was the complication? Everybody was astounded at the simplicity of this overhead construction. The next slide showed one of the carriages with the cross bar in its single form which was first employed by Messrs. Siemens and Halske; while a third was a photograph of the overhead construction. The next showed the rack railway of the Stänsstad line. The Stänsstad line was partly on a incline, and when they got to the rise, in some parts as much as 25 per cent., a rack was employed with a locomotive. On the level the carriages had the motive power on board. The Burgdorf-Thun was the next line to be shown. The pressure was transformed from 16,000 to 750, the transformers being in the power house. The switchboard of this line he showed principally to call their attention to the extreme simplicity of it as regards the front. Everything went to show that this multiphase railway working, instead of increasing complications, tended to decrease them. At the Oerlikon works, some slides of which were exhibited, he said they did the right thing in not "snapping" everything they saw. As a matter of fact, nothing was put in their way, and they could have "snapped" everything they saw in the works, but he thought the members showed very good taste in not "snapping" special modes of manufacture. The photographs taken included a traveller under construction, a large electric crane (a class of machinery which the Oerlikon works had been manufacturing for several years), and a 1,140 H.P. vertical spindle dynamo direct coupled to a turbine such as they had seen at Rheinfelden. His remaining slides included the rope transmission referred to at Schaffhausen and a view of the Jungfrau railway, besides a number showing some of the members of the Institution who took part in the visit.

Mr. ROBERT HAMMOND thought that, judging from the pictures, one might gather that the whole of the time spent in Switzerland had not been devoted to scientific pursuits. But, criticising the visit, he thought it better to say that they had worked too hard. They might not imagine this from the pictures, but when they had to get up at six o'clock in the morning and have dinner at 10.30 p.m. they began to get tired. They must all feel that Mr. Crompton had given a splendid *résumé* of what they saw. Truly he had said that Switzerland had before it a splendid example in the works of Sulzer; and one could not dwell upon the point too strongly—that splendidly equipped workshops did influence the engineering of a whole nation. Then, again, a point which Mr. Crompton had not time to dwell upon (but with which he was sure he would perfectly agree), was that in the works of Messrs. Escher, Wyss and Co. they had works of a firm that had been making turbines for generations. Some may think that this utilisation of water power began by the introduction of electricity, but it was most interesting in the works and offices of this firm to see the ancient pictures of 100 years ago of the early turbines which the progenitors of the firm had made for the utilisation of water power. They had been learning their engineering for a century; some say, in fact, that they began the century before last or even two or three centuries ago, but he would not go into that question there. At any rate, it was shown that their engineering, and the works they were now supplying all over Switzerland, were the outcome of generations of engineers. Mr. Crompton had said that Swiss dynamo manufacturers were turning out better dynamos than we in England, but, sorry as he was to differ, he could hardly follow this. It was certainly not compatible with his statement that there was a very large temperature rise. Speaking personally, the dynamo work had not impressed him so much as

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the engineering work. He understood that what they really had to do that evening was to see what lessons learned in Switzerland they could apply to themselves in England. It was their duty to see that, though they had a splendid time, and though they were grateful to those members of the Institution who inaugurated the idea of these annual or bi-annual visits which had proved so valuable in other societies, they felt they had brought home some lessons that they could apply to their engineering here. Now, manifestly the big thing they saw was the utilisation of water power, and it had been said that of course we cannot emulate the Swiss because we have not the water. He would like to draw attention to a point which struck him on the very first day of the visit. In the engine room of the Rheinfelden power house they saw 16,000 H.P. being distributed and obtained from water, and of course, the natural lesson seemed to be "Oh, would we had the water in England." Well, it would be in the memory of some of the members who were at the luncheon afterwards that it was pointed out, and he would point it out again, that though we had not the water in England, we had the coal; and it was not the actual turning force of the machines which constituted the whole cost of electrical energy. One characteristic of the visit was that they did not get informed upon many commercial points. He would venture to say that if a similar tour through England were to take place, the tourists would have been deluged with costs per unit delivered to consumer, and percentage of costs to revenue, and revenue per unit delivered to consumer, and all those cabalistic figures which so many delight in. They passed through Switzerland, he believed, without knowing what was the cost per unit anywhere! He himself had inquired at one of the works visited, but did not succeed in finding anyone who could give him information. From this he gathered that in Switzerland the engineer concerned himself with engineering, and looked upon the commercial part of the business as something not in his province. As one acquainted with many consulting engineers in this country, he was pleased to find that the engineer in Switzerland had so improved his position. Some had come back with the idea that consulting engineers were unnecessary and absolutely ignored in Switzerland. But he did not form that idea. At the very first works they visited he found that there was not only a consulting engineer, but they kept him on the premises. In this country it was the unfortunate practice to force consulting engineers to consult for many places, but in Switzerland they gave him board and lodging on the spot. Finally he came back to the question of water power again. Though we had not the water here, we had something which took the place of it, and which formed a certain proportion of our costs. He was very sorry he was not able to attend the discussion on Mr. Crompton's Paper recently, as he had been shipped off to consult somewhere, but he had put a few figures together which would apply equally well now. He had just looked into the proportion which coal bears to the total cost of production. He would take Kensington. The cost of coal was 25 per cent. of the total costs, including the works costs, management costs, and in fact all the costs which they found classed by the Board of Trade as cost of production. Therefore, if they were to abolish the coal bill at Kensington—the total cost being 3·04d.—they would only abolish ¾d. of it; and it was therefore absurd to talk of the substitution of water for coal as a thing which would reduce the cost from 3d. to ¾d. The most they could hope to do was to eliminate the whole of the coal bill, but in substituting water for coal they put in a thing which entailed some expense. The real lesson to be learnt by the application of water was not so much the substitution of water for coal as the big fact that an aggregation of load was the real element in those costs.

Mr. M. G. S. SWALLOW thanked Mr. Crompton and the members of the Institution for the great interest they had taken in Swiss electrical engineering. He quite agreed with Mr. Hammond that the most remarkable fact in Swiss engineering was the manner of using water power for transmission to long distances. No doubt one of the most interesting plants they saw was the last one they visited. He was not in a position to give any data of this line, but they had a general idea of the distribution of power in the committee's report. During his stay in England he had been over a part of the Central London Railway, and had been comparing notes on the method of working railways in England and in Switzerland. He confessed he was astonished to see that while three-phase current was principally used for the transmission, three-phase current was not to be used for propelling the trains. No doubt there were very urgent reasons why this should be so, but the practice so far in Switzerland of using three-phase current throughout had fulfilled all points, even when the railway had a large traffic.

Prof. C. A. CARUS-WILSON was sure that those members who had the benefit of Mr. Swallow's guidance over the Burgdorf-Thun railway—of which he (Mr. Swallow) was the resident engineer—would appreciate the remarks that he had been able to give them, especially in connection with three-phase railway working in England. It must indeed be astonishing to a railway engineer coming from Switzerland to see our Central London Railway, with its three-phase generating plant, and then to find continuous-current generators on the locomotives. He quite agreed with Mr. Crompton in the impression that must have been conveyed upon the majority of the members in Switzerland that the Burgdorf-Thun railway was the most remarkable thing we saw; and it was specially remarkable in this particular: that the people who were interested in putting down this railway knew very well that they were undertaking a very critical thing. This was a broad gauge line, linked with other standard lines, and carried the normal traffic. In every respect it was a standard broad gauge railway. That the promoters of this enterprise should have undertaken to equip the line with three-phase motors was the greatest proof, he thought, that we should have the same great confidence that the leading engineering firms in Switzerland had in the application of three-phase systems to railways. It was not a matter of doubt that the financial success of the Burgdorf-Thun line had yet to be proved, and if there had been any doubt as to the comparative efficiency and economy between three-phase and continuous current, then he thought the Swiss would have gone in for continuous plant. They had a very striking and interesting illustration of three-phase railway practice, not only in the Burgdorf-Thun railway, but in the other electric railways which they visited in Switzerland. One of the most interesting comparisons they had was between the locomotives made for the Jungfrau railway by the two great competing Swiss firms—viz., the Oerlikon Co. and Messrs. Brown, Boveri and Co. He himself had noted a few points of difference, which showed that even the great firms of Switzerland were not at all decided. The two classes of locomotive made for this railway differed very materially in many important respects. The Oerlikon locomotives were 19 tons against Brown Boveri's 13 tons; the Brown-Boveri motors were very much uglier than the Oerlikon motors, the gearing being cut differently; while one of the most interesting differences between the two locomotives was that the Oerlikon Co. did not use the same resistance for the two rotor resistances, while Brown, Boveri and Co. did. He noticed a very peculiar effect while travelling on the Jungfrau railway, in the shape of a distinct jerking at the moment of starting. It was not a uniform start, and after discussion they had decided that it was due to the fact that the engine was a Brown-Boveri, in which the resistance of the two motors were coupled to the same rotor resistance, and this gave a very peculiar hunting effect in mounting an incline. The Oerlikon people had got over this by having separate resistances. One of the most emphatic objections against polyphase motors for railway work was the very small clearances they were obliged to work with. It must have struck terror into the minds of mechanical engineers when they learned the extraordinary narrow clearances that these Swiss polyphase electric motors were working on. On the Burgdorf-Thun railway the clearance was only 1½mm. This was a thing hardly to be attempted by English engineers, but the Swiss had tried even ½mm. The chief draughtsman at the Oerlikon works had told him that 40 H.P. motors had been tried with only ½mm., but that they had been obliged to go up to 1½mm. Mr. Crompton had already alluded to the question of overhead conductors. This was constantly raised against three-phase work; but there was one very important point in connection with Swiss railways which should not be overlooked, and that was that all their railways crossed roads on the level. He thought those who had travelled on the Burgdorf-Thun line must have been astonished at the simplicity of construction. The three-phase motor seemed to lend itself in a remarkable way not only to the class of work it was put to in the mountain railways, but also for ordinary traffic and ordinary steam railways. One great advantage was that the uniformity of running depended upon the frequency and not upon the load. The Burgdorf-Thun railway at full load only had a drop of 2 per cent., and the speed was kept constant within these limits. Perfect regulation of the speed could be obtained by varying the rotor resistance. But what astonished him most was to see the Engelberg train coming down a 25 per cent. grade, and held by nothing whatever but the return current from the three-phase motors as it was generated into the line.

Mr. LAWRENCE BIRKS had visited several other stations after the party broke up, and showed on the screen a slide of the Hagnek power station. (Hagnek is a small village on the Lake of Bienne.) It had no special attraction for power utilisation, except that a canal was cut from the river Aare to the lake to carry off the surplus water of the river. Some two years ago a scheme was initiated for using the water of this canal for power purposes, and a weir was thrown across it giving a fall varying from 5 to 9 metres. Three slides were then shown of the weir in course of construction, the power house, with its five turbine chambers and the switchboard in a special building on one side; whilst the third was a closer view of the weir, showing the method of putting in the piers. Two more slides were shown of a plan and elevation of the power house and a section of the same. The power, he said, was generated by means of five turbines each of 1,350 H.P., running at a speed of 100 revolutions. The regulation was either automatic by means of movable guide plates, or by hand opening and closing the gates with the help of a separate 25 H.P. turbine. The alternators were directly coupled to the turbine shafts. These were of Messrs. Brown, Boveri's make, and generated 1,000 kw. each direct at 8,000 volts. The exciters were driven by bevel gearing placed underneath the alternators, and were separately excited from secondary exciters. There were spare secondary exciters driven by a separate turbine. The power from this station—some 5,000 kw.—was distributed to a distance of 25 kilometres in every direction from the station. 2,000 kw. was employed in a calcium carbide works five kilometres distant, while the remainder was distributed to villages.

Mr. MARK ROBINSON, as a builder of engines, greatly appreciated Mr. Crompton's remarks on Swiss mechanical engineering, and particularly the work done by Messrs. Sulzer. A few weeks ago he had had the pleasure of a day with Mr. Sulzer in an inspection of his works, which certainly deserved all that Mr. Crompton had said of them. But he did not like the praise given to the absence of scratches and to the extraordinary finish. This was better deserved by the magnificent accuracy of the work. They did not work in Switzerland on the repetition system, and they obtained without it an accuracy which was not bettered in England; and this was very much to their credit. What struck him most was not the mere geographical fact that they had water available, but the great development of three-phase work; and it seemed to him that the gentlemen who understood the electrical side of the matter much better than he did would benefit themselves and others by turning their attention to three-phase work, and seeing whether the immense development of it in Switzerland ought not to be repeated over here. With regard to Prof. Carus-Wilson's remarks and the danger he appeared to suggest of the small clearance of 1½mm., such an amount seemed to him large enough to walk through.

Prof. CARUS-WILSON: I was speaking of railway work.

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Mr. ROBINSON: Oh, I see—on account of the obstructions that might get in.

Mr. J. RAWORTH wished to make one suggestion that had nothing to do with Switzerland. Mr. Crompton had told them that evening that part of the funds subscribed in connection with the Royal Engineers (Electrical Engineers) Volunteers detachment which was going to South Africa was to be used in making the men more comfortable when they were out there, and not for the purchase of plant. He knew that some of the people to whom the appeal had been made thought that the finding of plant ought to have been done by the Government, and therefore did not respond very heartily (being under the impression that the money subscribed was for this purpose), but would have done had they known the purpose to which Mr. Crompton intended to apply the funds. He had not very much to say about Switzerland, because if he went into the details that some of the gentlemen had he would not have finished that evening. If ever it should fall to their lot to entertain their Swiss hosts in this country, he was quite sure they would be willing to pay some measure of tribute to the progress of electricity in England. They would be able to see some works which would astonish them, and if they would only come here they would not be let off with any less hospitality than they had provided for the Institution in Switzerland. The report gave details of most of the installations they had seen, and the committee had done their work very well indeed; but they had omitted one thing in the third paragraph. This paragraph said that they had visited Rheinfelden power house, &c., where they had been most hospitably entertained at lunch by the directors of the Kraftubertragungswerke, but it did not state that Herr Rathenau, of the Allgemeine Elektricitäts Gesellschaft, came all the way from Berlin to that luncheon, to give the members a very warm invitation to Berlin another year.

Mr. JAMES SWINBURNE was one of the few unfortunates who was unable to go to Switzerland, but he had been to Switzerland on another occasion. One thing he dared say they noticed in going into engineers' offices abroad was that they generally saw a pile of journals, not only German, but every journal they had heard of, and probably a great many they had not heard of. The Continental engineer as a rule was an immense reader. He knew absolutely everything that was going on in every other country as much as in his own. In England he was afraid they did not do that. They had worked on another system. In the early days of electric lighting each person had some system of his own; and then they got into the stage in which they had a Tom dynamo, a Dick dynamo, or a Harry dynamo, and this inventive desire had been most disastrous for England. On the Continent there was a general tendency to uniformity of practice, and this was due to the fact that engineers were not running about introducing their own inventions. This was one reason why the Germans and the Swiss had gone ahead of us in many ways. Another departure from our practice was that they sacrificed electrical efficiency to cheapness and mechanical strength. Now, mechanical strength was not necessarily opposed to electrical efficiency, but he thought that if they investigated the electrical or mechanical efficiency of many of the dynamos made on the Continent, they would find them very far behind and very expensive machines in the long run, although he did not know that they broke down often. Another fundamental difference, which was perhaps a commercial difference, was that in England an owner of a works considered it a necessity to put them into some dirty corner of the town where they could make lots of smoke, and looked upon his works only as a thing which brought him in so much money a year. On the Continent, however, the owner's or at any rate the manager's house was probably on the works; the whole place was beautifully kept clean, and very often they would find a garden close at hand. He had been over a great many works in Germany and Switzerland, and had only seen one which approached an English works for dirtiness and untidiness. This was not a matter of expense, because it meant that if a man kept his works perfectly clean and tidy and everything comfortable for his workmen, they took more pride in the works and in their own work. Another difference was that the trades unions were not so strong as they were here. He had found Continental workmen divided into two very widely different classes, the one very uneducated and the other really able men, a distinction which they did not get in England. The trades unions tended to level down the workmen. But there was nothing in England at present like the superior Continental workman as a class. Another thing was the difference between the law of electric lighting in England and abroad. He did not know very much about Continental law, but the general principle, he believed, was that the local people gave concessions. They were not anxious as a rule to run the station themselves. In Germany, too, the stations were financed in quite a different way to English enterprises. They were generally financed by banks. The English looked upon a bank as a thing where they could put a certain amount of money, and then draw cheques, but abroad a bank was a sort of speculative concern which supported enterprise. He would also like to point out that Continental works had a different way of developing. For instance, Messrs. Siemens' works in England were really a branch of Messrs. Siemens and Halske in Germany, while the Allgemeine Co. owned other works under different names in different countries. Brown, Boveri and Co., in the same way, had manufacturing places in different countries, and they gradually spread out in that way. This was a thing they did not do in England at all, but they ought to do it, especially as they had more chance of getting capital in England. Finally, he would like to protest against Prof Carus Wilson's astonishment at a motor running downhill without any brakes; he thought it showed a want of confidence in electrical things to utter such a sentence. If a motor had sufficient torque to take them up a hill, surely it had sufficient torque to take up the less power in going down that hill.

On the motion of Mr. R. P. SELLON the discussion was adjourned until January 25th.

(To be concluded.)

THE THIRD AVENUE RAILWAY, NEW YORK.*

The important work of changing over the main lines of the Third Avenue Railway Co., of New York, from cable to electricity, using the underground conduit system, is now completed. There are in all four sections; the first is the cross-town line, running along 125th-street; the second runs between 130th-street and 65th-street; the third between 65th-street and the Post Office; and the last, which was opened on December 10th, is the Boulevard line from St. Nicholas-avenue to 71st-street.

While the lines now in operation comprise 29 miles, measured as single track, the company still has 29 miles of track in various parts of the city on which electric construction is well under way. Some of this work is nearly completed, but on other parts of it the present congestion in the iron industry is seriously hindering the conversion. The Dry Dock Railway system in the lower end of Manhattan Island is still being operated with horses, and while various forms of mechanical power are under consideration, none, so far as is known, has been decided upon. The conditions in the lower section of the city, in the streets upon which these cars run, are so different from those in the northern end that the officials of the Third Avenue Co. have evidently decided not to make any change there, at least until the more extensive work being undertaken on its up-town lines is further advanced.

The lines which have already been put in operation are particularly interesting from the fact that radical innovations have been introduced in both track and car construction, while the main power station, under way at 216th-street, is the largest in operation or being built in the world. These changes, particularly in track construction, run counter to many preconceived opinions, and while the system has not yet been in operation for a sufficient length of time to permit any accurate information as to durability of the track or the lasting popularity of the cars, the immediate impression is most favourable.

Track Construction.—In the construction adopted, two types of conduits are used; that for new construction, which comprises all of the work of the company except that on Third-avenue proper, and that for the portion on Third-avenue. The most notable features of the new construction are the use of cast-welded joints in conduit construction, the combination steel and cast-iron yokes, and the employment of a continuous creosoted wooden stringer under the rail at all points except at special work. The most noticeable feature of the track construction on Third-avenue is the use of a spring liner, placed between the base of the rail and its seat on the yoke. The object of this liner, and also of the wooden stringer used in the new construction, is of course to secure an easy riding track, and this has certainly been secured. The management of the road is equally well satisfied with both methods of construction, and it is hard to say which would be selected for new work.

The spring adopted is not of the elliptic type, but is so designed that when the centre goes down the ends rise, presenting a corrugated surface of enormous strength, the weight to compress which flat is estimated at from 10,000lb. to 12,000lb. The springs are 4in. wide, and the deflection at the passage of a loaded car carrying about 6,400lb. on each wheel is about $\frac{1}{32}$in., and is noticeable from the street. Upon certain sections the tracks are used conjointly with the Metropolitan Street Railway Co., but in every case of this kind separate conduits and conductor bars have been installed. A plan is given of a section of this kind.

The contractors for the track construction were: Roadwork, Naughton and Co.; underground feeder conduits, J. T. McRoy and National Conduit and Insulation Co.; rails and special work, Lorain Steel Co.; yokes, manhole frames and covers, Pennsylvania Iron Works; bolts, tie rods, &c., Sternberg and Co.; creosoted timber, Eppinger and Russell; spring liners under the rails, Charles Scott Spring Co.; cast-welded joints, Falk Co. The system of flexible track used is the design of John H. Robertson, superintendent of the company, who had also general charge of the engineering features of the new line. The consulting engineer of the company is Dr. Louis Duncan, who had entire charge of all the electrical construction and equipment.

The Change from Cable to Electricity.—The immense traffic on the lines changed to electricity emphasised the necessity of the least possible interference with the regular operation of the cars while the work was in progress. On the new construction the traffic was cared for by horse cars running on temporary tracks laid at the side of the street. This was hardly feasible, however, on the main line on Third-avenue, on account of the length of the line, enormous traffic, and existing rolling stock. It was therefore decided to keep the line in operation by cable almost to the moment when the change could be made to electricity. To provide for this the concrete of the conduit was first chipped away at the points where the insulator boxes were to be located. These boxes were then set in place, and the insulators and conductors were introduced in the conduit, but to avoid interference with the cable were hung on hangers, which all wed them to be slid away from the slot. When the work was completed, and the

*Abstract from the *Street Railway Journal*.

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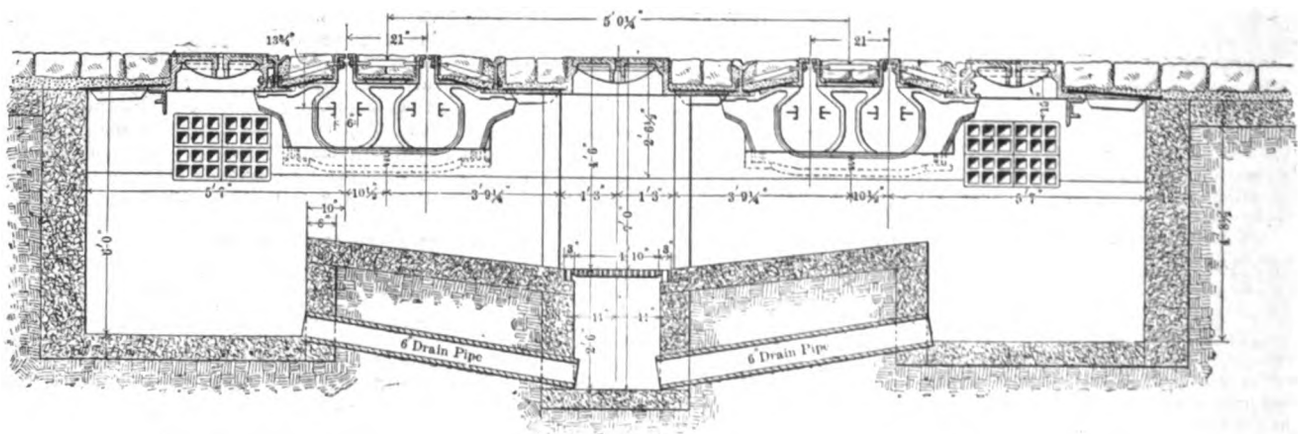
company was ready to make the change from cable to electricity, the traffic was stopped on a Sunday morning. The cable was first withdrawn and wound on the cable drums at the station, after which the portion of the cable-carrying machinery in the conduit which would have interfered with the operation of the electric ploughs had to be removed. This ironwork included the carrying pulleys, which numbered over 400 to the mile of single track, the slide pulleys, brackets, frames, hangers, &c., and the guard slot rails at the curves. Practically all of this material had to be removed from below, and it amounted in all to over 1,000 tons. The two lines of insulators, with their conductor rails, were then slid forward on their bearings into position. The change took only about 24 hours for each section, somewhat longer than was originally thought, as it was found that the cable, either while in service or during removal, had broken a number of the porcelain insulators. It was also found that some tools, including a crowbar, had been left in the conduit by the workmen, short-circuiting the conductors. The removal of these obstacles was soon effected, however, and the road then operated without hindrance.

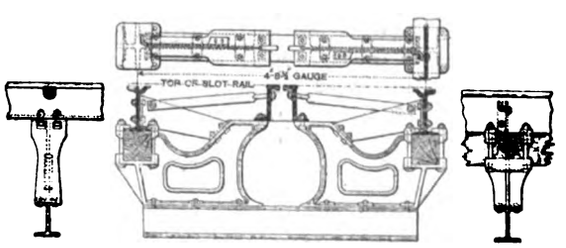
Rolling Stock.—Four types of cars are employed—viz., a 22ft. body closed car, mounted on a single truck; nine bench open cars for summer, also mounted on a single truck; a 32ft. cross-seat closed car, mounted on double trucks; and a combination open and closed car, mounted on maximum traction trucks.

The single truck cars constitute a part of the former equipment of the railway company, when in operation by cable, but have been equipped with two Westinghouse No. 68 motors each, and are mounted on Peckham "Metropolitan Special" trucks. The third and fourth types of cars are those in which the novel features referred to have been introduced, and which attract particular attention.



Section of Manhole of Duplex Construction where Two Companies operate over same Track.

The 32ft. car was designed by the superintendent of the railway company, Mr. Robertson, to fit both summer and winter conditions. Of these, the company has 100, built by the St. Louis Car Co. The company has long felt the need of a convertible car of a practicable type. This need has been accentuated in the case of the Third Avenue Co. by certain local conditions, chief among which has been the large expense and trouble of storing cars. The high cost of real estate in New York compels the company to use car houses having two floors, and in its Harlem car house, which is the main car house



Standard Yoke, New Construction.

of the company, the equipment not in continuous use is stored on the second floor, while that in regular service is kept on the ground floor. If a sudden change of temperature comes on, it takes the greater part of a day to substitute the equipment in storage for that in service. As a result the need for the change often disappears before the change itself can be effected. The company also realises the deterioration to which cars in storage are subject, the duplication of equipment required, and the other drawbacks to separate summer and winter equipment.

The inside of the dash is equipped, beginning at the left of the motorman, with motor controller, sand box handle, air brake handle and hand brake handle. The motorman in stopping the car, operates the first two in succession with his left hand, leaving the right hand for the spindle brake or air brake, as he may prefer. Two novelties in the platform fixtures of the air brake apparatus have been introduced. One is the use of a pressure gauge with two indicators, one showing the pressure in the reservoir, the other that in the jam cylinder. Heretofore the usual practice has been to indicate the reservoir pressure only. The other improvement has been in making the "lap" position more easily found. This position is half-way between the "emergency stop" and off positions, and the motorman had to look at his dial to tell when his handle was at "lap." On the Third-avenue cars the swing of the handle is stopped at "lap" by a light coil spring, which must be compressed in passing from "lap" to "off." This makes the manipulation of the brake, particularly the release of the air as the car slows down, very easy for the motorman, and an act which can be accomplished almost instinctively. The gong is worked by a treadle, and the sand box is carried under the platform, and can be filled without interfering with the passengers in the car. The opening to the sand box is so arranged that though it is on the platform, no rain can enter and pack the the sand. The De Witt sand box, which has been adopted as standard on the cars of the company, is used. Each car carries 20 lights, 18 within the car, spaced equally along each cornice and on the ceiling, one on the rear platform, and one in the headlight. Consolidated car heaters and New Haven registers are used. The total weight of the car with motors is 36,000lb.

The plough differs somewhat in details from that of the Metropolitan Street Railway Co., but is similar in general character, so that the cars of one road can run on the tracks of the other without difficulty. Each car is equipped with four Westinghouse No. 69 motors, and is mounted on two Peckham short wheel base "14-B"

trucks. These trucks have a wheel base of only 4ft., and the motors are hung outside the axles. An exceptionally long truck base is used, the king pins being 22ft. apart. The hand brake shoes press on the outside of the wheels, while the air brake shoes operate by a toggle movement between the wheels. The air brake application is also novel, and consists of the use of four jam cylinders, one for each pair of wheels. The motor compressor is carried underneath the car between the trucks. The system of the Standard Air Brake Co. is employed.

The combination car, the fourth type to which reference was made at the beginning of this discussion on rolling stock, consists of a closed end, 18ft. long, and a five-bench open end. The car is a single ender, the closed portion always being first, and is mounted on two Peckham swing bolster maximum traction trucks, with 30in. large and 14in. small wheels. The truck base is 25ft.

The closed portion is entered at the centre of the car by a step, 15½in. in height, and a 13in. riser, which take the passenger to the platform, then by a third step, 8in. high, into the body of the car. The car is kept low by allowing the trail wheels of the truck to swing under the steps, while the large wheels swing between the car sills. The registers, sand box equipment, &c., of these cars are similar to those of the convertible cars already described. Both types are also fitted with a new type of wheel guard, devised by Superintendent Robertson, consisting of scoop made of curved steel rods, and terminating in a wooden toe-piece. This guard is mounted on the body of the car, just in front of the truck, and is normally carried about 2in. above the track, but is automatically dropped in case a body should come in contact with a hinged trigger, which is carried under the front of the dash. The company has 60 of these combination cars.

The company also has 12 Brill snow sweepers. Each is equipped with two No. 56 Westinghouse railway motors and two K-8 controllers, and carries in addition one No. 56 motor for rotating the brooms and an R-17 controller.

Power Stations.—The current for operating the lines of the Third Avenue Co., including the Union Railway trolley system, will be

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ger erated at a 96,000 H.P. power station now being erected at 216th-street and Kingsbridge-road.

The Third Avenue Railroad Co., finding it essential to equip its lines electrically before this permanent power house could be completed, decided to erect temporary generating plants, utili-ing as far possible the steam units formerly employed for operating the cable roads. To supplement this power a new station was equipped at 129th-street. The designs were prepared by Westinghouse, Church, Kerr and Co., and the contracts for carrying out the plans awarded the same company. Speed in erecting was an important factor, and it is a fact worthy of record that at the 129th-street station the engines, boilers and generators were constructed and the plant of 6,000 H.P. was erected and running within three months from the closing of the contract. The temporary power equipments aggregate a maximum of about 9,000 kw.

The power station equipment at 129th-street and Amsterdam-avenue was placed in an existing car house of corrugated iron. The east side of the building, 200ft. long, was turned into a boiler room, and a brick partition was built to separate it from the engine and generating room. The boiler room contains four batteries, each of two 520 H.P. Babcock and Wilcox water-tube boilers, double-decked, with forged headers. Each boiler is fitted with a superheating loop of a type which during the last few years has been installed in many of the boilers manufactured by the foreign Babock and Wilcox Co., and which is now being introduced in this country by the American house of that name. The superheater consists of a set of U-shaped tubes, expanded into wrought-steel headers or manifolds, similar to those of the boiler proper. Steam is received into the upper header through two large pipes coming down from a perforated "dry pipe," placed in the upper part of the steam drum. The steam then flows through the tubes of the superheater to the lower header, which delivers it into two pipes, one on either side of the boiler, which convey it to a flanged T, from which it flows through the usual piping to the engines. The location of the pipes is such that, being near the furnace, they get the heat necessary for superheating; at the same time they are not exposed to the hottest part of the gases, so there is no danger of their burning out. The only risk of the latter is when the fire is pushed and no steam is being delivered to the engines. This occurs, as a rule, when steam is being raised hurriedly from cold water. To provide for these times a pipe connection leads from the lower header, as shown, to the lower part of the steam drum. This pipe is fitted with a valve, and when this is opened the superheater is flooded and made part of the steam generating surface of the boiler. Water for feeding the boilers is obtained from the city mains, and is supplied by meter. A steam heater, using the exhaust from the engines, raises the temperature of the feed water before entering the boilers.

Induced draught is furnished by a pair of large, slow-running fans, either of which is of sufficient capacity for the whole furnace equipment. The fans have three-quarter housings and vertical discharge. The fan wheels are of special construction and proportions, carried on heavy 6in. forged steel shafts, running in water-jacketed boxes, the wheel shafts being connected to the engine shafts by marine couplings. The driving engines are horizontal, one of them and its fan being reserved as spare, and dampers are provided so that either fan may be operated at will. Regulation of the draught is controlled automatically by the variation of steam pressure in the boilers: a rise in boiler pressure partially closes a valve which reduces the amount of steam entering the cylinder of the fan engine. This arrangement maintains a uniform boiler pressure by controlling the amount of draught, through regulation of the fan speed. The waste gases are discharged from the fans through a self-supporting iron stack 10ft in diameter, which rises a few feet above the roof of the power house.

The generating plant includes eight units. Each consists of a Westinghouse 23in. and 40in. × 20in. compound non-condensing engine, direct connected to a 375 kw. Westinghouse direct-current multipolar spring-coupled generator. Each engine has a capacity of 740 I.H.P. under 150lb. steam pressure running at 215 revs. per min. They are compound automatic, single valve, with positive acting gear, arranged for steam distribution to give equal division of load between cylinders under widely varying conditions. The main shafts are of open hearth steel, 10in. in diameter. The weight of flywheels is 16,000lb., and of each engine 82,000lb. The eight generators are of the direct-coupled type. The field-casting is divided in a horizontal plane, and the lower field-casting carries the journals for the armature. The windings are so proportioned that when running at rated speed the machines will operate at 500 volts with no load, and will over-compound to 500 volts with a load of 680 amperes. This load can be carried continuously, the temperature not exceeding 40°C. above the surrounding atmosphere, and an overload of 50 per cent. can be carried for short periods. The field frames are of best quality cast iron, and the pole pieces of laminated steel.

The switchboard also follows the standard Westinghouse practice, consisting of eight 600 ampere generator panels, a load panel equipped with a 600 volt differential voltmeter, an 8,000 ampere shunt ammeter, and eight feeder panels, all of which carry the necessary instruments for controlling and metering the current.

The eight units are compactly placed side by side, occupying a minimum of floor space. At the south end of the engine room a 1,000 kw. Westinghouse rotatory converter has been erected, which will be supplied with alternating current from the 65th-street station for conversion into direct current, to help out this station at the peak of the load. This rotatory will eventually form part of the equipment of one of the sub-stations when the permanent installation shall be completed.

The 65th-street station, as stated, was formerly used for operating the cable road. The engines formerly used for this purpose are now supplying power by rope drive to four 1,000 kw. Westinghouse rotary converters, which are used temporarily as generators for supplying direct current for the car service. The collector brushes are of course raised, making the three-phase side inoperative. The shafts have also of course no starting motors, but were made extra long to carry a driving pulley, and fit into an outboard bearing to support the weight of the rope-driven pulley. When the permanent plant shall be completed, the rotaries at this station will be applied to convert the alternating current from the central power house to direct current for feeding the city end of the line. No change will be required in the generator, except to shorten the shaft and attach a starting motor. At the Bayard-street station two 1,000 kw. Westinghouse rotatories are being installed, and will be utilised temporarily in a similar manner as are those at the 65th-street station.

The machinery at the 129th street power house, although built and erected in so short a space of time, has run smoothly and been equal to every call made upon it. It supplies current for the 125th-street and the Boulevard lines down to 59th street. The 65th-street station now supplies the lines on Third-avenue to the City Hall, but as soon as the Bayard-street station is in operation current will be taken from it for the City Hall end of the line.

To maintain the car service during this transition period has taxed the ingenuity of the engineers, but in spite of all difficulties and obstacles the public convenience has been well conserved. Occasionally at the extreme southern end during the hours of heavy traffic an insufficiency of current has been apparent, but with the help of the Bayard-street station this will soon be obviated.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *January 5, 1900.*

The American Pacific Cable.—Capt. G. O. Squier, of the United States Signal Service, read a Paper before the American Institute of Electrical Engineers, on December 27th last, on the subject of the American Pacific cable. Capt. Squier reviewed the history of the subject, and stated that two plans were competing for public attention—one British and one American. The cardinal idea in the Brtish system, he said, had been that all State cables should touch only British soil, and this principle had, in his opinion, placed British cable traffic in the Pacific for ever at a disadvantage against the American cable, for the reason that the only available route involved a single span of cable from Vancouver Island to Fanning Island, over 3,500 miles in length. On the other hand, by the annexation of the Hawaiian Islands, the United States, while following a similar principle, would have no span longer than the present Atlantic cable, or about 2,500 miles in length. Since the speed of cabling decreased in general with the square of the length of the cable, and the speed of the whole system was limited by the speed of the slowest span, that system requiring the longest single span was ultimately at a disadvantage, provided the systems were in direct competition. In the projected Pacific cable enterprises, however, although they would operate in close relations with each other, each had a sufficient prospective traffic to guarantee the enterprise as a sound financial success from the beginning. He discussed the route of the United States cable, including data of instances furnished in the Paper. The route included a submarine mountain rising from the floor of the ocean 2,200 fathoms deep to within 80 fathoms of the surface, and a submarine abyss over 4,900 fathoms deep. He pointed out that the longest span was only 2,286 miles, while the French Brest-Cape Cod cable was 3,250 nautical miles. Wake and Midway Islands, though mere atolls a few feet above the sea, were superior in this respect to Fanning Island. Of the eleven cables spanning the North Atlantic, the Anglo-American

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Co.'s cable laid in 1894, and the Commercial Cable Co.'s cable No. 3, laid also in 1894, had, he said, the greatest speeds. The former contained 650lb. of copper and 400lb. of gutta-percha, and the latter 500lb. of copper and 320lb. gutta-percha per nautical mile. Either of these types of cable would give good results, and no cable of less equivalent speed should, he thought, be considered. The following "conservative" estimate was made from the evidence obtainable relative to the establishment of this enterprise by the Government on a sound financial basis :—

Maintenance and Repair per Annum.

Annual expenses of two cable repair ships.....	$200,000
Annual expenses for new cable, assuming entire cable to be replaced in 40 years, or 200 miles per year	200,000
Working expenses	125,000
Reserve fund, and interest on capital.....	400,000
Total net earnings of cable required	$925,000

This provision for laying 200 miles of new cable per year should perpetually maintain the value of the cable as an asset; and the reserve fund further provided that the entire capital should be replaced at the end of 50 years, or what was equivalent, that a sinking fund should be established which at the end of 50 years would suffice to lay an entire new cable in addition to the permanent maintenance of the original one. Taking average conditions for long cables ten years ago, the annual expenses for maintenance and repair—*e.g.*, for new cable required, &c., and not including the fixed expenses such as the repair ships—were, he said, about $80 per nautical mile; but the cost of such work was lower now. Assuming 30 per cent. for "dead" traffic, and an increase of 90 per cent. of speed for duplex working, it was estimated that the maximum capacity of the cable in total paying code words, of eight letters each, would be about 11,800,000 per annum. The cost of maintenance and operation, &c., as above being taken as $925,000 per annum, the average cost of transmission per telegraphic word was about 0·08 cent. The present commercial rate from Washington to Manila was $2·38 per word, Government rate $2·255 per word, and the rate for "right-of-way" messages three times the normal rate. It was pointed out that at the present commercial rate to Manila, after allowing for present land rates to San Francisco, the proposed cable would therefore be required to operate less than 50 minutes per day in order to earn the income of $925,000 per year. Allowing the present rate to be reduced one-half, the cable would have to work less than two hours daily. Finally, if the rate per code word, of an average of eight letters, was placed at 50 cents from San Francisco to Manila, then, upon the above supposition, it would only be necessary for the cable to operate daily less than four hours to meet expenses.

Annealing Armour Plates.—Mr. C. J. Dougherty, electrical superintendent of Cramps' shipyard in Philadelphia, read an interesting Paper on "The Electrical Process of Annealing Armour Plates in the Construction of Warships," before the Engineers' Club in that city, on Dec. 16th last. In order to mount Harveyised plates, properly they must first be locally annealed in the spots where they are to be drilled; and after futile efforts to do this by other means, the electrical method was resorted to, and has proved so successful that it is now used entirely by the Cramps. In principle the apparatus is like the well-known Thomson electric welder, the ends of the secondary coils being held on the surface of the plate at the spot which is to be annealed; the secondary current therefore passes through the surface of that portion of the iron and raises it to a red heat, which draws the temper of the hardened shell. As the chilling action produced by the surrounding iron is great enough to restore the temper if the current is stopped suddenly, the current is reduced very gradually, from 10 to 20 minutes being allowed for this gradual diminution. The apparatus consists of a transformer, the secondary of which is made of a very large copper casting closely surrounding the primary, and both are surrounded by iron; the secondary is slit in one spot, and the two ends terminate in the contact points. The transformer is surrounded with oil, and the terminals are kept cool by a flow of water through them. The ratio of transformation is 100 to 1, the primary current about 100 amperes at 300 volts and the secondary about 10,000 amperes at 2·5 volts to 2·8 volts. The contact surfaces are only about half a square inch, and the current density at those spots is therefore about 40,000 amperes per square inch. The total weight of the transformer is about 1,000 pounds, which, when resting on the plate, is sufficient to make good contact. Directly under these contacts the metal remains hard and cannot be drilled; the space to be drilled lies midway between the two contacts. The alternator, of which there is one for each transformer, is separately excited, and is driven by a continuous-current motor connected to the continuous-current power mains running throughout the yard. These two machines together are transported to where the work is to be done. The annealing current is regulated by varying the exciting current of the alternator, the rheostat for which is placed where the work is to be done; four wires are therefore required from the work to the generator. Two of these sets of annealers have been in use by the Cramps for some time. The plates for the "Alabama" were all annealed in this manner. The Harveyised plates are now being superseded by the Krupp plates, which are hardened to a depth of 2in. instead of only ¾in.; but notwithstanding this greater depth, the electric method of annealing is found to answer very well for these also. The fact that the generating machinery, together with the whole shed which protects it, was transported about the yards to near the work, instead of running mains from a stationary plant, was explained by the statement that it was less trouble to transport this machinery than to run the wires. With the present system each transformer must have its own alternator and exciter, and in this connection the question arose in the discussion why choking coils are not used in the secondary circuit instead, which would require the running of two wires only, and would enable both transformers to be supplied from the same alternator. The reason why this apparently simpler method is not used was not explained.

LEGAL INTELLIGENCE.

Tudgey v. National Telephone Co. (Ltd.).

In the City of London Court, Mr Commissioner Kerr on Tuesday decided a claim made by Mr. E. Tudgey, farmer, Home Farm, Walton-on-Thames, against the National Telephone Co. for £10. Plaintiff's case was that defendants signed a contract agreeing to give plaintiff £10 if he allowed certain telephone poles to be erected on his land. After much negotiation the necessary permission was granted; but the defendants subsequently removed the poles from the ground, because of difficulties experienced in obtaining wayleaves farther along the line. Defendants now declined to pay the agreed sum of £10. The defence was that the company's local manager had no authority to sign the contract, and that as defendant's land was never used, no sum became payable.

Mr. Commissioner KERR found for the plaintiff, with costs.

Mayor, &c., of Cardiff v. S. Z. de Ferranti (Ltd.) and others.

This case came before Mr. Justice Mathew, sitting without a jury, in the Queen's Bench Division, on Thursday.

Mr. A. T. Lawrence, Q.C., and Mr. Leslie appeared for the plaintiffs, and Mr. J. Walton, Q.C., Mr. Laing, Q.C., and Mr. Palloch for the defendants.

Mr. LAWRENCE, in opening the case, stated that this was an action brought by the mayor, burgesses and Corporation of Cardiff against Messrs. S. Z. de Ferranti (Ltd.) and Messrs. F. Ince and S. Z. de Ferranti personally, for damages for non-completion of some electrical plant which the defendants undertook to manufacture and work for the plaintiffs. The Corporation of Cardiff had an electricity supply station, and in the beginning of 1896 they desired to increase and improve the generating plant.

Mr. Justice MATHEW said that if the question to be decided involved any technical details being gone into, he should adjourn the hearing of the case in order to obtain the services of an assessor.

Mr. LAWRENCE said he did not think it would be necessary to go into any technical details at all.

Mr. LAING said that it might be necessary to call experts on an engineering question.

Mr. Justice MATHEW said he should reserve to himself the right of getting the services of an assessor, if necessary.

Mr. LAWRENCE said that in March, 1896, the Corporation invited tenders, and supplied specifications and conditions upon which those tenders were to be submitted. On April 2 Messrs. Ferranti tendered to supply a 300 H.P. steam alternator at £3,250, and on April 16 the Lighting committee of the Council accepted the tender. On June 4 the contract was executed, Messrs. F. Ince and S. Z. de Ferranti being sureties. The contract provided shortly that the contractors should, to

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the satisfaction of the Corporation and the borough engineer, execute and complete the work in the best manner and with the best material, and that the whole of the works, including extras and variations, should be completed and handed over to the borough engineer on Sept. 15, 1898. In default the company agreed to pay to the Corporation the sum of £1 per cent. on the contract price for every week of delay. The work was not completed within the time specified by the contract, and the Corporation claimed the penalties by way of liquidated damages under the contract.

The hearing was adjourned.

In re The Phaeton Electrical Co. (Ltd)

Mr. Justice Wright, sitting as an additional judge of the Chancery Division, on Wednesday made an order under which the voluntary winding-up of this company was directed to be continued under the supervision of the Court.

LIGHT (ELECTRIC) RAILWAY INQUIRIES.

Inquiries have now been held into nearly the whole of the applications lodged in November, 1898, and May, 1899, and below will be found particulars of the manner in which they have been dealt with by the Light Railway Commissioners. In the case of Bath, where there were two schemes (one by a private syndicate and the other by the Bath Corporation), both applications were rejected, the Commissioners holding that the syndicate could not succeed, as the road authorities (the County Council and the Bath Corporation) opposed, and that the Corporation could not succeed because 7 out of the 18 miles of line proposed to be constructed were outside the City area. The Commissioners suggested that the Corporation should formulate a scheme in conjunction with the Bath Rural District Council. There is an increasing tendency on the part of the Commissioners to adopt a settled and more uniform system in connection with light railway schemes. In unopposed schemes procedure under the Light Railways Act is not so expensive and does not involve the delay which Private Bill procedure or an application for a provisional order under the Tramways Act does. Light railway schemes can also be brought forward twice a year. Still, it is probable that, on the expiry of the Light Railway Act in 1901, the law will be amended in certain respects. At present the procedure in relation to appeals from orders of the Commissioners involves considerable delay and uncertainty, and is moreover tedious and expensive. In support of this view, we need only refer to the Leeds and Bradford project, where two rival local authorities succeeded in delaying and mutilating a really useful scheme for inter-urban communication. Aberdare has been refused on the ground that a line wholly lying within the area of a single sanitary authority is not a "light railway."

November, 1898.

District and Promoters.	Result.
Aldershot and Farnborough (Power and Traction, Ltd.)...	Granted
Ayr, Prestwick and Monkton (Drake and Gorham Electric Power and Traction Co.)	Withdrawn
Barnsley and District (British Electric Traction Co.)	Granted in modified form
Camborne, Redruth and District (Camborne, &c., Light Railway Co.)	Refused
*Cheltenham and District (T. Nevins)	Granted in modified form
Colchester (British Electric Traction Co.)...	Refused
Colne and District (Colne Town Council)	Withdrawn
Crystal Palace (Crystal Palace Light Railways and Tramways Co.)	Ditto
Doncaster and District (British Electric Traction Co.) ...	Ditto
Doncaster Corporation (Doncaster Corporation)	Granted
Dudley and District (Extensions) (British Electric Traction Co.)	Ditto
East Anglian (Drake and Gorham Power and Electric Traction Co.)	Granted in modified form
Finchley, Hendon and District (Finchley District Electric Traction Co.)	Refused
Hamilton, Motherwell and Wishaw (Hamilton, &c., Light Railway Co.)	Ditto
Hampstead, Finchley, &c. (Metropolitan Tramways Co.)...	Ditto
Hastings, Bexhill and District (Hastings, &c., Light Railway Co.)	Granted in modified form
Highgate, Finchley and Wood Green (Metropolitan Tramways Co.)	Refused
Hounslow and Twickenham (Drake and Gorham Power and Electric Traction Co.)	
Isle of Thanet (Extensions) (Isle of Thanet Light Railway Co.)	Granted
London United Tramways, Light Railway Extensions (London United Tramways, Ltd.)	Refused
Middlesbrough, &c. (Imperial Tramways Co.)	Adjourned
Middleton (Extension) (British Electric Traction Co.) ...	Refused
Musselburgh (Drake and Gorham Electric Power and Traction Co.)	Ditto
Nelson and District (Nelson Corporation).....	Granted in modified form
Nelson, Colne, &c. (Greenwood and Batley)	Granted in modified form
Rhyl and Prestatyn (Rhyl and Prestatyn Light Railway Co.)	Granted
St. Helens, Leigh & Bolton (Lancashire Light Railway Co.)	Withdrawn
Southend-on-Sea and District (Southend Corporation) ...	Granted
South Staffordshire (British Electric Traction Co.).....	Ditto
Spen Valley (British Electric Traction Co.)	Ditto
Swansea (Swansea Improvements, &c., Co.)	Refused
Waltham Cross (Metropolitan Tramways, &c., Co.)	Granted

* The extension scheme lodged in Nov., 1899, was granted early in Jan., 1900.

May, 1899.

Aston, Erdington and Sutton Coldfield (J. J. Gittings, E. Horton and W. J. Kershaw)	Withdrawn
Barrowford and District (Barrowford Urban District Council)	Granted
*Bath and District (H. T. Ellis, J. W. Davies, J. F. Hosken)	Refused
Blackpool and Garstang (Blackpool and Garstang Light Railway Co.)	Withdrawn
Bromsgrove (J. Booth, G. Brodie, J. Humphreys and others)	Granted
County Middlesex (Middlesex C. C. and Metropolitan Tramways Omnibus Co.)	Not yet held
Darlington (Imperial Tramways Co.)	Granted
Finchley (Finchley Urban District Council)	Not yet held
Finchley, Hendon, Edgware and District (Finchley District Electric Traction Co.)	Refused
Gateshead and District (Gateshead and District Tramways Co.)	Granted
Leicester, Anstey, and Newtown Linford (Railway Developments)	Not yet held
Nelson (Barrowford Branch Extension) (Nelson Corporation)	Granted
Nuneaton and District (Nuneaton and District Light Railway Co.)	Not yet held
Ormskirk and Southport (T. O. Callender, W. Winnard, A. Wright)	Granted
Peterborough and District (British Electric Traction Co.)	Not yet held
Ryde and Sea View (E. I. Bax, G. Ellis, A. R. Davey) ...	Refused
South Staffs. (Extensions) (British Electric Traction Co.)	Granted
Watford and District (J. Fell, S. Hunter, W. J. Kershaw)	Withdrawn
Worcester and District (Worcester Tramways).....	Adjourned
Aberdare (British Electric Traction Co.)	Refused
Rhondda Valley (British Electric Traction Co.)	Postponed

* Corporation application lodged in Nov., 1899, has also been rejected.

TRADE NOTES AND NOTICES.

[Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.]

"THE ELECTRICIAN" TABLE OF ELECTRICITY SUPPLY WORKS OF THE UNITED KINGDOM.

SPECIAL NOTICE.—Alterations and additions for inclusion in "'The Electrician' Electrical Trades' Directory and Handbook" Edition of the above Tables must be sent in by Wednesday, January 24th, at latest.

NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers, or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London:—

READY IN A FEW DAYS.

"The Electrician" Electrical Trades' Directory and Handbook for 1900.—The New Edition of the "Big Blue Book" will be ready shortly.

"Submarine Cable-Laying and Repairing."—By H. D. Wilkinson M.I.E.E., &c., fully illustrated; price 12s. 6d. This work gives a detailed technical summary of modern practice in manufacturing, laying, testing, and repairing submarine telegraph cables.

"Practical Notes for Electrical Students."—By Messrs. A. E. Kennelly and H. D. Wilkinson. Price 6s. 6d., post free. The authors give in a clear and concise manner a good summary of the general principles of electrical science.

"Magnetic Induction in Iron and other Metals."—By Prof. J. A. Ewing. Price 10s. 6d., post free. *New Edition nearly ready.*

"The Incandescent Lamp and its Manufacture."—By Gilbert S. Ram. Price 7s. 6d., post free. The principles underlying the manufacture of the incandescent lamp are carefully and fully dealt with in this volume.

"The Steam Engine Indicator and Indicator Diagrams."—Edited and enlarged by W. Worby Beaumont. Price 3s. 6d., post free. This work is a concise guide to the objects, construction, and use of the steam engine indicator and to the interpretation of indicator diagrams.

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"THE ART OF ELECTROLYTIC SEPARATION OF METALS."—A second issue of Dr. Gore's book is now ready, price 10s. 6d., post free. The author treats fully both the theoretical principles of the art of electrolytic separation of metals and the practical rules and details of technical application on a commercial scale. The work is adapted to the use of the manufacturer as well as the student.

"THE MANUFACTURE OF ELECTRIC LIGHT CARBONS."—A Practical Guide to the establishment of a Carbon Manufactory. Fully illustrated, price 1s 6d.; post free, 1s. 9d. In this work the author gives useful hints as to the manufacture of electric light carbons, including the preparation of material, firing, saturating, and coring, together with a description and estimate of cost of the plant required.

"THE CENTENARY OF THE ELECTRIC CURRENT, 1799-1899."—By Dr. J. A. Fleming. Price, paper covers, 1s. net, post free 1s. 3d.; strong cloth, 2s. 6d., post free.

"LOCALISATION OF FAULTS IN ELECTRIC LIGHT MAINS."—By F. C. Raphael. Price 5s., post free. The book deals with the important subject of localising faults in electric light and power cables; and the various methods of insulation testing are here collected and discussed.

"MOTIVE POWER AND GEARING FOR ELECTRICAL MACHINERY."—By E. Tremlett Carter, C.E., M.I.E.E. Price 12s. 6d., post free. In this comprehensive work an account is given of the scientific principles and modern practice in the use of engines for dynamo driving, not only for isolated power plants, but also for public electric lighting and power stations. The various forms of gearing in the power station and for electric motors are also dealt with; and the book contains, in addition, numerous tables giving exact data of the equipment and working of electric power stations.

"THE MANUFACTURE OF CARBONS FOR ALL ELECTRICAL PURPOSES."—by Francis Jehl. 10s. 6d., post free. This is a practical handbook, giving a complete description of the art of making carbons for electric lighting, electrodes, &c., with particulars of the various gas generators and furnaces used in carbonising. The work also contains particulars of the cost, &c. of erecting and working carbon works, and plans of a model factory.

"DRUM ARMATURES AND COMMUTATORS," by Mr. F. Marten Weymouth, also ready. Price 7s. 6d., post free. Prospectus on application. This is a complete treatise on the theory and construction of drum winding, and of commutators for closed coil-armatures, together with a *résumé* of the principal points involved in their design, and an exposition of armature reactions and sparking.

"WIRELESS TELEGRAPHY: SIGNALLING ACROSS SPACE WITHOUT WIRES BY ELECTRIC WAVES." A Review of the Work of Hertz and his Successors.—By Dr. O. J. Lodge, with a large number of illustrations. New and Enlarged Edition, 5s. nett. *Now ready.*

"ELECTROMAGNETIC THEORY."—By Oliver Heaviside. *Vol. I.*, 12s. 6d. *Vol. II.*, 12s. 6d.

"ELECTRIC MOTIVE POWER," by Albion T. Snell, contains the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. Price 10s. 6d., post free; abroad, 11s.

"ELECTRICAL TESTING FOR TELEGRAPH ENGINEERS."—By J. Elton Young, M.I.E.E. The scope of the book aims at furnishing a fuller treatment of the subject, from the standpoint of the Telegraph Engineer, than it has hitherto received, whilst it endeavours to facilitate a thorough comprehension of the theory of testing as applied to electrical lines in general. Demy 8vo, fully illustrated. 10s. 6d., post free.

"ELECTRO-CHEMISTRY."—By Dr. G. Gore. Third Edition Price 2r., post free.

"THE POTENTIOMETER AND ITS ADJUNCTS": A Universal System of Electrical Measurement.—By W. C. Fisher. Fully illustrated. Price 6s., post free.

"THE STUDENTS' GUIDE TO SUBMARINE CABLE TESTING."—A new edition of this book, by Messrs. H. K. C. Fisher and J. C. H. Darby, is now ready, price 6s. net; abroad, 6s. 3d. This work is intended to serve as a guide to operators already in the telegraph service, and to those who desire to enter that service. The great cable companies now insist that their operators and probationers shall pass certain examinations in electrical subjects. The book is very fully illustrated.

"BIBLIOGRAPHY OF X-RAY LITERATURE AND RESEARCH."—A valuable compilation. Being an attempt to classify the data relating to X-Ray work. This work contains a quantity of general as well as special information bearing upon the whole subject of electrical discharge research. Edited by C. E. S. Phillips. Price 5s., post free.

"ARMATURE WINDINGS OF ELECTRIC MACHINES."—By H. F. Parshall and H. M. Hobart. This work has been compiled from notes made by Mr. Parshall in his capacity as Chief Designing Engineer of the Edison and General Electric Companies of America, and is intended to serve as a working treatise on dynamo design. Large 4to, 370 pages 140 full-page illustrations and 65 full-page tables, 30s., post free.

IN THE PRESS.

"THE ELECTRIC ARC."—By Mrs. Ayrton.

"SECONDARY BATTERIES, THEIR DESIGN AND MANUFACTURE."—By E. J. Wade.

"PRIMARY BATTERIES: THEIR CONSTRUCTION AND USE."—By W. R. Cooper. *Nearly ready.*

"PRACTICAL TELEPHONY."—By Dane Sinclair and F. C. Raphael.

"'THE ELECTRICIAN' WIREMAN'S POCKET-BOOK."—Edited by F. C. Raphael. *Nearly ready.*

TENDERS INVITED.

The *Postmaster-General* invites tenders for the work of laying underground conduits and pipes for telephone purposes in several parts of the Metropolis. An advertisement contains further particulars, and forms of tender can be obtained from the Controller of Stores (Mr. Chas. E. Stuart), General Post Office, London, E.C. Tenders will be received until noon of Monday, Feb. 15.

The *Keighley* Corporation invite tenders for the supply of two Lancashire boilers, with mechanical stokers, economisers, feed pumps, &c., and a 120-kw. and 200-kw. high-speed direct-coupled steam dynamos for continuous current. Copies of specification, &c., may be obtained from the borough electrical engineer (Mr. J. M. Smyth), Bridge-street, Keighley. An advertisement contains further particulars, and tenders, addressed to the chairman of the Electricity committee, must be delivered not later than Saturday, Feb. 3.

The *West Ham* Guardians invite tenders for the supply and erection of plant for the electric lighting of the workhouse and school premises at Union-road, Leytonstone, and for the erection of an engine and battery house. An advertisement contains further particulars, and plans and specifications may be inspected at the clerk's office, where forms of tender, &c., can also be obtained. Tenders to the clerk (Mr. Fred. E. Hilleary) by 4 p.m. of Feb. 7.

The *Sunderland* Corporation invite tenders for the supply of a tramway switchboard. Specifications, &c., can be obtained from the borough electrical engineer (Mr. John F. C. Snell), Dunning-street. An advertisement contains further particulars, and tenders (addressed to chairman, Lighting committee) must be delivered at the office of the town clerk (Mr. Fras. M. Bowey) by noon of 26th inst.

The *Belfast* Electric committee invite tenders for the supply and erection of 400 kw. steam dynamos. Specifications and conditions of contract may be obtained on application to Mr. Victor A. H. McCowen, city electrical engineer, and tenders must be lodged at the office of the town clerk (Sir Samuel Black) by noon of Thursday, Feb. 8. An advertisement contains further particulars.

The Corporation of *Great Yarmouth* invite tenders for the supply and erection of two water-tube boilers and three 200 kw. continuous-current steam dynamos. Copies of specification and all further information can be obtained from Messrs. Preece and Cardew, 13, Queen Anne's-gate, Westminster, S.W. Sealed tenders have to be delivered at the Town Hall, Great Yarmouth, by 10 a.m. of Thursday, Feb. 15.

The *Tunbridge Wells* Corporation invite tenders for two Lancashire boilers. Specifications may be obtained from the borough electrical engineer (Mr. Horace Boot), and tenders must be sent in to the town clerk (Mr. W. C. Cripps) by Feb. 5. An advertisement gives further particulars.

The *Tunbridge Wells* Corporation also invite tenders for a 400 kw. steam alternator. Tenders to Mr. W. C. Cripps by 25th inst.

As announced in an advertsement, the *Glasgow* Corporation require tenders for the supply and erection of two overhead electric travelling cranes for the Tramways Department. Specifications, &c., may be obtained from the general manager (Mr. John Young), 83, Renfield street, and tenders must be lodged with the town clerk (Sir J. D. Marwick) not later than 6 p.m. on Feb. 5.

The *Tynemouth* Corporation invite tenders for the supply and delivery of electricity meters. Copies of specification may be obtained at the offices of the consulting engineers (Messrs. Lacey, Clirehugh and Sillar), 2, Queen Anne's-gate, London, S.W., and 78, King-street, Manchester. Tenders must be delivered to the town clerk (Mr. Horatio Adamson), Town Hall, North Shields, by 31st inst. An advertisement contains further particulars.

The *Leyton* Electric Lighting committee invite tenders for the supply and erection of a switchboard. An advertisement contains further particulars, and tenders must be sent to the engineer and manager (Mr. F. Harman Lewis) by Feb. 14.

The *Stoke-upon-Trent* Guardians invite tenders for the electric lighting of a portion of the workhouse premises. Specifications, &c., can be obtained from the consulting engineer (Mr. G. R. Peers,) 96, Deansgate, Manchester, and tenders must be sent in to the clerk to the Guardians, (Mr. C. Daniel), Union offices, Stoke-upon-Trent, not later than 9 p.m. of Tuesday, Feb. 13. An advertisement gives further particulars.

Tenders are invited for the wiring and electrical fittings for the Stockport Infirmary. Further particulars are set out in an advertisement, and tenders, addressed to the chairman of the Board, must be in by Saturday, 27th inst. All further information can be obtained from Mr. S. Meunier, gas and electricity offices, Stockport.

The *Bradford* Tramways committee invite tenders for the electrical equipment of about eight miles of tramway on the overhead trolley system. Tenders to town clerk by Feb. 3.

The *Plymouth* Corporation invite tenders for the supply and erection of a 500 kw. high-speed steam dynamo, motor-generators, &c., 500 kw. high-speed steam alternator, 260 accumulator cells, four Lancashire boilers, and high and low-pressure, paper-insulated and lead-covered mains, &c. Tenders to the town clerk (Mr. J. H. Ellis) by 31st inst.

The *Hull* Electric Lighting committee require tenders for the supply and erection of 30 cast-iron street section pillars, each containing eight switch fuses, &c. Tenders to the chairman of the committee, Town Hall, Hull, by noon of 25th inst. Samples of designs

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must be delivered to the city electrical engineer (Mr. A. S. Barnard), Dagger-lane, Hull, by 24th inst.

The *Portsmouth* Corporation invite tenders for 12 months' supply of stores for their electricity department. Tenders by Feb. 10 to superintendent, electric light station, Gunwharf-road, Portsmouth.

The *Glasgow* Corporation invite tenders for an electric or hydraulic lift for the new Art Galleries. Tenders to the town clerk (Sir J. D. Marwick), City Hall, Glasgow, by 29th inst.

The *Glasgow* Corporation also invite tenders for supplying and erecting electric motors and shafting for laundry machinery, mechanical stokers, elevator and conveyor at the Ruchill Fever Hospital. Tenders to the clerk, Police Department, by 31st inst.

The *Barking* District Council invite tenders for the supply of two continuous-current transformers and switchgear, underground cables and roadwork, for their Creeksmouth extension. Tenders before noon, Jan. 23.

The *Newcastle-upon-Tyne* Corporation invite tenders for the construction of about 11 miles of double track tramway — rails, fastenings and poles being supplied by the Corporation. Tenders by noon Jan. 24.

The *Westminster Electric Supply Corporation* require tenders for four dry back marine boilers. Tenders to secretary, Eccleston-place, London, S.W., by 23rd inst.

The *Aberdeen* Electric Lighting committee invite tenders for the supply of a 420 kw. direct-coupled continuous-current dynamo. Tenders by 22nd inst.

The municipal authorities of *Astudillo* (Palencia), Spain, invite tenders, until the 26th inst., for the concession for the electric lighting of the town for 20 years. Particulars from and tenders to El Secretario del Ayuntamiento.

Tenders are being invited, until the 27th inst., by the municipal authorities of *Porcuna* (Jaen), Spain, for the concession for the electric lighting for 20 years. Tenders to El Secretario del Ayuntamiento.

The municipal authorities of *Frosinone* (Roma) invite tenders, until the 20th inst., for the concession for public and private electric lighting for 40 years. Particulars from and tenders to La Segreteria Comunale di Frosinone (Roma).

TENDERS RECEIVED AND ACCEPTED.

At their last meeting the Gloucester City Council had under consideration the report of their consulting engineer (Mr. Robert Hammond), on the tenders received for the plant required for the extensions to the municipal electricity works, and in accordance with his recommendations the contracts were allotted as follows:—

Section A.—Boiler House Plant.

Tinkers (Ltd.) (*accepted*)	£955	0	0
E. Danks and Co.	940	0	0
R. Taylor and Sons	950	0	0
E. Chester and Co.	959	0	0
Dutilh-Smith, McMillan and Co.	959	10	0
Yates and Thom	1,010	0	0
Tetlow Bros.	1,040	0	0
C. K. Stothert and Co.	1,256	0	0

Section B.—Engine House Plant.

Mather and Platt (*accepted*) (Willans)	£3,988	0	0
Dutilh-Smith, McMillan and Co. (Paxman engine)	3,140	0	0
Ernest Scott and Mountain (own)	3,750	0	0
Ashton, Frost and Co. (Willans)	3,985	0	0
Mather and Platt (Belliss)	4,434	0	0
Easton, Anderson and Goolden (own)	4,028	0	0
Indiarubber Co. (Willans)	4,110	0	0
Indiarubber Co. (Belliss)	4,250	0	0
Johnson and Phillips (Willans)	4,130	0	0
Crompton and Co. (Willans)	4,353	0	0
Crompton and Co. (Belliss)	4,740	0	0
Electric Construction Co. (Willans)	4,508	0	0
Electric Construction Co. (Belliss)	4,752	0	0
E. Chester and Co. (own)	4,912	0	0
Brush Co. (Bellis)	5,002	0	0

Section C.—Switchboard Extension.

Crompton and Co. (*accepted*)	£251	0	0
Electrical Transmission Co.	210	0	0
Electric Construction Co.	270	0	0
Edwards Electrical Co.	280	0	0

Section D.—Condensing Plant.

E. Chester and Co. (*accepted*)	£493	0	0
Klein Engineering Co.	536	0	0
Dutilh-Smith, McMillan and Co.	538	0	0
Blake and Knowles Steam Pump Works	552	0	0
Ashton, Frost and Co.	590	0	0
Worthington Pumping Engine Co.	618	0	0
Mirrlees, Watson and Yaryan Co.	660	0	0
Middleton Engineering Co.	759	1	7

The Battersea (London) Vestry have authorised the Callender Co. to provide stoneware casings, so as to form spare ways for future feeders, at an estimated cost of £1,500. The tender of Messrs. J. and A. Law has been accepted for the supply of arc lamp-posts, at £3,126.

The Bermondsey (London) Vestry have received seven tenders for the supply and erection of a refuse destructor in conjunction with the projected electric lighting station. The tenders, a list of which is appended, have been referred to the Electric Lighting committee for consideration:—

		Alternative tender.
Horsfall Destructor Co.	£11,952	£11,116
Manlove, Alliott and Co.	11,300	10,444
Hughes and Stirling	10,242	9,562
Baker and Sons	8,199	7 399
Heenan and Froude	7,400	7,000
S. Willoughby	6,250	5,850
W. F. Mason (Ltd.)	6,123	5,914

The following firms have tendered for the supply of accumulators to the Hackney Vestry in connection with their electric lighting scheme. The tenders have been referred to the Electric Lighting committee for consideration and report: Electrical Power Storage Co., Chloride Electrical Storage Syndicate, Hart Accumulator Co., D.P. Battery Co., and the Tudor Accumulator Co.

Three offers have been received for the leasing of the Greenock tramway lines, viz.: The Greenock and Port Glasgow Tramways Co., the Drake and Gorham Electric Power and Traction Co., and Mr. W. M. Murphy. The tenders are being considered by the Law and Finance committee.

The Metropolitan Asylums Board have accepted the tender of Messrs. Siemens Bros. and Co. for electricity meters, at £30, and that of Messrs. Hayward, Tyler and Co., for wall-plug covers, at £10. 18s. 10d.

The tender of Mr. T. L. Hellyar has been accepted by the Hammersmith Vestry for the electric lighting of the Ravenscourt Park public library at £125. Seven tenders, ranging from the amount of the accepted to £199. 18s, were submitted.

The tender of Messrs. G. H. Woods and Co. has been accepted by the Salford School Board for the electric lighting of the new school in Grecian-street North, Lower Broughton, at £792. 10s.

APPOINTMENTS VACANT AND FILLED.

The directors of the London Electric Supply Corporation invite applications for the position of superintendent engineer at their Deptford station, commencing salary £600 per annum. Applications should be addressed to the managing director, 25A, Cockspur-street, London, S.W. See advertisement.

The Brush Electrical Engineering Co. require a superintending engineer to superintend, from their London head office, the execution of the company's lighting, power and traction contracts. An advertisement contains further particulars, and applications must be sent to the company, 49, Queen Victoria-street, London, E.C., by 22nd inst.

A first-class electrical engineer is required for the Glasgow Corporation tramways. Particulars are set out in an advertisement elsewhere, and applications must be addressed to the manager of the tramways department (Mr. John Young), 88, Renfield street, Glasgow, or or before Feb. 24.

The Bedford Corporation require an assistant electrical engineer. Applications to the chief engineer (Mr. Wm. J. Hope-Johnstone) by 29th inst. Further particulars are given in an advertisement.

A telegraph foreman is required for the telegraph department of the Gold Coast (West Coast of Africa), at a commencing salary of £250 per annum. Applications to Crown Agent for the Colonies, Downing-street, London, S.W., by 22nd inst.

A firm in the North require a works foreman capable of superintending and organising the manufacture of all kinds of switch and transformer work. See advertisement.

An electrical fitter is required for the Southampton electric tramway department. Applications to borough electrical engineer (Mr. F. H. Chaplin). See advertisement.

An assistant electrical engineer is required for the Lancs. County Asylum Whittingham, Preston. Applications to the medical superintendent. See advertisement.

The Staffordshire County Council require a science master (chemistry and physics) for the County Technical Schools, Stafford. Salary £200 per annum. Applications by Feb. 2 to the Director of Technical Instruction, county offices, Stafford.

An electrical engineer is required for the Hertford County Lunatic Asylum, St. Albans. Further particulars are given in an advertisement, and applications must be sent to Prof. W. E. Ayrton, F.R.S., 41, Kensington Park-gardens, London, W.

Mr. W. Gannon, M.A., late science inspector of the Staffordshire County Council, has been appointed principal of the Norwich Technical School.

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BUSINESS NOTICES.

Mr. W. M. Mordey, of 82, Victoria-street, Westminster, London, S.W., has taken into partnership Mr. R. A. Dawbarn, who joined the Brush Co., more than a decade ago, and has for some time held the position of superintending engineer, with control of the company's traction and central station departments. Both members of the firm are well known to readers of *The Electrician*, and it may be said that few engineers have had a longer or more practical experience in the designing, laying out, estimating, and carrying out of lighting, power, and traction undertakings of all kinds. Mr. Dawbarn, as long ago as 1893, secured the premium offered by the Corporation of Winchester for the best scheme for electric lighting, and in 1895 a similar premium was secured by Mr. Dawbarn when offered by the Battersea (London) Vestry. The new firm starts under the brightest auspices.

Messrs. Nalder Bros. and Thompson (Ltd.) write as follows regarding the notice which appeared in our issue of Jan. 5 (p. 377):—

TO THE EDITOR OF THE ELECTRICIAN.

Referring to the notice made in a recent issue of your journal of the voluntary liquidation of Messrs. Nalder Bros. and Co. (Ltd.), late of Red Lion-street, we should be glad if you would note that this in no way affects ourselves. As is generally known, we purchased in 1896 the goodwill, plant, &c., of the ammeter, voltmeter, and switchboard business carried on by that firm, and that we are the sole makers of the N.C.S. measuring instruments and switches specified above. We regret to have to ask you to publish this letter, but we are compelled to do so owing to the fact that we have had inquiries made of us as to whether the voluntary liquidation of Nalder Bros. and Co. (Ltd.) would affect the contracts which we have in hand. We may say that while our relations with the above firm have always been of the most friendly character, there is absolutely no connection between us, and we shall be glad if you will kindly publish this fact.

Mr. E. R. Dolby, consulting engineer, has taken into partnership Mr. Percy M. Williamson. In future the style of the firm will be Dolby and Williamson.

We are informed that Mr. J. Hardie McLean has severed his connection with Messrs. W. Lucy and Co. (Ltd.).

Mr. Edward Lomer, 12, St. Mary-axe, London, E.C., has been appointed agent in this country of the Accumulatorenfabrik Actien-Gesellschaft, of Berlin and Hagen (Westphalia), Germany, for the sale of accumulators and accessories.

The Private Wire and Telephone Installation Co. notify their removal to larger and more convenient premises at 5, Palmer street, Westminster, S.W. The company was established five years ago at 110, Cannon-street, E.C., and the new move has been taken in consequence of the steady increase of the company's trade.

Mr. A. Lester Taylor, of Liverpool, having relinquished his private consulting business in order to devote his whole time to the fire offices who retain his services, Mr. A. Kelly, late managing assistant to Mr. Lester Taylor, has acquired the business. Mr. Kelly was also for four years electrical engineer on the staff of Messrs. Laird Bros., of Birkenhead.

Messrs. Rouch, Lambert and Penny, who have been for many years with Messrs. King, Mendham and Co., and Mendham and Co., of Bristol, have started business at 6, St. Stephen's-street, Bristol, as electrical engineers, contractors, and manufacturers.

The Shillingford Works Co. announce that they have amalgamated their business with that of the Trusty Engineering Works (Ltd.), Cheltenham. The name of the company will be the Shillingford Engineering Co. (Ltd.), Trusty Engine Works, Cheltenham.

The Manchester Electric Co. have removed to 6, Todd-street, Corporation-street, Manchester.

Messrs. F. L. Perken, E. T. Perken and Arthur Rayment (trading as Perken, Son and Rayment), scientific instrument makers, &c., 99, Hatton-garden, London, E.C., have dissolved partnership. Debts by Messrs. F. L. and E. T. Perken, who continue under the style of Perken, Son and Co. Mr. Arthur Rayment will trade on his own account.

BANKRUPTCIES, LIQUIDATIONS, &c.

At the Newcastle Bankruptcy Court on Thursday last William Dalzell, electrical engineer, Newcastle-on-Tyne, came up for examination. In reply to the official receiver, debtor stated that he started business in June, 1897, with £850 capital. He carried out various contracts, but the net effect had been to convert him from a capitalist to the moderate extent of £850 (exclusive of £200 borrowed) into a bankrupt with £300 to £400 of liabilities. The examination was adjourned till Jan. 25. The creditors include: A. C. Hands, £21; Clarke, Chapman and Co., £21; Beanland, Perkin and Co., £34; E. Scott and Mountain, £15; J. and R. Dick, £10; Edison and Swan Co., £60; W. T. Glover and Co. (Ltd.), £32; Gent and Co., £14; Crossley Bros., £83; J. Hunt and Co., £16.

Claims against the London Provincial Electrical Co. (Ltd.) 110, Cannon-street, London, E.C., must be in by 22nd inst. Mr. H. De Vaux Brougham, 33, Carey-street, London, W.C., is liquidator.

It has been decided to wind up voluntarily the New Electricity Supply Syndicate (Ltd.), and to appoint Mr. F. King, 39, Victoria-street, London, S.W., liquidator.

A meeting of the Protean Battery Syndicate, Ltd., will be held at the office of Mr. Chas. Watkins, 15, Basinghall-street, London, E.C., on Feb. 21, to receive an account of the winding-up. Mr. J. Bidden is liquidator.

A first and final dividend of 2s. 9d. will be payable on 25th inst., at Messrs. Locking and Scott's, Bowlalley-lane, Hull, in the bankruptcy of C. H. Kitching, electrical engineer, &c., 20, St. Hilda-street, 172, Beverley-road, and 42, Chariot-street, Hull.

Claims against Thos. Ford (trading as Thos. Ford and Co.), electric fittings manufacturer, Victoria Works, Emily-street, Highgate Birmingham, must be in by 31st inst. Mr. L. J. Sharp, 174, Corporation-street, Birmingham, is trustee.

F. B. de Foe Paynter, electrical engineer, 2, Faversham-road, Catford, has been adjudicated bankrupt.

Plant Sale.—Messrs. Wheatley Kirk, Price and Co. will sell by auction, at an early date, the entire contents of the works of Lloyd and Davis, 62 and 64, Sumner-street, Southwark, London, S.E., comprising the motive power and gearing, fixed and loose engineering plant, loose tools and utensils, stores, &c. Further particulars are given in an advertisement. Admission by catalogue only, which can be obtained gratis, together with any further particulars, from Mr. Alfred Hammond, solicitor, 25, Bedford-row, W.C.; and of the auctioneers, 49, Queen Victoria-street, London, E.C., and Albert-square, Manchester.

The Carlisle Corporation have for disposal a complete set of electric lighting plant. Some information is given in an advertisement, and all further particulars can be obtained from the city electrical engineer, electricity supply station, Carlisle.

Apparatus for the Front.—Messrs. Julius Sax and Co. (Ltd.) inform us that they have made an offer to the Imperial Yeomanry Hospital Corps which has been accepted. The hospital camp will consist of from 50 to 60 tents, each containing 10 beds, all to be intercommunicating, with bells and indicators in a special mess tent. Messrs. Sax and Co. will present to the Hospital Corps a complete outfit of pushes for each tent, with bells and indicators to correspond. A special indicator is being put on an extended back board, carrying dry cells in a separate watertight compartment, this rendering the outfit very portable. The indicators consist of the firm's registered electrical replacement movements, and will have an enamelled zinc as well as a glass front, the latter being made to slide in from one side, to ensure easy replacement in case of breakage. A watertight bell is placed in the top centre of the board. One of the firm's electricians has volunteered to go out with the Yeomanry Corps to superintend the fixing, &c., of the bell system, his place at the works being kept open.

Westinghouse Works in Russia.—It is stated that, suitable concessions having been made by the Russian Government, arrangements are in progress for establishing a branch of the Westinghouse Electric and Manufacturing Co. near St. Petersburg.

Ediswan Leaflets.—Two leaflets issued by the Edison and Swan Co. describe a useful advertising device for shop window use. Two bichromate cells fitted in a wooden box drive a small motor with worm gear, which revolves a stand fitted with shelves containing articles for sale and likely to attract the attention of the passers-by. Seeing the attraction which moving objects usually afford, these stand outfits will doubtless have considerable vogue. The "Rapid" detector set is also shown, the complete outfit measuring about 4in. by 2½in. The indicating galvanometer is fitted on the top of the case between the terminals, and the weight being only about 8oz., this set possesses many advantages. The "Belgrave" telephone, for use in private houses, hotels, offices, &c., is also illustrated in two styles.

Calendar.—A useful large-figure hanging pad calendar is issued by the Commercial Cable Co., which, in addition to its usefulness as a calendar, gives a quantity of information of use to commercial houses relating to cablegrams. Included in the information are some rules for counting messages in code and in plain language.

Instrument Catalogue.—A neatly arranged catalogue of electrical testing instruments and physical apparatus, manufactured by Mr. R. W. Paul, of 44, Hatton Garden, London, E.C., is just ready, and can be obtained on application. Over 80 illustrations are given of a large variety of instruments, many of which have been before the public for several years and have become regular stock instruments, while others are of new or improved type. Mr. Paul is himself the manufacturer of these instruments, which are made in London at his factory on Great Saffron-hill.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Jan. 10 to Jan. 16, with the ports of destination:—

Africa—Cape Town, £886 (including £108 telegraph material); Chinde, £3,322 (telegraph material); Durban, £300 (including £232 telegraph material); East London, £125; Port Elizabeth, £485 (including £231 telegraph material). *Australasia*—Auckland, £30; Christchurch, £45; Melbourne, £326 (including £306 telegraph material); Napier, £29;

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Sydney, £1,421. *Belgium*—Ostend, £29. *Canada*—Halifax, £80; Montreal, £88. *Ceylon*—Colombo, £523. *China*—Shanghai, £630. *Denmark*—Copenhagen, £105. *Holland*—Amsterdam, £55; Flushing, £96 (telegraph material). *Hong Kong*, £31. *India*—Bombay, £144; Calcutta, £1,140 (including £156 telegraph material). *Japan*—Yokohama, £781. *Mauritius*, £352. *Norway*—Christiania, £1,067 (including £117 telegraph material). *Russia*—St. Petersburg, £1,443 (telegraph material). *Siam*—Bangkok, £93. *Spain*—Barcelona, £70; Malaga, £100. *Straits Settlements*—Singapore, £52. *Sweden*—Gothenberg, £57; Stockholm, £128 (including £90 telegraph material). Total £14,032, against £7,101 in the corresponding week last year (Jan. 12 to Jan. 18).

MUNICIPAL, FOREIGN, AND GENERAL NOTES.

Alleged Embezzlement.—At Greenwich, Arthur William Longman was charged with stealing £200 by falsifying the accounts of his employers, Messrs. Elliott Bros, Century Works, Lewisham. It was alleged that the wages book, which prisoner kept, had been falsified. Mr. O. Smith estimated that the amount misappropriated was nearly £500. The prisoner had to deal with about £400 per week, and there was no check upon the items in the wages book. Committed for trial.

Alfreton.—The District Council recently issued circulars to ratepayers in order to ascertain their views on the electric lighting question. 751 papers were distributed, 181 voted in favour of electricity, 106 voted but did not promise to use it, 56 voted against it, 28 signed but did not answer the questions, and 380 papers were returned blank. There is evidently an opening for electricity works in the district, and many stations have been started with fewer promises of support. The matter will be fully considered at next Council meeting.

Barnsley.—The electricity supply works are approaching completion, and it was announced at Tuesday's Council meeting that a supply of current would probably be available in a week or ten days.

Battersea (London).—The Vestry have approved the rules (prepared by Prof. Kennedy) to be observed by contractors in the wiring of local premises in connection with the supply of continuous current at a pressure of 230 volts on the three-wire system. The following conditions are laid down in the rules:—

All conductors must be protected either by incombustible tubes or by hardened casing. If tubes are used, no elbows may be employed, but corners must be turned either by bends or by the use of a suitable box. Details of all such arrangements should be submitted to the engineer for his approval before they are carried out, in order that there may be no difficulty in approving the installation afterwards. Where wood casing is employed the conductors must be separated by a continuous fillet of wood, which must not be less than ⅜in. wide, except with the very smallest branches, and must be increased up to 1½in. wide for main conductors. The capping must in all cases be secured by screws and not by nails, and the screws must be fixed in the outer edges of the casing, unless the middle fillet is at least 1½in. wide.

If conductors have to be carried along damp walls they must either be run in iron or metal pipes, or if in wood casing they must be lead covered, and the casing itself blocked out from the wall at least ⅜in. In the latter case, and wherever wood casing is to be embedded in plaster, it must be covered inside and outside with at least two coats of waterproof varnish. On no account must staples be used to fasten a conductor to any wall or ceiling.

Wherever conductors are connected to switches, fuses, or other appliances, great care should be taken that the whole of the wires forming the conductor are nearly twisted and clamped into the terminal, so that no loose wire or strand can project. The insulating material should only be bared back sufficiently to allow of the conductor entering into the terminals properly, and the ends of the insulation should be thoroughly sealed to prevent creeping of moisture. The braiding, lead, or other non or semi-insulating material should be cut back for a sufficient distance from the end of the insulating material.

Bolton.—There are at present 712 customers, representing an equivalent of 55,113 8 c.p. lamps connected, against 477 customers and 38,958 lamps last year. The borough electrical engineer has been requested to report upon the electrical equipment of the Farnworth tramways.

Bradford.—The Corporation received 40 applications for the position of borough electrical engineer, in succession to Mr. A. H. Gibbings. This list has been reduced to 10, and the final selection will be made in a few days.

Bristol.—The Sanitary committee have been asked to make an experiment in street lighting by incandescent electric lamps, and the Electrical committee is to report upon the proposal.

Cardiff.—The Tramways committee have decided to send a deputation to Glasgow, Liverpool, Hull and Bradford in order to inspect the electric tramways in those towns. The Electric Lighting committee have requested the engineer and manager of the electricity works (Mr. N. Appelbee) to prepare a full and exhaustive report upon the present conditions of the electricity undertaking and the public lighting.

Edinburgh.—The Town Council have decided, on the recommendation of the Electric Light committee, to increase the salary of the resident electrical engineer (Mr. Frank A. Newington) from £600 to £750 per annum. We are glad to notice that the recommendation has been adopted by a practically unanimous vote.

Exports from the United Kingdom to French Colonies.—For the year 1898 telegraphic wire and apparatus to the value of £12,413 was exported to French colonies from the United Kingdom, against £24 in 1897.

Felling.—A petition is to be lodged against the Tyneside electric power bill, which is being promoted by the Durham Electric Supply Co. Steps for obtaining a provisional order are to be taken by the Council.

Glasgow.—At the meeting of the Glasgow Corporation yesterday (Thursday) it was resolved to proceed with the further extension of feeders and mains for the electric lighting of the city, at an estimated cost of £56,520. The projected work includes the laying of pipes from the central lines to the outskirts of the city on both sides of the river Clyde.

Havana.—The Havana Electric Railway Co. has been formed in New York, for the purpose of acquiring and consolidating the various street railway interests in Havana. Amongst those interested in the deal are the International Bank, of Paris, Col. G. B. M. Harvey, and Mr. F. S. Pearson, the well-known tramway engineer of New York.

Hebburn.—Applications have been made to the Board of Trade by three companies for provisional electric lighting orders, but all are to be opposed by the District Council, who themselves intend to apply for orders.

Leeds.—Owing to the increasing demand for electric current the City Council are to be recommended at their next meeting to sanction considerable additions to the generating plant at the electric lighting station, Whitehall-road. There are 50,000 more electric lights connected than at the corresponding period last year, and it is calculated that by the beginning of 1901, should the present rate of increase continue, the capacity of the existing plant will be exhausted. The committee propose to demolish the Britannia Mills premises adjoining the generating station, in order to erect thereon new buildings. The new plant will be of the two-phase type.

Leith.—The Town Council recently applied to the Secretary of State for Scotland for sanction to a loan of £10,000 for electric lighting purposes, and in reply the Scottish office has requested the Council to submit details as to how it is proposed to apply the £10,000, an estimate of the probable revenue of the electricity undertaking and of the expenditure (exclusive of all debt charges) for the current year, and a copy of the burgh accounts for 1898-99.

Light Railways.—An inquiry was held at Cheltenham on Friday into the application of Mr. Thomas Nevins for an order to extend the light (electric) railway authorised in June last. The extension, which will run from Pittville-circus to the Midland station (a distance of about 2¾ miles), was sanctioned.

An inquiry was held at Worcester on Wednesday into the application of the Worcester Tramways Co. to construct light (electric) railways in the city and outlying districts. The gauge proposed to be adopted is 3ft. 6in., and the lines will be worked on the overhead trolley system. The scheme was supported by the Kempsey Parish and the Upton Rural Councils, while the Worcester Corporation opposed. The town clerk urged that difficulties must arise as a consequence of running both trams and light railways, and that the city authorities desired to have a complete scheme either of tramways or light railways over the whole city. They had no desire to block any proposal to improve travelling facilities in the city, but they objected to a piecemeal scheme. Lord Jersey suggested that, rather than give a decision adverse to the promoters, an adjournment should be taken to allow the promoters and the Corporation to continue their negotiations, with a view, if possible, to an amicable settlement, and the inquiry was accordingly adjourned.

Limerick.—The Council have had under consideration a report from Mr. J. Enright in regard to the erection of electricity supply works. It has been decided to ask Mr. Enright to prepare plans and specifications of a scheme entailing an expenditure of about £19,000.

Marylebone (London).—A deputation of ratepayers waited upon the President of the Board of Trade on Wednesday, on the subject of the defective supply of electric current in the district. Two memorials were presented to the President, and altogether about 600 complainants were represented. The President (Mr. Ritchie) was accompanied by Sir Courtenay Boyle, the Hon. T. H. W. Pelham, Mr. Garnham Roper, and Mr. A. P. Trotter, the Board's electrical adviser.

Dr. Fletcher Little said that the deputation consisted of customers and users of the electricity supply of the Metropolitan Electric Supply Co., who had suffered and were suffering from the failure of the company to supply current continuously. For several years past the current had been unequal, and occasionally it had failed altogether. For the past two or three months the failures had been of almost daily occurrence, and sometimes they had occurred twice a day. The duration of the failure had frequently extended over several hours. Sometimes the company had given notice of intention not to supply during

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several hours in the afternoon, but in the majority of cases the failure had taken place without notice, thus inflicting manifest injury on all classes. There was a sudden cessation of work, and in some cases there was danger to life. Representations to the company not having resulted in putting an end to the state of things complained of, the vestry recently took out a summons for penalties for the company's default, and the magistrate adjourned the summons for three months. In a case of that kind they were advised that it was hopeless for them to proceed by summons. They prayed the President of the Board of Trade to introduce, either in a provisional order or a bill, a clause placing the company in the same position as other trading companies, and giving them a right to compensation for their breach of contract and duty to them. They would then be able to protect themselves. Dr. Fardon, representing Middlesex Hospital, said that during the past 12 months the authorities of the hospital had been put to serious inconvenience by the deficiencies of the company. The voltage of the current supplied had been so low that when the current was switched on the lamps gave hardly sufficient light even for necessary purposes. That entailed the turning on of an extravagant number of lamps. The voltage had frequently fallen down to 95, or even below that. Frequently during the latter weeks or months of the past year they had had the light entirely and momentarily extinguished without the slightest warning. They might imagine what the effect of that was in a hospital where operations were very often carried on at all hours of the day. Their operating theatre, which relied on the electric light for its illumination, had on more than one occasion been plunged into immediate darkness in the midst of important operations. Mr. Ritchie: Has there been any amelioration of the situation since Dec. 15? Have you had any reason to complain of total failure of light since that time?—Yes; Dec. 18 was the last time when it occurred during an operation, but on Dec. 20, Dec. 23, and Jan. 4 the hospital was plunged into darkness—once for 45 minutes. Other speakers followed, after which Mr. Ritchie said he thought the complaints had been so universally acknowledged and so clearly established that it was not really necessary to elaborate that subject or to trouble gentlemen to make speeches upon it. He had had representations from various quarters—from public bodies and from private persons. He had had himself individual experience in a friend's house, where he was dining one night. A hurried resort had to be made to candlesticks and lamps of all kinds, sorts, and descriptions, and he had heard of similar experiences from many personal friends; so that, having regard to all those facts, there could be no question at all that their complaint was a substantial one and well grounded. The Board of Trade had communicated with the company more than once, and he had received a letter that morning from them in which they said there was no reason to apprehend any further failures. They stated that since Dec. 15 there had been no ground of complaint. Those complaints were very serious, and, according to the admission of the company themselves, they certainly were greatly lacking in foresight and greatly to blame, he thought, in not having seen what the development of their supply would be, and in not having properly provided for the demand that would be made upon them, because he understood that inefficient light was just as costly as efficient light, and it seemed therefore to him that they had great reason to complain not only because of the inadequacy of the light, but because they had to pay as much for the inadequate light as if they were given proper light. It would be his duty to tell the company of the statements made that day, and to point out that those statements differed from the statement made by the company in the letter, to the effect that since Dec. 15 the supply had been adequate. There had not been any suggestion as to what the Board of Trade could do in the circumstances of the case. Dr. Little had asked the Board to bring in a bill or provide in a provisional order for damages for breach of contract, and he seemed to think that lighting companies were specially exempted under the common law for neglecting to fulfil their contracts. They were, however, just as liable as any other companies for any breach of contract between themselves and their customers. The Board of Trade issued regulations, and they were binding upon the company. Their regulations required the company to maintain a constant supply. In case of default they were liable to penalties, unless it were shown that default was caused by inevitable accident or by *force majeure*. The only power was that of summoning before a magistrate and getting the company mulcted in penalties. The only remedy for defaults of that kind was competition. Parliament had more than once endorsed the action of the Board of Trade in granting provisional orders both to local authorities and to districts already supplied by a company.

At the Vestry meeting last evening Mr. John Lewis referred to the deputation to the Board of Trade. He thought that the remarks of the President pointed to the fact that the Board was in favour of allowing a competing company to come in. He hoped that the Vestry would itself see the advisability of applying for an order. It should be clearly pointed out to the President that, while objecting to another company, the Vestry were desirous of retaining electric lighting powers in their own hands. Dr. Fletcher Little moved that all negotiations with the Metropolitan Company cease from that date, and, seeing the Company's valuation amounted to the excessive sum of £933,211 for its interest in St Marylebone, the Vestry memorialise the London County Council to obtain Parliamentary powers to purchase the entire undertaking of that Company, in order to maintain one large generating station, at Willesden, whence to supply at wholesale prices the various public bodies within their respective districts, and to sell to each of such public authorities at cost price such part of the undertaking as may be within their respective areas. After a brief discussion the resolution was withdrawn.

Middlesborough.—The Electric Lighting committee recommend the Corporation to give a supply of electric current outside the compulsory area to consumers willing to enter into a three years' agreement and to pay 10 per cent. on the cost of laying the mains.

New York.—The city authorities have awarded the contract for the construction of the underground rapid transit railroad to the Macdonald Syndicate, at $35,000,000. The line will be operated electrically, and will run from the City Hall to the northern limits of the city. It is expected that the work of construction will take three years. A second underground line is advised by the Commerce Commission for freight. The latter line would skirt the city's water-line, and connect all the docks and piers.

Private Bill Legislation.—The County of Durham electric supply bill seeks power to incorporate a company to supply electrical energy in bulk within Gateshead, South Shields Chester-le-Street, Sunderland, Houghton-le-Spring, Durham, Easington, and Hartlepool. The capital proposed to be raised is £270,000, in shares of £10 each, and with the right to borrow £90,000 on mortgage. The first directors of the company will be Messrs. Emile Garcke, W. L. Madgen, J. S. Raworth, R. P. Sellon, and one other person to be nominated by them. It is proposed to erect two generating stations—one at Gateshead, on the southern bank of the river Tyne; the other at Harraton, on land lying between the North Biddick Colliery and the river Wear.

The Hove Town Council will oppose the bill of the Brighton Corporation for power to construct electric tramways, &c., in order to obtain a *locus standi* before committee. The Dyke-road portion of the Brighton electric tramway scheme has been dropped.

The Southport and Lytham tramroad bill is really a reconstruction of the 1899 bill, which was rejected by a House of Lords Committee at the instance of the Preston Corporation. The preamble recites that it would be to the public and local advantage if a direct means of communication were established between Southport and Lytham across the estuary of the Ribble. The scheme includes five tramlines. The first is to be over 3½ miles long, and connects the already authorised line with a point near the sands in the township of Hesketh-with-Becconsall. Thence the line proceeds across the sands for 7 furlongs 4·10 chains on a pier with open ironwork supports. Thence a conveyer bridge would carry the tramcars across the trained channel of the river Ribble, suspended on a carriage of steel travelling on ropes of steel. On the other side of the bridge is to be a similar pier on open ironwork supports. These, which are to be over three miles long altogether, will complete the tramway to the town of Lytham. The estimated cost of the works is put at £183,500.

A meeting of proprietors of the Blackpool, St Annes, and Lytham Tramways Co. has approved the bill introduced to obtain powers to double the lines throughout the whole length from Blackpool to Lytham; to increase the rate of speed from eight to 12 miles an hour; to make arrangements with the Blackpool Corporation to obtain running powers over the Corporation lines up to the present terminus at North Shore; and, further, to obtain powers to substitute the present motive power (steam) with any other which they might think fit.

The local authorities of Eccles, Worsley, Little Lever, Urmston, Little Hulton, Farnworth, Whitefield, and Barton have resolved to support the South Lancashire electric tramway scheme, subject to the local authorities mentioned having running powers over the lines where the tramways are co terminous.

A conference was held on Tuesday between representatives of Glamorgan county and the Cardiff City Councils, with regard to the South Wales Electrical Powers Co.'s scheme, with the idea that the two bodies should join in opposing the bill. No decision was, however, come to.

Under the bill deposited by the Metropolitan District Railway Co. further powers are sought to work electrically certain railways owned or used by the company. It is proposed to erect a generating station near Lot's-road, Chelsea, and to lay cables from the generating station, under the bed of Chelsea creek, and along the West London Extension Railway, to the railway of the company at West Brompton and Earl's Court stations. Power is also sought to abstract water from Chelsea creek for condensing purposes. By part 3 of the bill the company ask for permissive power "to work by electrical power the traffic on their existing railways or any of them or any part thereof, and on the City lines and extension railways of the company and the Metropolitan Co., and on any railways of the Metropolitan Co. which the com-

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pany are authorised or empowered to run over, work or use." It is, however, provided that these powers shall in no way prejudice the right of the Metropolitan Co. to run over the Inner Circle Railway, or make such running powers "less easy and convenient," nor shall these powers be exercised over any part of the railways of the Metropolitan Co. without their previous consent. Provision is also made to enable the company, the Metropolitan Co., and the Brompton and Piccadilly Circus Railway Co. to enter into agreements for the mutual supply of electricity one to the other.

In the Stockport Corporation tramways bill power is sought to construct a large number of new tramways in conjunction with the existing tramway system. It is proposed to carry animals and goods (both light and heavy packages) at rates to be fixed by the bill. The cost of construction of the new permanent way is estimated at £90,853. 18s. 1d., and the prospective revenue is given at £24,745 per annum.

The St. Saviour's (London) District Board of Works have decided to oppose the bill of the City of London Electric Lighting Co., as they consider that the company has not fulfilled its obligations under existing bills in connection with the erection of workmen's dwellings in their district.

The Airdrie and Coatbridge tramways bill, which is being promoted by the New General Traction Co., has the support of the Airdrie Town Council and has already passed the Standing Orders of the House of Commons. The bill will probably be opposed by the Coatbridge Council.

The Brompton and Piccadilly Circus Railway Co. seek an extension of time for the compulsory purchase of lands and for the construction and completion of its railway. By an Act of last session the company was empowered to construct an extension railway to connect with the Metropolitan District Railway at South Kensington.

The Baker-street and Waterloo Railway Co. propose to extend their authorised railways to Bishop's road, Paddington, in one direction, and in the other to near Oakley-street, Westminster Bridge-road, to the Schools for the Blind, and to the New Kent road, with subways for foot passengers at Bishop's-road and the Elephant and Castle station of the City and South London Railway.

The City and South London Railway Co. desire to increase the internal diameter of the tunnel for the station at the terminus at Islington to 30ft.

The Charing Cross, Euston, and Hampstead Railway Co. require an extension of time for the compulsory purchase of land, and for the construction of certain authorised railways.

Sevenoaks.—After consideration of a report by Mr. W. C. C. Hawtayne, the Council decided to oppose the application of the Electrical Power Distribution Co. for a provisional order.

Shoreditch.—The Vestry have applied to the London County Council for sanction to a loan of £15,000 for electric lighting purposes. With regard to the proposed new generating station at Haggerston, the Finance committee, at a meeting of the Vestry on Tuesday, advised that the sanction of the County Council should be asked to a loan for the total estimated cost of the station. As no estimate was submitted, the matter was referred back. The Lighting committee reported having received a deputation from Messrs. Lights (Ltd.), who asked to be permitted to declare their consumption of electricity for motive power purposes for the year ended June 24, 1899, at 100,000 units, so as to entitle them being charged on the lower rate of 1½d. per unit, although their actual consumption was only 93,385 units, which at 1¾d. amounted to £680. 18s. 8d. Upon full consideration of the matter, the committee recommended the Vestry to grant the request. This was agreed to. Mr. J. Rider Hunt is to get out the quantities for the new generating station, at a fee of 10s. per cent. on the amount of the accepted tender. The vestry clerk has been instructed to take steps to oppose the bill of the County of London Co., and to endeavour to co-operate with other local authorities in so doing.

Skegness.—A committee has been appointed to visit towns where electricity works are in operation, and to collect information as to municipal electricity supply, with a view to its adoption at Skegness.

Southport.—On Wednesday the seal of the Council was ordered to be affixed to the agreement for the purchase of the Birkdale and Southport Tramways Co.'s undertaking at £12,500. Application has been made to the Board of Trade to sanction a loan of this amount. The lines will be equipped electrically.

Telephone Trunk Extensions.—Chippingham and Swindon have been added to the towns connected with the trunk line system of the country.

Volunteers for the Front.—Mr. L. L. J. Lawrence, A.I.E.E. (managing director of Lawrence and Co.), having volunteered his services, has been appointed electrician to the City of London Imperial Volunteer Corps, and will sail for South Africa on 20th inst. He will be assisted by Mr. H. Woolhouse, formerly of the National Telephone Co.

Workhouse Lighting.—The South Dublin Rural Council have decided to obtain a report from Mr. G. M. Harriss on the advisability of lighting the workhouse electrically.

PATENT RECORD.

The following list of Applications for Patents and Specifications published has been compiled for this journal by Messrs. J. C. CHAPMAN and Co., *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs, and Trade Marks may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after the acceptance of the complete Specification. The names within parentheses are those of communicators of inventions. When complete specification accompanies application, an asterisk is affixed.*

December 22, 1899.

25,451. THE BRITISH THOMSON-HOUSTON CO. (LTD.). London. Improvements in electric switches. (E. Oxley, United States.)*

25,452. THE BRITISH THOMSON-HOUSTON CO. (LTD.). London. Improvements in means for cooling electric brake shoes. (A. Ekstrom, United States.)*

25,453. THE BRITISH THOMSON-HOUSTON CO. (LTD). London. Improvements in alternating-current motors.) (A. G. Davis, United States.)*

December 23, 1899.

25,464. M. WESCHER and P. WOLLENHAUPT. Cologne. Improvements in electric alarms.*

25,490. M. A. P. MONNIER. London. Improvements in secondary batteries.

25,491. P. MARINO. London. Improvements in accumulator batteries.*

25,509. B. G. HODGES, H. SMITH, and W. A. A. BURROWS. Derby. Improvements in methods or means of insulating electric wires.

25,513. A. F. SPOONER. London. Improvements in electric arc lamps. (P. Vassia, France.)

December 27, 1899.

25,576. VERITYS LTD. and L. J. STEELE. Birmingham. Improvements in resistance switches and automatic cut-outs for starting, regulating, and protecting electric motors and their circuits.

25,591. E. GUARINI. London. Repeater for wireless telegraphy. (Date applied for under Patents, &c., Act, 1883, sec. 103, May 27, 1899, being date of application in Belgium.)*

25,594. F. EPPLER. London. Improvements in and relating to the process of galvanically inlaying metal on materials.*

December 28, 1899.

25,601. A. W. PRENTICE. Glasgow. Improvements in inspection and junction pieces for electric wire conduits.

25,621. A. P. LUNDBERG and G. C. LUNDBERG. London. Improvements in electric light switches.

25,622. A. P. LUNDBERG and G. C. LUNDBERG. London. Improved method of fitting the covers of electric light fittings to their base parts.

25,628. I. W. J. LINDBOHM. London. Improvements in electric fishing apparatus.

25,641. H. W. SCHLOMANN and A. DE CASTRO. London. Improvements in electro-mechanical accumulators.

December 29, 1899.

25,681. V. I. FEENY. London. Improvements in and connected with electro-dynamometers. (Allgemeine Electricitats Gesellschaft, Germony.)*

25,683. J. J. STANGER. London. Improved apparatus for electro-therapeutic treatment.

25,688. C. E. R. KEDDIE and E. SOLMERSITZ. London. Improved apparatus for automatically controlling the light of electric, gas, and other lamps.

December 30, 1899.

25,699. G. J. GIBBS. Bradford. Improvements in or appertaining to electromotors.

25,701. J. A. STEVENS and W. R. HAIGH. Glasgow. An improved controlling apparatus for electric motors.

25,709. F. H. ROYCE. Manchester. Improvements in electrically-driven cranes.

25,710. R. J. URQUHART. Manchester. Improvements in electrical apparatus for opening gas cocks from a distance. (The Aktiengesellschaft für Fabrikation von Bronce-waren und Zinkguss vormals Spinn und Sohn, Germany.)

25,721. A. PALLAVICINI. Berlin. Improvements in plates for storage batteries.

25,730. J. BRYANT, H. SMALLMANN, and A. H. ELSOM. London. An improved electrical commutator.

25,736. E. SCHAEFFER. London. Improved electrical igniting apparatus for internal combustion engines.

25,740. B. G. LAMME. London. Improvements in current collectors for electrical machines. (Date applied for under Patents, &c., Act, 1883, sec. 103, June 5, 1899, being date of application in United States.)

25,744. THE BRITISH THOMSON-HOUSTON CO. (LTD.). London. Improvements in dynamo-electric machines. (H. G. Reist, United States.)*

25,745. THE BRITISH THOMSON-HOUSTON CO. (LTD.). London. Improved method of regulating dynamo-electric machines. (C. P. Steinmetz, United States.)*

25,746. THE BRITISH THOMSON-HOUSTON CO. (LTD.). London. Improvements in alternating-current electric meters. (C. P. Steinmetz, United States.)*

25,747. THE BRITISH THOMSON-HOUSTON CO. (LTD.). London. Improvements in safety devices for dynamo-electric machines. (H. W. Buck, United States.)*

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25,748. The British Thomson-Houston Co. (Ltd.). London. Improvements in electric railway systems. (A. H. Armstrong, United States.)*

25,749. The British Thomson-Houston Co. (Ltd.). London. Improvements in electric railway systems. (W. B. Potter, United States.)*

25,750. The British Thomson-Houston Co. (Ltd.). London. Improvements in controlling electric motors. (M. W. Day, United States.)*

25,751. The British Thomson-Houston Co. (Ltd.). London. Improvements in electric time switches. (C. H. Van Slyck, United States.)*

25,752. The British Thomson-Houston Co. (Ltd.) London. Improvements in electric meters. (C. D. Haskins, United States.)*

25,767. H. Rowntree. London. Improvements in or relating to electric motors.*

25,768. H. Rowntree. London. Improvements in and relating to electric lifts or elevators.*

January 1, 1900.

27. H. Lyon and J. B. Talbot Crosbie. Glasgow. Improvements in electric arc lamps.*

35. H. Hirst and T. Hawkins. London. A method of and apparatus for drying insulated wires for electrical purposes in the process of winding.

45. V. I. Feeny. London. Improvements relating to electrical incandescence lamps of the newest type. (Allgemeine Elektricitäts Gesellschaft, Germany.)*

63. J. Doust. London. Improvements connected with ceiling roses of electric incandescent lights. (Messrs. Schmahl and Schulz, Germany.)

65. G. C. Allingham and W. Fennell. London. Improvements in the manufacture of electric conductors or cables.

SPECIFICATIONS PUBLISHED.

Note.—All Specifications can now be obtained at the uniform price of 8d. each.

1898.

17,337. Vogt. Battery cell with double case, applicable also as a Leyden jar.

17,707. Feeny (Allgemeine Elektricitäts Gesellschaft). Electric incandescence lamps.

19,846. Thomas. Conduit terminal and junction box for electric wires.

20,068. Beez. Ohmmeter or apparatus for directly indicating resistances.

21,329. Placet. Means of maintaining and renewing the charge of electric accumulators working motors for carriages, boats, balloons, and other vehicles. (Date applied for under International convention, May 27, 1889.)

21,652. The British Thomson-Houston Co. (Ltd.) (Case). Method of and means for synchronising electric motors.

22,394. Post. Chemical electrical excitants.

26,315. Murphy. Means for supporting electric motors for tramway cars.

26,610. Crompton and Pochin. Electric arc lamps.

27,053. Foy. Overhead electrical wire holder.

27,536. Bottelli. Incandescent electric lamps.

31,354. Aron and Aron Electricity Meters (Ltd.). Apparatus for electrically winding up or giving tension to driving springs.

1899.

487. Paul. Gearing for transforming a continuous rotary movement into an intermittent rotary movement.

635. Franzen. Electrical appliances for controlling the supply of gas to burners and effecting its ignition from a distance.

825. Harris. Electrical measuring instruments.

963. Crudgington. Electric arc lamps.

1,697. Thompson (Thompson). Electrical apparatus for operating mechanism at a distance.

1,863. Oaling and Braunerhjelm. Electrical condenser and apparatus for producing powerful electric waves. (Date applied for under International Convention, 25th November 1898.)

1,921. Webster. Electric arc lamps for stage and like purposes.

2,123. Niblett and Sutherland. Means for preventing the creeping of acids or other deleterious matter in electrical apparatus.

3,160. Smithson and Sharpe. Electromagnetic cut-outs and other like apparatus, especially applicable to electric arc lamps.

3,773. Murphy. Dynamometer for use in laying submarine cables.

4,327. Westinghouse. Electro-pneumatic controlling systems. (Date applied for under International Convention, 20th August 1894.

7,144. Schultz. Electric apparatus for automatically regulating the physical condition, such as heat pressure, hygrometric state, and density of gases and liquids.

17,507. Feeny (Allgemeine Elektricitäts Gesellschaft). Electric lamps with illuminating bodies made of second-class conductors.

17,715. Johnson and Weeks. Appliances for the cutting off the current from electric elevators, motors, and for arresting the fall of the car.

18,968. Thompson (Sinding-Larsen). Electric incandescent lamps.

19,031. Kühlstein and Vollmer. Driving and steering gear for electrically-propelled motor road vehicles.

19,836. Robinson. Multiple mandrel attachments for phonographs and the like.

20,100. Railing and Collings. Suspension fittings for electric lighting systems adapted to high voltage.

20,121. Kappenberger. Process and apparatus for the production of insulators for electric wires.

20,162. Thompson (Antiseptic Appliance Co.). Antiseptic appliance for sound transmitter mouthpieces.

COMPANIES' MEETINGS AND REPORTS.

Eastern Telegraph Co. (Ltd.).

The report of the directors for the half-year ended 30th September, 1899, to be presented to the fifty-fifth half-yearly ordinary general meeting on the 25th inst., states that the revenue for the period amounted to £474,950. 8s 2d., from which are deducted £121,630. 3s 8d. for the ordinary expenses and £33,096. 17s. for expenditure relating to repairs and renewals of cables, &c., during the half-year. After providing £6,117. 18s. 5d. for depreciation of spare cable and £7,215. 2s. 2d. for income tax, there remains a balance of £306,880. 6s. 11d., to which is added £3,536. 0s. 9d. brought from the preceding half-year, making a total available balance of £310,426. 7s. 8d. From this balance has been paid—

Interest on debentures and debenture stock	£29,133	16	4
Dividends on preference stock	30,632	8	0
Two interim dividends of 1½ per cent. each on the ordinary stock	100,000	0	0
	£159,766	4	4

After carrying £10,000 to reserve for maintenance ships, £5,000 to reserve in connection with the removal of head offices, £2,000 to insurance of goods in transit fund, and £100,000 to the general reserve fund, there remains a balance of £33,660. 3s. 4d., which is carried forward to the next account. The revenue includes £24,054. 18s. 5d. dividends for the half-year upon the company's shares in other telegraph companies.

In July last the directors offered to the holders of the 5 per cent. debentures, repayable at par on Aug. 1, 1899, the option of exchanging the debentures for a like amount of 3½ per cent. of the company's preference stock. The total amount of the debentures outstanding was £89,600, of which £32,900 was exchanged into 3½ per cent. preference stock, and the balance paid off at par in accordance with the terms of the issue.

With the view of providing additional security to submarine telegraph communication between this country and South Africa, landing rights at Cape Town have been obtained from the Government of the Cape of Good Hope for a third cable between this country and South Africa. The first section, from Cape Town to St. Helena, was completed on Nov. 26 last, a further section being laid from that island to the island of Ascension on Dec. 16. The continuing cable to be laid thence to St. Vincent is now being manufactured, and it is expected the expedition will leave the Thames the end of this month.

Reference was made at the last general meeting to proposed new cables between South Africa and Australia, and a proposal has been submitted by the Eastern Extension, Australasia and China Telegraph Co., in conjunction with this company, for carrying out this important extension. By the terms of the proposed agreement the tariff is to be reduced at once between Great Britain and Australia to 4s. per word, to be followed by further reductions on a sliding scale to 2s. 6d. per word, according to the growth of revenue from this traffic. The companies have made this offer conditional on the Eastern Extension Co. being granted the same rights in dealing direct with the public in Australia as are enjoyed in this and other countries.

In accordance with the terms of the trust deeds, the first quinquennial examination of the staff pension and superannuation funds has recently been made, with the result that the funds are reported by the actuary to be in a satisfactory condition: they do not, however, admit of the retiring age being reduced from 60 to 55 years, which experience proves would be most desirable. The actuary advises that in order to bring about this change the contributions by the staff and the company to the pension fund would have to be increased from 2½ per cent. to 4 per cent. respectively. It is believed that the staff will readily agree to assume this additional liability, and a resolution will be submitted to the meeting authorising the directors to increase the company's contribution from the 1st inst. to 4 per cent. and provide a sum sufficient to enable the trustees to pay the pensions which have already been purchased to Dec. 31, 1899, at the age of 55 instead of 60 years. The shareholders will also be recommended to approve of an alteration in the superannuation trust deed by which the age limit will be reduced to 55 years, the company guaranteeing to make up the loss (if any) that there might be in the fund on account of such reduction.

The retiring directors, Sir John Wolfe Barry, K.C.B., and Mr. Francis Alexander Johnston, offer themselves for election, as do the auditors, Messrs. Deloitte, Dever, Griffiths and Co., and Messrs. Welton, Jones and Co.

NEW COMPANIES, STATUTORY RETURNS, &c.

TINDALL, EARLE AND HUTCHINSON (LTD.)—This company was registered on Jan. 11, with a capital of £20,000 in £10 shares (100 deferred), to acquire the business of Tindall and Co. and to carry on the business of mechanical, electrical, hydraulic, and general engineers, &c.

AFRICAN TRANS-CONTINENTAL TELEGRAPH CO. (LTD.)—The annual return to Dec. 28, 1899, gives the capital as £300,000 in £1 shares, of which 170,300 have been taken up, and £169,305 has been received.

ELECTRIC LIGHTING AND TRACTION CO. OF AUSTRALIA (LTD.)—The annual return to Dec. 25, 1899, has been filed. The capital is £300,000 in £5 shares (30,000 preference), of which 3,403 ordinary and 20,000 preference have been taken up. £3 has been called up on each of 2,003 ordinary and 20,000 preference; 1,400 shares are considered as fully paid.

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CITY NOTES.

MEMORANDA.—Bank rate 4½ per cent. (Jan. 18, 1900). Price of silver 27½d. per oz. (Jan. 18). Consols (2¾ per cent.) 101⅛—101⅜ for money, 101⅛—101⅜ for account; 2½ per cent. 99—99½ (Jan. 18). Stock Exchange Settling Days: Consols, Feb. 2; Stocks and Shares Continuation Days, Jan. 24 and Feb. 7; Ticket Days, Jan. 25 and Feb. 8; Pay Days, Jan. 26 and Feb. 9; Mining Share Carry-over Days, Jan. 23 and Feb. 6.

ANGLO-AMERICAN TELEGRAPH CO. (LTD.)—The half-yearly meeting of this company will be held at Winchester House, Old Broad-street, London, E.C., on Friday, Feb. 2. The register of transfers will be closed from the 19th inst. to Feb. 2 inclusive.

BRITISH INSULATED WIRE CO. (LTD.)—Dividend warrants for the half-year ended Dec. 31 have been posted to holders of the 6 per cent. preference shares.

CAPE ELECTRIC TRAMWAYS (LTD.)—An interim dividend of 4 per cent. free of tax, has been declared.

DIRECT UNITED STATES CABLE CO. (LTD.)—The directors have declared an interim dividend of 3s. per share (free of tax), being at the rate of 3 per cent. per annum, for the quarter ended Dec. 31 (payable 31st inst.), set aside £15,000 to reserve and carried forward about £6,347. The transfer books will be closed from 16th to 30th inst. inclusive.

EASTERN EXTENSION, AUSTRALASIAN AND CHINA TELEGRAPH CO. (LTD.)—The interest on this company's Four per Cent. mortgage debenture stock for the half-year ending Jan. 31 inst., will be paid by warrant on Feb. 1. The register will be closed from 27th to 31st inst. inclusive.

FLEETWOOD AND DISTRICT ELECTRIC LIGHT AND POWER SYNDICATE (LTD.)—The first annual meeting of this syndicate was held last week, Mr. J. A. Seed presiding. In their annual report the directors stated that the installation was almost completed, and it was hoped that a supply of electric current would be available before the end of March. All the streets of Fleetwood were to be illuminated electrically, and the demand, for current from private consumers was very encouraging.

NORTHALLERTON ELECTRIC LIGHT AND POWER CO. (LTD.)—At an extraordinary meeting on Tuesday, it was decided to increase the capital of the company by 8,000 £1 shares. The present capital is £2,000. The increase is due to the demand for current for both public and private lighting.

STOCK EXCHANGE NOTICE.—The Stock Exchange committee has been asked to allow the further issue of £230,255 sterling 4 per cent. 500-year debenture stock of the *Commercial Cable Co.* to be quoted in the official list.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	'99–1900	£	£		£	£
*Birmingham Tramways.	Jan. 13	3,987	+ 235	2	7,915	+ 303
Blackpool Corporation...	„ 11	123	+ 11	41	20,957	+ 4,375
Blackpool and Fleetwood	„ 13	142	+ 29	2	283	+ 3
Bradford Corporation ...	„ 14	354	+ 103	64	24,621	...
Brisbane Trams	Nov. 29	1,615	+ 463	9	21,327	+ 6,597
*Bristol Trams & Carriage	Jan. 12	2,681	+ 124	2	5,417	+ 381
*Buenos Ayres & Belgrano	Dec. 17	2,469	+ 800	50	109,196	+ 47,485
City & South London Ry.	Jan. 14	1,124	+ 17	2	2,268	+ 18
Dover Corporation	„ 13	146	− 5	41	8,503	+ 999
Dublin United.....	„ 12	2,865	+ 266	2	4,981	+ 514
Dublin Southern Dist....	„ 12	579	− 21	2	1,015	
*Glasgow Corporation ...	„ 13	8,227	+ 339	...	...	...
*Liverpool Corporation...	„ 6	6,774	+ 706	1	6,774	+ 706
Liverpool Overhead Rly.	„ 14	1,529	+ 192	2	2,984	+ 308
*Sheffield Tramways	„ 14	1,820	+ 613	2	3,639	+ 1,155
*South Staffs. Trams.....	„ 12	607	− 22	2	1,012	− 75

* Partly electrical.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Jan. 10.	Price Wednesday, Jan. 17.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Jan. 17. Highest	Lowest
			TELEGRAPHS.			£ s. d.			
£110,900	100	4%	*African Direct Telegraph 4% Mort. Deb. (red.)	99 103	99 103	3 17 8	January and July.....	...	...
25,000	10	...	Amazon Telegraph.....	3 4	3 4	...	June and December ..	...	...
£125,000	100	5%	Do. 5 per Cent. Debentures	85 90	85 90	5 11 1	...	...	...
£875,520	Stock	15/0	Anglo-American	64 67	64 67	5 2 11	Feb., May, Aug., Nov.	66½	...
£3,062,240	Stock	30/0	Do. Preferred	113 115	114½ 115½	5 3 10	„ „	115⅞	114¼
£3,062,240	Stock	18/0	Do. Deferred.....	17 17½	17¼ 17½	5 1 5	...	17¼	17⅛
$10,000,000	$100	$2½	Commercial Cable Capital Stock	165 175	165 175	...	Jan., Apr., July, Oct.	...	...
£1,332,823	Stock	4%	* Do. 4 per Cent. Debenture Stock	102 104	102 104	3 16 11	„ „	104½	102½
16,000	10	8/0	Cuba Submarine Ordinary	8½ 9½	8½ 9½	8 8 5	February and August	...	...
6,000	10	10/0	Do. Preference 10 per Cent.	19 20	19 20	5 0 0	„ „	...	...
12,931	5	2/0	Direct Spanish Ordinary.....	4 5	4 5	4 0 0	April and October.....	...	...
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference	9 10	9 10	5 0 0	„ „	...	...
£30,000	50	4½%	Do. 4½ per Cent. Debentures	101⅝ 105⅝	101⅝ 105⅝	4 5 9	January and July.....	...	...
60,710	20	3 0	Direct United States Cable	11½ 12	11¾ 12¼	5 14 3	Jan., Apr., July, Oct.	12⅛	11⅞
£120,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red.)	99 102	99 102	4 8 3	June and December ..	...	...
£4,000,000	Stock	5%	Eastern Ordinary ....xd	143 153	151 156	4 9 9	Jan., Apr., July, Oct.	155	150½
£1,795,000	Stock	3½%	Do. 3½ per Cent. Preference Stock .....xd	96 99	96 99	3 11 3	„ „	98¼	96⅜
£1,432,268	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.)	115 120	114 119	3 7 10	May and November ..	116	...
250,000	10	2/6	Eastern Extension.....xd	14½ 15	14¾ 15¼	4 11 10	Jan., Apr., July, Oct	15	14 3/16
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	116 121	116 121	3 6 7	February and August	...	...
£16,200	100	5%	* Do. 5% (Austln. Gov. Sub.) Deb.,1900 (reg.) ...	99 103	99 103	4 17 1	January and July.....	...	...
£64,400	100	5%	Do. (Bearer)	100 103	100 103	4 17 1	„ „	...	...
£300,000	100	4%	*Eastern and S. African 4% Mort. Deb , 1909.....	101 104	101 104	3 16 11	February and August	...	...
£200,000	25	4%	Do. 4 per Cent. Mauritius Sub. Debs.(red.) ...	101⅞ 104⅞	101⅞ 104⅞	3 16 10	May and November ..	...	...
180,227	10	1/9	Globe Telegraph and Trust	10⅜ 11¼	10⅜ 11¼	4 13 4	Jan., Apr., July, Oct.	11¼	10⅞
180,042	10	3/0	Do. 6 per Cent. Preference	14⅜ 15¼	14⅜ 15¼	3 18 8	„ „	15¼	14¼
150,000	10	5/0	Great Northern of Copenhagen	30 32	30 32	3 18 2	January and July.....	32	30¾
£86,300	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb.(red.) ...	99 102	99 102	4 8 3	...	101	....
17,000	25	12/6	Indo-European.....	48 52	48 52	4 16 2	May and November ...	...	...
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904 ...	106 109	106 109	5 10 1	March and September	...	...
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.)	101 104	101 104	3 16 11	June and December ..	...	...
11,839	8	4/0	Reuter's.....	7 8	7 8	5 0 0	April and October.....	...	...
3,381	£100 Cert.	6%	Submarine Cables Trust	125 130	125 130	4 13 0	„ „	125	...
15,609	10	...	West African Telegraph	2½ 3½	2½ 3½	4 9 3	December and July ...	...	...
£200,000	100	5%	* Do. 5 per Cent. Debentures (red.)	99 102	99 102	4 18 0	March and September	...	...
30,008	2½	...	West Coast of America	½ 1	½ 1	...	...	...	...
£150,000	100	4%	* Do. 4 per Cent. Debentures	100 103	100 103	3 17 8	January and July.....	...	...
88,321	10	6d.	West India and Panama	⅞ 1⅛	⅞ 1⅛	...	May and November ..	1	...
34,563	10	6/0	Do. 6 per Cent. 1st Preference	9¼ 9¾	9¼ 9¾	6 3 1	„ „	9¼	9⅛
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	7 8	7 8	7 10 0	„ „	...	...
£80,000	100	5%	* Do. 5 per Cent. Debentures	104 107	104 107	4 13 6	January and July.....	...	...
£389,731	Stock	4%	Western & Brazilian 4 per Cent. Debenture Stock ...	102 105	100 104	3 16 11	June and December ...	...	...
207,930	10	3/0	Western Telegraph (late Brazilian Submarine)	11¼ 14¾	14½ 15	4 13 4	Mar., June, Oct., Dec.	14⅜	14¼
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1900)	106 109	106 109	4 11 9	June and December ...	...	...
£158,100	100	6%	*Western Union 6 per Cent. Sterling Bonds (red.) ..	98 103	98 103	5 16 6	March and September	...	...
			TELEPHONES.						
44,000	£5	3/0	Chili Telephone (fully paid)	2 3	2 3	6 13 4	August	...	...
224,850	10s.	0/1½	Consolidated Telephone Const. & Manufacturing ...	⅛ ¼	⅛ ¼	4 15 3	July	...	...
72,680	1	0/6	Monte Video Telephone Ordinary	¾ ⅞	¾ ⅞	5 0 0	October.....	...	...
86,492	1	1 0	Do. 5 per Cent. Preference	¾ 1	¾ 1	5 0 0	...	...	...
490,000	5	3/0	National	5 6¼	5⅝ 5⅞	5 6 8	February and August	5⅝	5½
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Preference ...	14 15	14 15	4 0 0	„ „	11⅞	14¾
15,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference ...	14 15	14 15	4 0 0	„ „	14¾	...
250,000	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref. ...	5⅛ 5⅜	5¼ 5½	4 10 11	„ „	5⅜	5¼
1,329,471	Stock	3½%	* Do. Debenture Stock 3½ per Cent. (red.)	98 100	98 100	3 10 0	June and December ...	99	...
171,504	1	0/4	Oriental	¾ 1	¾ 1	5 0 0	April and October.....	...	...
58,000	5	2/6	United River Plate	4½ 5	4¾ 5¼	7 2 10	July	4¾	...
16,639	5	1/4	Do. 5% Cumulative Preference	4½ 5	4¾ 5¼	4 15 3	...	...	...
£179,947	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	102 104	103 106	4 14 4	June and December ...	...	...

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Jan. 10.	Price Wednesday, Jan. 17.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Jan. 17. Highest	Lowest
			ELECTRICITY SUPPLY COMPANIES.			£ s. d.			
100,000	1	...	Bl'ckh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.)	⅜ 1	⅜ ⅛	...	...	...	...
6,000	10	7/9⅔	Bournemouth and Poole Elec. Supply Ord.	12 13	12 13	3 0 0	...	...	...
6,000	10	4/6	Do. 4½ per Cent. Cumulative Pref.	10 11	10 11	4 1 10	...	...	...
19,661	5	2/6	Brompton & Kensington Electricity Supply Ord.	7 8	7 8	3 15 0	...	...	...
12,000	5	3/6	Do. 7 per Cent. Preference	9 10	9 10	3 10 0	March and September	...	...
20,000	5	...	Calcutta Elec. Supply Ordinary (fully paid)	6½ 7	6½ 6⅞	...	...	6½	...
30,000	5	4/0	Charing Cross & Strand Electricity Supply Corp.	9¾ 10¼	9¾ 10¼	4 5 9	February and August	...	...
20,000	5	...	Do. (Nos. 3,001 to 50,000)	9⅝ 10⅛	9⅝ 10⅛	...	...	...	...
20,000	5	2/3	Do. 4½ per Cent. Preference	5¾ 6	5¾ 6	3 15 0	,, ,,	6	...
34,000	5	2/6	Chelsea Electricity Supply Ordinary	7⅛ 8⅛	7⅛ 8⅛	3 10 7	March	...	...
£100,000	Stock	4½%	* Do. 4½ per Cent. Debenture Stock (red.)	109 111	109 111	4 1 1	June and December	110½	...
$1,200,000	$1,000	5%	Chicago Edison 1st Mort. 5% 20 year Gold Bonds (red.)	100 110	100 110	4 10 11	April and October	...	...
60,000	10	7/0	City of London Electric Lighting Ordinary	10 11	10 11	5 9 1	February and August	10¼	10¼
40,000	10	6%	Do. 6 per Cent. Cumulative Preference	12½ 13⅛	12⅝ 13⅛	4 8 11	January and July	...	...
£400,000	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	122 127	122 127	3 15 9	June and December	...	...
40,000	10	...	County of London and Brush Prov. Ordinary	10 11	9½ 10½	...	...	10	...
20,000	10	6/0	Do. 6 per Cent. Cumulative Preference	13 14	13 14	4 5 9	March and September	...	...
£200,000	Stock	4½%	Do. 4½% Deb. Stock Certs. (all pd.) (red.)	107 110	106 109	4 2 7	...	109½	...
15,000	5	10/4	Kensington and Knightsbridge Ordinary	12 13	12 13	4 1 6	...	...	...
10,000	5	6%	Do. 6 per Cent. 1st Preference	7⅞ 7¾	7⅞ 7¾	3 17 5	January and July	...	...
110,000	2	...	London Electric Supply Ordinary	2⅜ 2⅝	2⅜ 2⅝	...	...	...	...
48,050	5	3/0	Do. 6 per Cent. Preference	5⅝ 6	5⅝ 5⅞	5 4 4	...	...	...
£100,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures	102 104	102 104	3 16 11	Mar., June, Sept., Dec.	...	...
62,500	10	5/0	Metropolitan Elec. Supply Ord. (Nos. 1 to 62,500)	13½ 14½	14 15	3 6 8	April and October	...	...
22,500	10	3/7½	Do. (Nos. 62,501 to 85,000)	13 14	13½ 14½	3 7 10	...	...	...
£220,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage	116 118	115 117	3 16 11	June and December	...	...
£125,000	Stock	24/8	Do. 3½ per Cent. Mort. Deb. Stock (red.)	95 97	95 97	3 13 2	...	95½	95½
6,452	10	6/0	Notting Hill Electric Ordinary	15½ 16½	15½ 16½	3 15 0	March	...	...
10,000	5	5/0	Oxford Electric Ordinary	6⅞ 7⅛	6⅞ 7⅛	3 9 0	,,	...	...
300,000	1	8%	Rand Electric	⅞ ⅞	⅞ ⅞	10 18 4	...	...	...
£130,070	Stock	5%	River Plate El. Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb.	80 90	80 90	5 11 1	...	...	...
150,000	$100	$2	Royal Electric Company of Montreal Shares	150 170	150 170	4 14 2	...	...	...
£123,200	100	4½%	* Do. 4½ per Cent. 1st Mortgage Debentures	104 106	104 106	4 5 6	April and October	...	...
31,980	5	5/0	St. James's and Pall Mall Electric Ordinary	14 15	15 16	4 16 8	February and August	15⅛	15⅛
20,000	5	3/6	Do. 7 per Cent. Preference	9 9½	9 9½	3 13 8	,, ,,	...	...
65,000	5	...	South London Electric Supply Ordinary (fully paid)	4 4½	4 4½	...	...	...	...
79,900	5	5/0	Westminster Electric Supply Ordinary	12½ 14½	14 15	4 0 0	March and September	14½	...
			ELECTRIC MANUFACTURING, &c., COMPANIES.						
125,000	1	7½d.	Aron Electricity Meter 6 per Cent. Cum. Pref.	⅜ ½	⅜ ½	6 17 2	...	...	...
45,000	1	...	British Electric Works Co. Ordinary	14 6 15/6	12/6 13/0	...	...	...	...
50,100	1	...	Do. 5 per Cent. Cumulative Preference	17/0 18/0	16/0 17/6	...	...	...	...
£50,000	100	...	Do. First Mortgage Debentures	99 101	99 101	...	...	...	...
40,000	5	5/0	British Insulated Wire Ordinary	11½ 12½	11½ 12½	4 0 0	...	...	...
27,500	5	3/0	Do. Preference xd	6½ 6⅞	6 6½	4 13 4	...	...	...
90,000	2	2/0	Brush Electrical Engineering	1⅞ 2	1⅞ 2	5 0 0	September	...	...
90,000	2	1/2½	Do. 6 per Cent. Pref. Non-Cumulative	2⅛ 2⅜	2⅛ 2⅜	5 1 1	,,	2⅛	2⅛
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Deb. Stock	110 115	110 115	3 18 6	February and August	114½	115
£50,000	Stock	4½%	* Do. 2nd Debenture Stock (red.)	102 105	102 105	4 5 9	June and December	...	...
20,000	5	5/0	Callender's Cable Construction Ordinary	12½ 13½	13 14	5 7 2	,, ,,	13⅛	13⅜
20,000	5	2 6	Do. 5 per Cent. Cumulative Preference	5½ 6	5½ 6	4 3 4	...	...	...
£90,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb. (red.)	110 115	110 115	3 18 3	November and May	...	...
300,000	1	0/9½	Castner-Kellner Alkali Co. (fully paid)	1⅛ 1⅜	1⅛ 1⅜	5 16 5	...	...	...
60,000	1	0/7½	Chadburn's Ship Telegraph Ordinary	⅝ 1⅛	⅝ 1⅛	5 6 8	...	...	...
60,000	1	0/7½	De. 6 per Cent. Cumulative Preference	⅝ 1⅛	⅝ 1⅛	5 6 8	...	...	...
32,098	3	1/0⅜	Crompton and Co. (Nos. 1 to 32,098) xd	3½ 4	3½ 4	4 10 9	January and July	3⅝	3⅝
£100,000	100	5%	* Do. 5 per Cent. First Mortgage Deb. (red.)	98 101	98 101	4 19 0	,, ,,	...	...
60,000	1	0/3	Davis and Timmins 6 per Cent. Cum. Pref.	⅜ 1	⅜ 1	...	...	...	...
99,261	5	1/9½	Edison and Swan United ("A" Shares) (£3 paid)	1½ 2⅛	1⅞ 2⅛	8 0 0	February and August	...	...
17,139	5	2/9⅜	Do. (£5 paid)	3⅜ 4⅛	3⅜ 4⅛	6 13 4	,, ,,	...	...
£314,023	Stock	4%	Do. 4 per Cent. Mortgage Deb. Stock (red.)	93 95	91 93	4 6 0	June and December	91½	91½
26,100	5	5/11⅛	Edmundson's Electric Corporation Ord. (fully pd.)	4⅜ 5⅛	4⅜ 5⅛	5 14 3	Half-yearly	...	...
112,100	2	1/2⅜	Electric Construction Co. (Limited)	1⅞ 2⅛	1⅞ 2⅛	5 8 3	January and July	2⅛	...
25,000	2	2/9⅛	Do. 7 per Cent. Cumulative Preference	2⅝ 3⅛	2⅝ 3⅛	4 6 2	July	...	...
182,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.) xd	104 107	103 103	3 15 6	January and July	...	...
91,195	1	...	Elmore's Patent Copper Depositing	⅜ ⅝	⅜ ⅝	...	...	...	...
30,000	5	...	Henley's Telegraph Works Ordinary	12 13	12 13	...	February and August	12½	12⅛
15,000	5	...	Do. 4½ per Cent. Preference	5 5⅛	5⅛ 5⅞	3 19 3	,, ,,	5⅛	...
£50,000	Stock	4½%	Do. 4½ per Cent. Mortgage Deb. Stock (red.)	111 114	111 114	4 0 0	,, ,,	...	...
50,000	10	10/0	India Rubber, Gutta Percha, &c., Works	20½ 21½	20½ 21½	4 13 0	,, ,,	21½	21½
£300,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	100 104	100 104	3 16 11	March and September	101	...
37,350	12	12/0	Telegraph Construction and Maintenance	35 37	35 39	4 12 4	March and July	37	36½
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909	102 103	103 103	3 16 2	...	104	...
20,000	5	3/0	Do. Manufacturing Ordinary	9 10	9 10	3 10 0	...	...	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5½ 6	5½ 6	4 3 4	...	...	...
30,000	5	5/0	Willans and Robinson Ordinary	9⅝ 10½	9¾ 10½	4 5 9	April and October	10½	...
30,000	5	3/0	Do. 6 per Cent. Cumulative Preference	7 7⅛	7 7⅛	4 0 0	,, ,,	7⅛	...
£100,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Debentures	104 106	104 106	4 0 2	May and November	...	...
			ELECTRIC RAILWAYS, TRAMWAYS, &c.						
12,000	10	6/0	Blackpool and Fleetwood Tramways	17 19	17 19	3 13 8	...	...	...
£167,900	100	5%	Brisbane Tramway 5 per Cent. Debentures	104 106	104 106	4 14 4	...	...	...
50,000	10	7%	Bristol Tramways and Carriage Ordinary	23 24	23 24	2 17 2	February and August	...	...
25,000	10	...	Do. Cumulative Preference (£6 paid)	6½ 6⅝	6½ 6⅝	...	...	...	...
£100,000	Stock	4%	Do. 4 per Cent. Debentures	117 118	117 118	3 7 3	...	...	...
45,000	10	9/0	British Electric Traction Ordinary	15 16	15½ 16½	1 10 0	...	16⅛	15⅞
30,000	10	6/0	Do. 6% Cum. Pref. (Nos. 30,001 to 60,000)	12½ 13½	13 13½	4 8 11	...	13⅜	13⅛
£200,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures	125 128	125 128	3 18 6	...	...	...
40,000	5	1/9	Buenos Ayres & Belgrano 6% "A" Cum. Pref.	4⅞ 5⅛	4⅞ 5⅛	5 17 1	...	...	...
27,500	5	...	Do. "B"	4⅜ 5	4⅜ 5	...	...	...	...
265,585	Stock	5%	Do. 5 per Cent. Debentures	105 108	105 108	4 12 7	...	107	...
213,553	10	3/0	Central London Ordinary	9½ 10	9½ 10	3 0 0	June and December	10	...
£365,000	Stock	2½%	City and South London Railway Con. Ordinary	59 62	59 62	3 8 6	January and July	60	59
37,000	10	...	Do. (Nos. 22,501 to 60,000) (£5. 10s. paid)	4½ 5⅛	4⅝ 5⅛	...	...	...	...
£150,000	Stock	5%	Do. 5 per Cent. Perpetual Preference (1891)	148 149	148 148	3 8 0	January and July	...	...
£200,000	Stock	5%	Do. (1896)	135 140	135 140	3 11 11	...	...	...
£187,701	Stock	4%	Do. 4 per Cent. Perpetual Debenture	125 130	125 130	3 1 11	May and November	...	...
20,000	10	7½%	† Imperial Tramways Ordinary	23 24	23 24	...	March and September	...	...
10,000	10	6%	† Do. 6 per Cent. Preference	15½ 15⅝	15½ 15⅝	3 13 10	,, ,,	...	...
£200,000	Stock	4½%	† Do. 4½ per Cent. Debenture	113 115	113 115½	3 18 6	January and July	...	...
30,000	10	1/3	Kidd'rm'nst'r & Dist. E. L. & Tr'ct'n 5% Pref. (£8 pd.)	8	8 8½	...	May and November	...	...
37,500	10	2½%	Liverpool Overhead Railway Ordinary	8½ 8¾	8¾ 9	3 12 2	February and August	...	...
10,000	10	5%	Do. 6 per Cent. Preference	13 13½	13 13½	3 15 6	,, ,,	...	...
125,000	Stock	4%	Do. 4 per Cent. Debenture	102 104	102 104	3 16 11	January and July	...	...
24,000	5	...	New General Traction Ordinary	3½ 4	3½ 4	...	...	...	...
30,000	5	6/0	Do. 6 per Cent. Cumulative Preference	5 5½	5 5½	5 9 1	May	...	...
4,000	10	...	Oldham, Ashton and Hyde Elec. Tramway Ord.	...	18 19	...	February and August	...	...
4,000	10	5/0	Do. per Cent. Preference	...	10½ 10⅞	...	,, ,,	...	...
13,334	10	...	Potteries Electric Traction Ordinary	11½ 12½	11½ 12½	...	...	...	...
20,000	10	5/10	Do. 5 per Cent. Cumulative Preference	10 11	10 11	4 10 11	...	...	...
£540,000	Stock	3%	Waterloo and City Ordinary	101 104	101 104	2 18 4	June and December	...	...

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption.

† The London Stock Exchange Committee refuses to quote these.

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THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,132. [No. 14. Vol. XLIV.] FRIDAY, JANUARY 26, 1900. PRICE SIXPENCE (by post, 6½d.). Abroad, 8d., or 15 cents. or 20fr., or 70pf.

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NOTES.

Through an unfortunate delay in the sending out of the official abstract, we are only now able to give our readers an account of Mr. C. E. S. Phillips' researches on the diselectrification produced by magnetism. This communication, made to the Royal Society last June, bears an unusually astonishing title, suggestive at once of a discovery of first importance. Nor is the astonishment in any degree lessened by reading the particulars of the research. To put the matter briefly, Mr. Phillips has found experimentally that "under certain conditions, an electrified body rapidly loses its charge when in the neighbourhood of a magnetic field," even though there be no relative motion between charge and field. In this discovery, whatever may be its explanation, we undoubtedly may perceive a new and important *datum* contributing to the revision of our theories of the relation of electrical charges to electromagnetism. Two kindred *data* have already called for special notice, in Mr. Phillips' prior discovery of what has been well termed the Phillips phenomenon, and in Lord Kelvin's recent mathematical speculations on the rotation set up in a charged body when a magnetic field is generated around it. Without now attempting to explain the diselectrification discovered by Mr. Phillips, we would call attention to the fact that although neither the magnetic field nor the charged body need be in motion, there are moving charged molecules in the exhausted interspace. The presence of these may be the cause of the transfer of electric charge from the charged body to the magnet poles, and their motion may afford the necessary conditions.

In a valuable communication from the physical laboratory at Leyden University to the Natural Philosophy section of the Dutch Academy of Sciences, Dr. Fritz Hasenoehrl describes his researches on the dielectric coefficients of liquid nitrous oxide and oxygen. It is interesting to observe the close agreement between Dr. Hasenoehrl's 1·465 for the dielectric constant of boiling oxygen and Dewar and Fleming's 1·491 for the same liquid in the same condition, the difference between the two values being only 1·8 per cent. A further remarkable point is the close agreement with the Clausius-Mosotti formula correlating the dielectric constant and the density of the substance. Thus, the author observes: "If we then assume 1·00059 for the D.C. of gaseous oxygen, and 1·1375 for the density of the liquid, we arrive at 1·556 as the D.C. of the latter, which value agrees as far as the order of magnitude with the values found by Dewar and Fleming. Conversely assuming the D.C. of the liquid oxygen, we obtain the value of 1·00051 for the gas instead of 1·00059."

A letter from Mr. John H. Barker, the Corporation electrical engineer at Cambridge, which we print in another column, makes it clear that we were in error in stating, in our account of recent electrical progress at Cambridge (*The Electrician*, Jan. 12, p. 390), that superheated steam was used in the trials of the new 500 kw. Parsons turbo-generator. It appears that superheated steam was neither mentioned in the conditions of the guarantee nor used in the actual trial. This fact makes the performance of the Parsons steam turbine even more remarkable than it would have been had the steam been superheated. Supplied with saturated steam at 140lb. pressure, and running condensing, at full load the engine required only 27lb. per horse-power hour. This is indeed a highly satisfactory performance, and trials like these should go far towards recommending the Parsons steam turbine to economy-seeking engineers.

We are interested in the statement which Mr. Barker incidentally makes, that superheated steam has not been used at the Cambridge works during the past 6½ years, owing to difficulty with the superheater. Some few years ago several sets of tests were made independently by Profs. Ewing and Kennedy on the then latest types of Parsons turbine. Comparing the tests made by Prof. Kennedy in 1893 with tests made by Prof. Ewing in the previous year, we called attention to the strong evidence these tests afforded that the Parsons

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turbine type of engine would show a higher economy with gaseous steam than with steam in a saturated or wet condition. The reason is clear, inasmuch as with superheated, or gaseous, steam there are no particles of water to clog the vane passages and increase internal friction.

It would be of great interest to know what the latest design of Parsons engine, as embodied in the 500 kw. Cambridge set, would be capable of showing, as regards economy, when run with thoroughly superheated steam. The failure of the superheater at the works apparently makes this trial impossible; but could it be undertaken, we venture to predict that a saving in fuel would be effected even greater in proportion than would be obtained with any piston type of steam engine. Makers of superheaters have long blamed engine builders for the scant use superheated steam has received, declaring that the cylinders and valve faces could not stand the high temperature of the dry steam. Here, at any rate, is one instance where the engine is especially suited to the use of very highly superheated steam, but where superheaters have failed to produce it satisfactorily.

Reviewing in the current number of the *Engineering Magazine* the "Progress in Automobile Construction" during the past two years, Mr. W. Worby Beaumont draws several pertinent and timely conclusions regarding the development of this important industry. So closely is the motor-car industry affected by electric traction progress, that it is of interest to note what Mr. Beaumont has to say on the general question. The progress already made consists, he considers, mainly in the removal of mechanical imperfections from types that already existed in 1897. To a much less successful extent have new types been introduced. Substantial increase of the propelling power is also to be noted, and, we may add, recalls the change which took place in electric tramcars after the first few cars had been built and run. It is a curiously persistent error to underestimate the amount of motor power, whether electrical or in some other form, required to replace animal power. Mr. Beaumont evidently considers that at present petroleum spirit is the most suitable motive power "for all long-distance, high-speed and high-endurance vehicles," and he regards with suspicion the attempts that have been made to use high-flash kerosene in place of spirit. Moreover, efforts in this latter direction "have not been encouraged by the flattery of imitation." In our opinion, however, the failure to use kerosene satisfactorily marks a decided limitation to the use of petroleum-driven vehicles. Steam road-vehicles, we are told, "have seen very little of development" in Europe during the past two years; and the cause of this is stated to have been M. Serpollet's preoccupation in the development of steam tramcars at Paris.

With regard to electric driving, Mr. Beaumont observes:—

> A great deal has been done in the two years in the development of the electric vehicle of various types, and the result of the two years' work seems to be that, for town work and short-radius runs, they are satisfactory and pleasing as to smoothness and quietness of running. They meet the requirements of those who do not wish to run more than 25 to 30 miles per day of roundabout work, and of those who do not study the cost either of vehicle or of running or maintenance. The secondary battery is still a thing of delicacy, which can soon be ruined by inconsiderate drivers who would use a starting switch as they would use a steam valve, and it is also a thing which is far more durable as a fixture than when used even in the most comfortably sprung automobile. As cabs the electromobiles have failed in London; they are in a similar plight in Paris, and at present none of these electric vehicles appears likely to take the place of horse vehicles in commercial work.

This view is not altogether encouraging, though it is to a large extent correct. The writer has put his finger on the trouble with electric cars—viz., the secondary battery; but it would have been more correct to have blamed the weight rather than the "delicacy" of the battery. It is the enormous weight of battery, and the effect of that weight on the build and wear of the vehicle, that are the principal drawbacks. We are, however, not without reasonable hope of considerable improvement in this respect in the future, just as there has been steady progress in the past. As to charging stations—which we are told "are not numerous," with the reminder that "charging takes a long time"—it will be time to increase their number when we are able to show a more durable and less heavy pattern of vehicle. We are not afraid that the electric motor-car industry will be killed for lack of charging stations.

It is sometimes instructive to see ourselves as others see us, even when we believe that we are being observed through yellow spectacles. The gas journals have frequently proclaimed the breakdown of electric light plant, but not until within the past week have they discovered a more alarming catastrophe in what is termed "The Breakdown of the Electric Lighting Acts." An article under this amazing title appears in the current number of the *Journal of Gas Lighting*, and we reprint it this week. It will afford merriment to our readers. So the Acts themselves, it seems, have completely failed in their purpose—and all because of that little local pother about the Metropolitan Electric Supply Co.'s shortcomings in Marylebone. "This is an age," we are assured, "that is pleased with change; and a change from electric light to gas will not be a reversion, but a step forward into greater brightness." Our readers will perceive that it is all settled—"this age" and "will be" admit of no doubt. Yet we think the commencement of the new century will show electric light still in the ascendancy, and the public still wary about being cajoled into risking big gas bills for "greater brightness."

We have received the prospectus of "The Taipo Accumulator Co., Ltd.," for which subscriptions will close on Monday next. No details are given of the nature or construction of the cell, and the only data as to its capabilities are that a battery "for lighting bicycles, measuring 4in. by 1¼in. by 4½in., weighs 1½lb.," gives a light for eight hours, and costs 5s. The capital of the company is put at £25,000, one-fifth for working capital, and the rest being paid in cash and shares to the vendor. The invention, if it is worth £20,000 when manufactured with a working capital of only £5,000, would be something distinctly out of the ordinary in the present condition of the storage battery industry; but if this is the case,

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we cannot but think that a more representative board of directors could have been found, and that manufacture on a larger scale would have been started forthwith. We are not told that the inventor is either an electrical engineer or a practical chemist. Of the other directors, one has the qualification of being a director of "Lockharts"; a second is styled "electrical engineer," but his name is only down among associates in the latest list of the Institution of Electrical Engineers; while the remaining two names are unknown to us. The payment to the vendor is mainly for British patent rights, and evidently the cost of establishing a suitable factory is to be defrayed out of the £5,000 working capital. It is stated that the cell has been reported upon by the consulting engineers—Messrs. O'Gorman and Cozens-Hardy—and that the opinion of Mr. Fletcher Moulton has been taken as to the validity of the patent. No extracts from these reports are given in the prospectus, but they may be seen at the offices of the company. We advise intending investors first to examine these reports, and then to choose some Government securities as a more profitable investment at the present crisis.

"The Designing of Electric Lighting Generating Stations."—A Paper on this subject was read last night, by Mr. A. Roberts, M.S.A., at a meeting of the Society of Architects, at St. James's Hall, Piccadilly.

Erratum.—Mr. Schaefer points out to us a clerical error in his article on "Indiarubber as Insulating Material for Cables," published in our last issue. In the last line of the first column on p. 427 read Blackpool instead of Bradford.

The Royal Society.—Among the Papers down for reading yesterday were: "On the Effects of Strain on the Thermo-electric Qualities of Metals, Part II.," by Dr. M. Maclean; and "On the Periodicity in the Electric *Touch* of Chemical Elements," by Prof. J. C. Bose.

Cambridge University Engineering Laboratory.—On the occasion of the opening of the John Hopkinson memorial wing of the Cambridge University engineering laboratory, on February 2nd, Lord Kelvin will deliver an address, after which the Master of Trinity will unveil a portrait of the late Dr. John Hopkinson, presented to the laboratory by subscribers.

Cable Interruptions and Repairs:—

	Date of Interruption.		Date of Repair.
Latakia—Cyprus	June 21, 1899	—	...
Cayenne—Pinhieros	Oct. 11, 1899	—	...
Mozambique—Lourenco-Marquez	Dec. 17, 1899	—	...
Tangier—Tarifa	Jan. 3, 1900	—	...
Iquique—Valparaiso	Jan. 9, 1900	—	Jan. 19, 1900
Serena—Valparaiso	Jan. 9, 1900	—	...

Proposed New Cable between England and Germany.—The Berlin correspondent of *The Times* reports that the German Telegraphs Administration some weeks ago placed proposals before the British Post Office for laying a new cable between Emden and the English coast. The assent of the British authorities to these proposals, he says, has not yet been obtained.

The Cantor Lectures.—The course of lectures which were to have been given by Major Cardew on "The Supply of Electrical Energy" has been abandoned, owing to his absence from England. Instead, the Council have arranged, and are able to announce, that Prof. J. A. Fleming, D.Sc., F.R.S., will deliver a course on "Electric Oscillations and Electric Waves," to be given on May 7th, 14th, and 21st.

Cuban Submarine Cables and the Spanish-American War.—A Reuter's telegram, in *The Times* yesterday, states that President McKinley has sent to the Senate papers bearing on the claim of the Cuba Submarine Telegraph Co. for £8,174 damages arising out of the war between the United States and Spain. The President at the same time submits to the Senate a brief message recommending the payment of the sum claimed as an act of comity and equity.

James Watt Anniversary Dinner.—The annual anniversary dinner to the memory of the immortal James Watt was held on Saturday the 20th inst., at the Windsor Hotel, Glasgow. under the auspices of the Institute of Engineers and Shipbuilders in Scotland. The chair was taken by Mr. Robert Caird, F.R.S.E., President of the Institute. Representatives of all departments of engineering, including not a few electrical engineers, were present, the gathering numbering some 270 persons.

Electric Siren for Lighthouses.—The *Railway and Engineering Review*, of Chicago, states that the Canadian Government has adopted for use at Vancouver, B.C., an improvement in fog signalling and lighthouse apparatus, which is a combination of the principle of the electrically vibrated phonographic diaphragm with two large megaphones, each of which emits an intense sound alternately. In connection with the roar of the huge electric siren there is a light which flashes every 40 seconds, the siren's roar being heard for the remaining 20 seconds of the minute. The mechanism is regulated by clockwork.

The Institution of Civil Engineers.—At the ordinary meeting of the Institution, on January 23rd, Mr. John Arthur Saner read a Paper on "Swing Bridges over the River Weaver at Northwich." Owing to the peculiar character of the foundations in the salt district, and the difficulty presented by subsidence, the author decided to adopt electrical power for the working of the bridges, though, so far as he knew, this plan had never been used before in England. Current is obtained from the outers of the local company's three-wire system, supplying at 440 volts, and a 20 H.P. motor together with two 4 H.P. motors are used direct-coupled at either end of the bridge, but fixed on to the abutments for withdrawing the wedges. The working of the bridges has given complete satisfaction.

The Late Prof. D. E. Hughes.—At the meeting of the Institution of Electrical Engineers, last night, the President (Prof. Silvanus P. Thompson) announced in a few feeling words the loss the Institution had sustained by the death of their past-President, Prof. D. E. Hughes, and referred in eloquent terms to his services to science. He moved that a vote of sincere condolence to Mrs. Hughes should be passed. Major-Gen. Webber seconded the motion, which was passed unanimously. The President then read a letter from the executors announcing that the funeral would be held in the upper portion of Highgate Cemetery, at noon on Saturday. A special service will be held at All Souls' Church, Langham-place, at 10.45 a.m. on Saturday, at which all scientific friends of the late Professor are invited to be present. The Council has arranged to be officially represented both at the service and at the funeral.

Electric Traction in Germany.—The first January number of the *Elektrotechnische Zeitschrift* contains, as usual, interesting statistics of the electrically-driven tramways in Germany. There are now 93 German towns or districts with electric tramways, as compared with 77 last year (see *The Electrician*, Vol. XLII., p. 459). In addition, there are 30 new lines definitely projected or in progress, and 39 extensions to existing railways in hand. The following totals are made up to September 1, 1899: Total length of lines, 1,270 miles; total length of track, 1,750 miles; number of motor-cars, 4,504; number of trailers, 3,138; total capacity of generating plant, 52,509 kw.; total capacity of power house batteries, 13,532 kw. The total length of lines and track in operation up to the end of December, 1899, is also given—viz., 1,420 miles and 1,970 miles respectively; and the length of lines at present in progress or definitely projected of which our contemporary has been able to obtain information is 520 miles, corresponding to 675 miles of track.

Electrically Welded Joints between Rails and Cables.—The *Street Railway Journal* describes some ingenious arrangements which have been adopted by the International Traction Co. in and around Buffalo for connecting the cross-bonds and other

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return copper to the rails. In general, the straight track is not welded to special work. To conduct the current around the special work short jumpers of scrap cable are connected to the welded rails at each side of the switch or crossing, and these jumpers, with the cross-bonds and return feeders, are electrically welded to the rails. Not a few practical difficulties arose in successfully welding copper with steel. These have been successfully overcome by Mr. C. K. Marshall, the company's electrical engineer. The cable is welded in between the web of the rail, and a round, flat disc of steel also welded to the rail. These discs or blocks are generally made of old car axles cut off, heated and swaged to the proper shape under a trip hammer. A slot is thus formed in one side of the block, and the welding is done by inserting the cable in this slot and then forcing the slotted side of the block against the web of the rail with a pressure of 50 tons applied at the same time as the current. The ends of the slot are milled somewhat larger, to allow an easy bend of the cable as it emerges from the block. The cable is at first drawn back and forth to prevent its burning, and is then allowed to rise with the other parts to a melting temperature. A block on the other side of the rail web is used as a return for the current. This block is made of larger bearing section, and is not carefully cleaned, so that after the weld is made this block can, as a rule, be removed. Sections through connections melted in this way show that the block, rail, and copper are practically one piece of metal.

The New German Telegraphs Act.—The telegraph administration of the German Government has hitherto had rather arbitrary powers with regard to the laying of its lines and their protection from outside disturbance by other electric conductors when laid. By a law, which passed the Reichstag on December 13th last, and came into force on January 1st, these powers are limited and defined. The administration is authorised to make use of the public roads so long as it does not diminish their accommodation for traffic, and it is bound to put the roads into good condition again as soon as possible. Certain rules are laid down to prevent, so far as possible, injury to the trees, &c., on the highways, and to the existing lines, pipes, &c., of other services. Any further work on the highways is to be carried out, if possible, in such a way as not to disturb existing telegraph lines; but, on the other hand, the expense of alteration, in the telegraph lines, subsequently necessary for the carrying out or extension of other services for the public good or the furtherance of traffic, is to be borne by the telegraph administration. For instance, guard wires, if required, are to be erected by the telegraph administration, and, although not explicitly stated in the Act, this provision evidently includes the conversion of single-wire telephone circuits into metallic when rendered necessary by electric tramway lines. Before new telegraphic lines can be laid or erected on a highway, plans are to be submitted to the local authority, and these are to lie for four weeks in the post-offices of the district in question, for the reference of others interested. The telegraph administration is entitled to use of the "air space" above private property, so long as the property is not damaged in any way; and officials are entitled to enter private property, and have access to roofs for repairs, &c., on telegraph lines, the only proviso being that they make good any damage they do. A clause expressly states that the new Act shall not in any way affect the existing law as to telegraph lines on railways, but its provisions are to apply to all German Government telegraph and telephone lines, including those in Bavaria and Würtemburg (each of which kingdoms has its own telegraph administration), and including lines for military and naval purposes.

Lecture on Wireless Telegraphy.—Under the auspices of the Glasgow Lecture Association, Prof. Oliver Lodge delivered a lecture on "Wireless Telegraphy," in the Queen's Rooms, Glasgow, on Jan. 18th. The lecturer first explained how Lord Kelvin's discovery of electrical oscillations in 1853 was subsequently made the basis of Maxwell's electromagnetic investigations, leading in 1864 to his famous exposition of the electromagnetic theory of light. It was left to Hertz to show how to produce, detect and measure electrical waves which were unable to affect the eye. Light vibrations, on this theory, differ from the electromagnetic vibrations only in point of size, the length of a light wave being of the order of thousandths of a millimetre, while that of an electromagnetic wave might be any length between a few inches and thousands of miles. The properties of reflection, refraction, polarisation, and interference were common to both types of vibrations, and proved their identity. The researches of Branly in France, of Righi in Italy, of Bose in India, of Popoff in Russia, and of Edison in America, were referred to, and he explained how Marconi had, in 1896, applied the results of these experiments to the transmission of wireless telegraphic messages over considerable distances—especially at sea. Profs. Slaby and M. Ducretet had also devised apparatus, which they used in land experiments, which were extremely successful over shorter distances. Prof. Lodge then entered into a somewhat popular elucidation of the principle of action of the wireless telegraphic apparatus. The running of the electric pulse up a vertical wire was likened to the running of a pulse along the thong of a whip, whereby at the end a great disturbance or crack was communicated to the ether or to the air. This corresponded to the sending of the signal. At the receiving station a certain small quantity of this energy was collected by a similar vertical wire, to the lower end of which was connected a "coherer"—a tube containing metallic filings—a battery, and a relay. When the electromagnetic impulse arrived, the metallic filings "cohered"; the current could then pass through it, and the tongue of the relay would be thrown over till the metallic filings were tapped back and were "decohered." The relay threw into action a larger battery in the ordinary telegraphic manner, and was able to write dots and dashes on a tape, as with the Morse instrument. A single sharp shock gave a dot, while a rapid succession of shocks gave a continuous dash. In conclusion, Prof. Lodge remarked that the absence of any connecting wire was not in itself very remarkable, for from the earliest times flash-lights and beacons had been in use for signalling purposes, advantage being taken of the possession by man of an instrument for detecting these signals infinitely more sensitive than the coherer—namely, the eye. The lecture was illustrated by numerous experiments and slides.

MEETINGS OF SCIENTIFIC AND ENGINEERING SOCIETIES, &c.

(TO-DAY) FRIDAY, January 26th.

PHYSICAL SOCIETY.

5 p.m. Meeting in the Chemical Society's Rooms, Burlington House. Papers to be read: (1) "Some Developments in the Use of Price's Guard Wire in Insulation Tests," by Prof. Ayrton and Mr. Mather; (2) "Reflection and Transmission of Electric Waves along Wires," by Dr. E. Barton and L. Lownds; (3) "The Frequency of the Transverse Vibrations of a Stretched India-Rubber Cord," by T. J. Barker.

INSTITUTION OF MECHANICAL ENGINEERS.

8 p.m. Annual General Meeting. The following Paper will be read and discussed: "Water Meters of the Present Day," by W. Schönheyder.

ROYAL INSTITUTION.

9 p.m. Evening Discourse, by the Hon. C. A. Parsons, F.R.S., on "Motive Power—High-speed Navigation—Steam Turbines."

THURSDAY, February 1st.

RÖNTGEN SOCIETY.

8 p.m. Ordinary General Meeting at 20, Hanover-square. A Paper on "Röntgen Rays in Diseases of the Chest," will be read by Dr. Hugh Walsham, after which Mr. A. Hastings Stewart will show a small Egyptian mummy and skiagrams of the same.

FRIDAY, February 2nd.

INSTITUTION OF CIVIL ENGINEERS.

2.30 p.m. Student's visit to the electrical works of the London United Tramways (Limited), 88, High-road, Chiswick.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.

7.30 p.m. General Meeting in the Lecture Hall of the Literary and Philosophical Society, Westgate-road, Newcastle-on-Tyne. Among the business of the evening is the discussion on Prof. R. L. Weighton's paper on "Receiver Drop in Multiple Expansion Engines."

ROYAL INSTITUTION.

9 p.m. Evening discourse by Signor G. Marconi on "Wireless Telegraphy."

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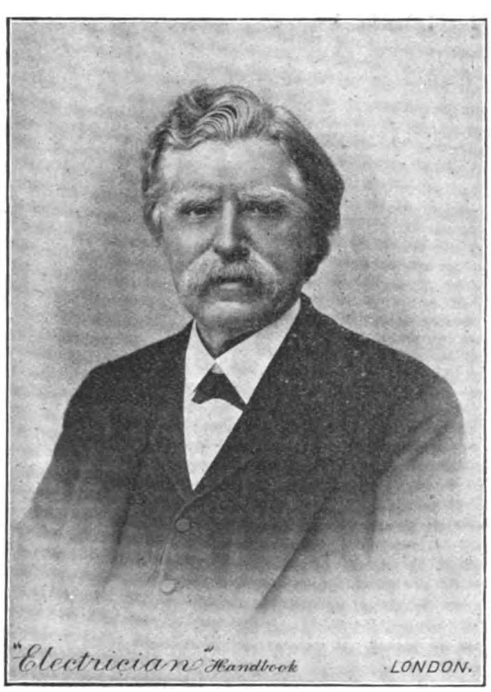
OBITUARY.

DAVID EDWARD HUGHES.

It is with profound sorrow that we have to announce the death, on Monday evening last, of Prof. D. E. Hughes. His death, at the age of 69 years, deprives the world of one of its most accomplished electricians, the electrical profession of one of its most honoured and respected members, and a world-wide circle of admirers of a genial and well-beloved friend. It can truly be recorded that David Hughes lived without making a single enemy, and died mourned by all whose good fortune it has been to come within the cheery circle of his friendship. We mourn his loss not only as a well-esteemed personal friend, but also as a compatriot to whose versatility and genius his native country has been astoundingly blind, while all the countries of the civilised world have showered honours upon his head.

David Edward Hughes was born in London on May 16, 1831. When but seven years of age he emigrated with his parents to the United States, where he developed such musical ability that he attracted the attention of Herr Hast, an eminent German pianist in America, who procured for him at a very early age the professorship of music in the college of Bardstown, Kentucky. Simultaneously with his musical studies Hughes appears to have developed a remarkable fondness for physical science and mechanics, and his studies in these branches of knowledge justified his appointment, at the early age of 19, to the chair of natural philosophy in the same college as that in which he held the professorship of music. Here, in the intervals between his educational duties, Prof. Hughes turned his inventive ability and knowledge of physical science to the development and improvement of electrical instruments, notably those for telegraphic purposes. The first important invention published to the world at this time was his world-renowned type-printing telegraph, an invention which was speedily taken up in the United States as a formidable competitor to the Morse system monopolised by the American Telegraph Co. A patent for this instrument was taken out in the United States in 1855, and in less than two years a number of small telegraph companies, including the Western Union—which was at that time in its early stages of development—had united to form one large corporation, the present Western Union Telegraph Co., to carry on the business of telegraphy on the Hughes system. In that same year Prof. Hughes returned to England for the purpose of introducing the instrument to the then existing Electric Telegraph Co., which controlled the telegraphic business in this country. Failing, however, in this endeavour, Prof. Hughes was compelled to carry his invention across the Channel to France, where it met with a much more enthusiastic reception at the hands of the French Government, who agreed to give the instrument a year of practical trial on the French land lines, and if found satisfactory it was to be finally adopted. Aided by his experience already acquired in America, Prof. Hughes was able to make the experimental trial a thorough and complete success. The instrument was adopted in France, and indeed throughout Europe, and honours showered thickly upon the head of the inventor. Napoleon III. created Prof. Hughes a Chevalier of the Legion of Honour; and scarcely more than two years later he received from the King of Italy the Order of St. Maurice and St. Lazare. In 1863 the type-printer came in for recognition in this country at the hands of the United Kingdom Telegraph Co., but it cannot be said that either the English companies or the English Government recognised to so full an extent as has been done abroad the merits of this remarkable invention. In 1863, owing to the success of the instrument in Russia after six months' trial, Prof. Hughes was created a Commander of the Order of St. Anne; and in 1867 he installed his instruments on the Prussian land lines, and in Austria. He received the Order of the Iron Crown from the King of Austria, while the Sultan of Turkey bestowed on him the Grand Cross of the Medjidie. In 1867 the Paris Exhibition awarded him one of the ten gold medals designed to reward the very highest achievements in science at that time. We may add that Prof. Hughes also received the Noble Order of St. Michael for the success of his instruments in Bavaria and Wurtemburg; while later, Switzerland, Belgium, and Spain acknowledged his genius by equally marked honours.



PROF. D. E. HUGHES, F.R.S.

It has been erroneously supposed that the unfortunate failure of the Government of Great Britain adequately to recognise the genius of Prof. Hughes has been connected in some way with the comparatively small part played by his type printing telegraph in this country. That, however, affords no justification for the lamentable procrastination of the Government in this respect. We have repeatedly called attention to the singular meritoriousness of Prof. Hughes' many researches in practical and theoretical science, from the point of view of a national recognition and honour; and although unfortunately it is now too late for Prof. Hughes himself to be gladdened by the receipt of such recognition from his own country, we trust that the nation which has failed to do him justice during his life will perceive a clear call to raise a suitable memorial to him now that he is dead.

With this end in view, we may continue to enumerate the benefactions bestowed by Prof. Hughes upon the world through the medium of his inventions and researches. Quite setting aside his type-printing instrument, he has accomplished far more than would be sufficient to justify a national memorial. Take, for example, his invention of the microphone, an instrument which is the very foundation of our modern system of commercial telephony. True, others before him had succeeded in transmitting sounds electrically over a distance, but it was not until Hughes made a free present to the world of the simple yet marvellously-ingenious carbon microphone, that practical telephony became a possibility. Whether in the invention of the instrument itself, or in the generous presentation of it freely to the world, he claims our admiration and honour.

Space does not here permit us to do more than enumerate some of Prof. Hughes' contributions to electrical science. Our readers are familiar with the long succession of researches he made in the domain of the experimental theory of magnetism. His Papers on this subject were read before many scientific and technical societies, and brought him not only the Fellowship of the Royal Society, but medals and similar honours from numerous lesser institutions. In 1886 he filled the presidential chair of the Institution of Electrical Engineers.

As another example of the fundamental character of Prof. Hughes' researches in regard to modern scientific development, it is not too much to say that he discovered the essential principle of wireless telegraphy. Unfortunately, the discovery was not published at a sufficiently early date, for it was only on May 5th last that the first public announcement of this fact was made, in an article contributed by Prof. Hughes himself to *The Electrician*. This article abundantly proved

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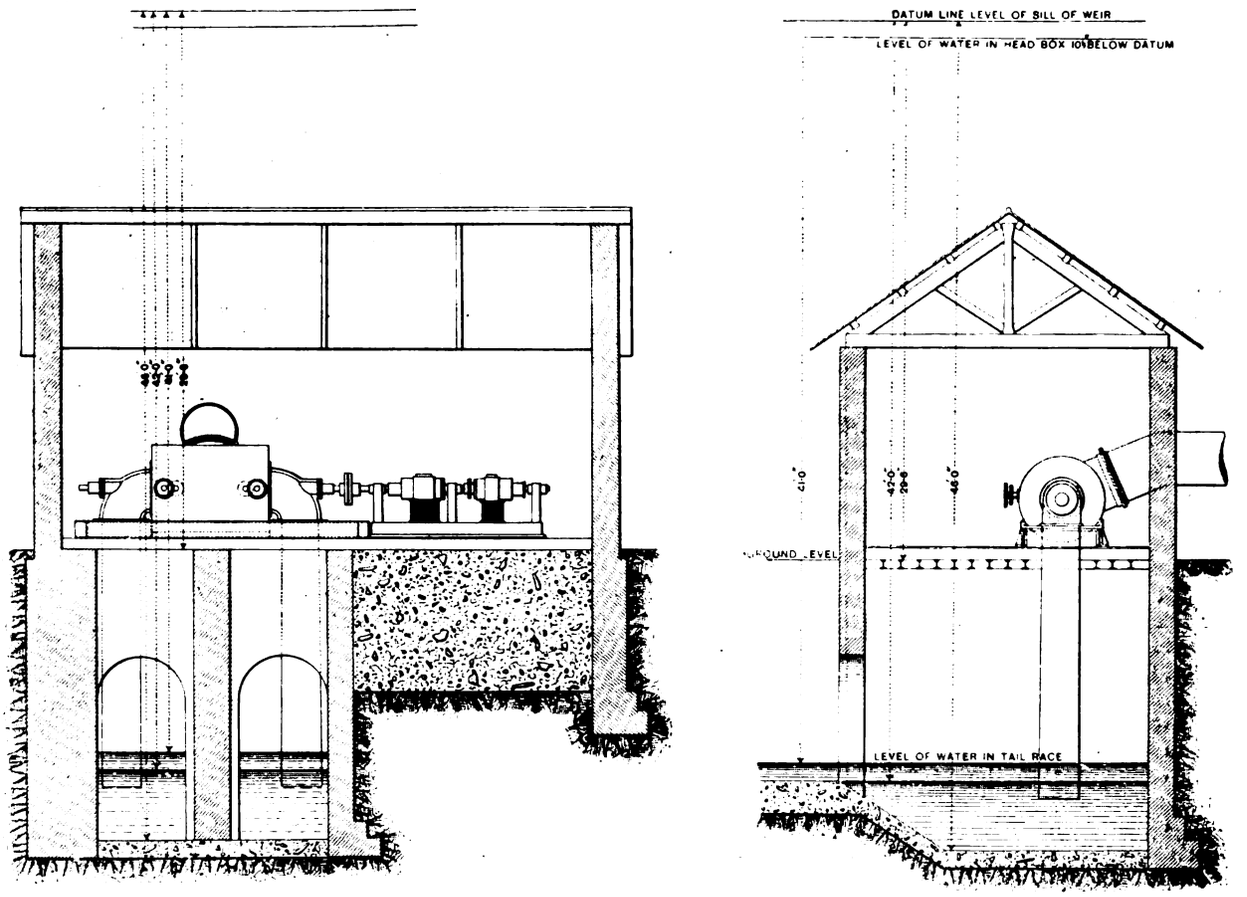
his claim to have been the first to transmit actual signals over a considerable distance by means of electrically-generated ether waves; which is, in fact, the basis and essence of wireless telegraphy on the Marconi system.

The compass of a mere biographical sketch in this journal does not admit of bringing out in any degree of prominence the versatility and surpassing genius of Prof. Hughes. But when the history of electrical science, discovery, and invention during the latter half of the nineteenth century shall have been written, the name of Prof. D. E. Hughes will be conspicuous among those whose labours have contributed to form the subject matter of its pages.

ISLE OF MAN ELECTRIC TRAMWAYS: WATER POWER UTILISATION PLANT.

As announced in our issue of the 12th inst., the Isle of Man Tramways and Electric Power Co. have recently put into operation a water power plant in connection with their Douglas-Laxey and Ramsey electric lines; and the successful results obtained have enabled them to shut down their steam plant entirely, the entire line, 18 miles in length, being worked solely by water power. The line in the summer time is used for tourist traffic, when the load on the several power stations reaches about 2,200 H.P., but for about seven months each year the line is dependent on the local passenger and freight traffic, which is comparatively light. The water power scheme, which was originated by Mr. Alexander Bruce, J.P., the chairman of the company, was designed by Mr. J. Shaw, A.M.I.E.E., the general manager and engineer, to work the line during these seven months, when the traffic is considerably reduced, and when it is necessary as far as possible to keep down the expenditure. As all the coal used by the company has to be imported from South Wales, the financial saving will be considerable.



PLAN AND ELEVATIONS OF WATER POWER STATION ON LAXEY RIVER.

The Laxey river, which is seven miles from the Douglas and 11 miles from the Ramsey termini, has been utilised for obtaining the requisite power. The water has been taken after it leaves the "washing floors" of the Great Laxey Lead Mines, and the tail water is discharged direct into Laxey harbour, the total fall being 41ft., which, after deducting pipe losses, &c., allows a working fall of 38ft. As part of the water is used for ore-washing purposes at the Snaefell and Great Laxey Mines, it contains an immense quantity of sand, and special precautions have been taken to prevent this from reaching the turbines. The head work consists of a concrete weir 40ft. long by 4ft. 6in. high, built across the

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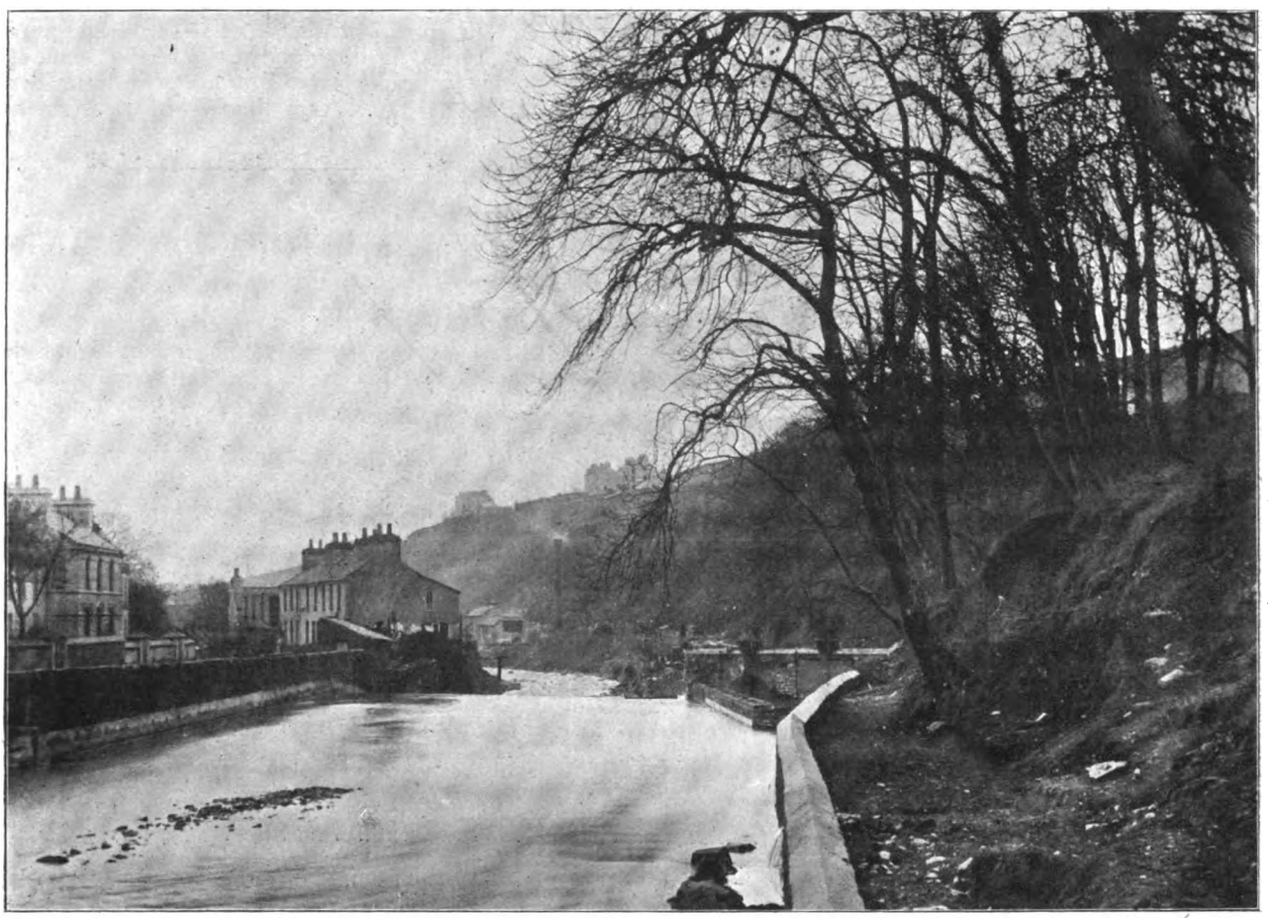
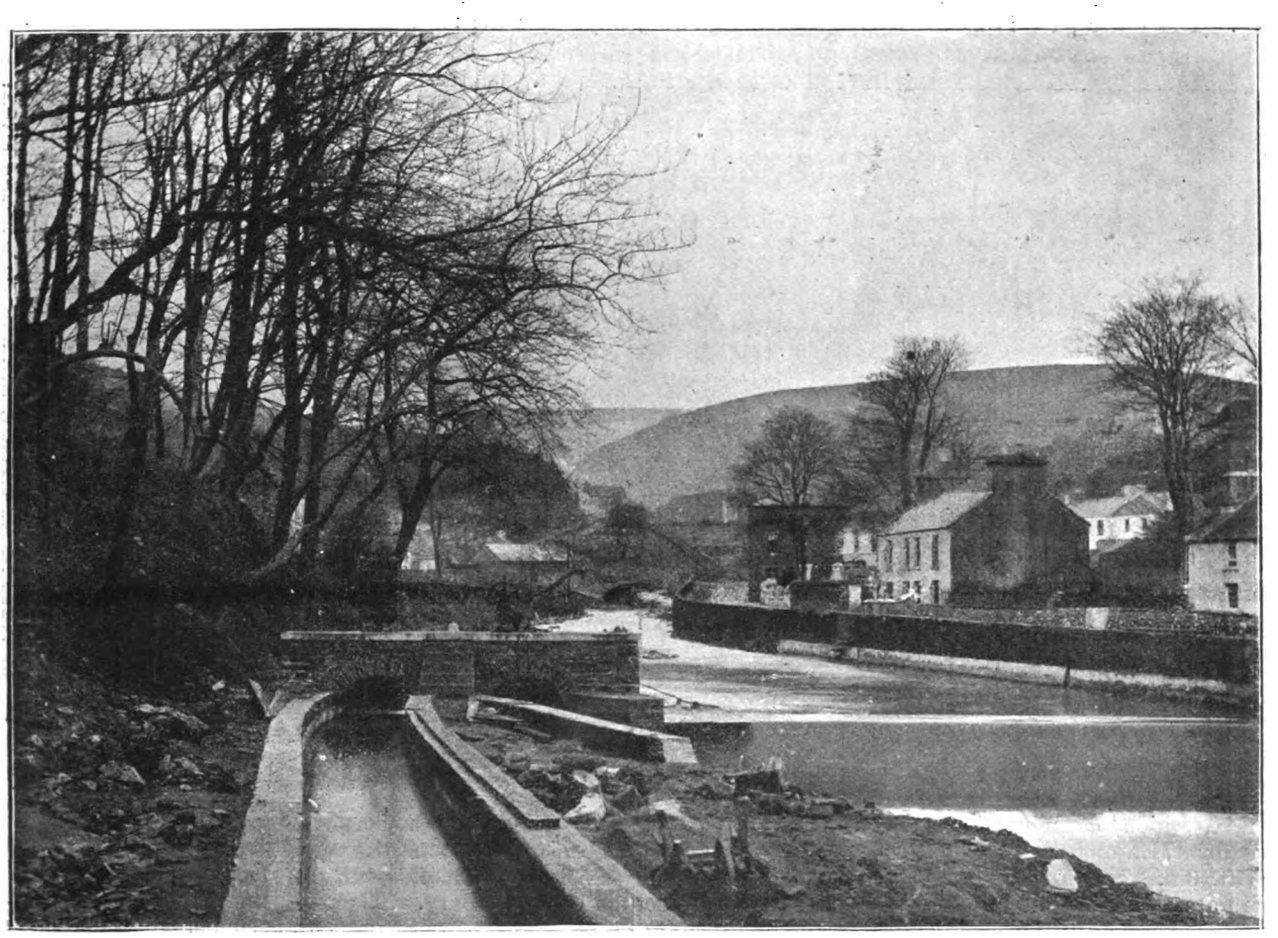


ISLE OF MAN ELECTRIC RAILWAY. VIEW ABOVE WEIR, SHOWING TOP WATER INTAKE.



ISLE OF MAN ELECTRIC RAILWAY. VIEW OF LAXEY RIVER AT DISCHARGE FROM TAIL WATER CANAL.

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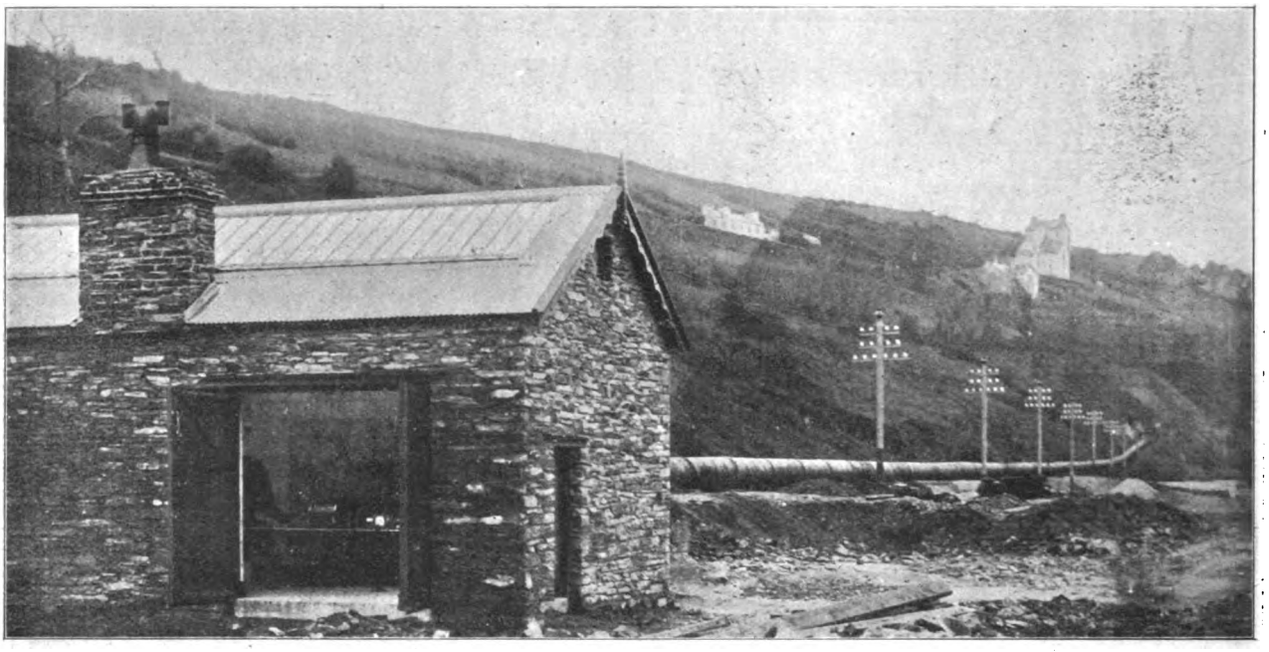
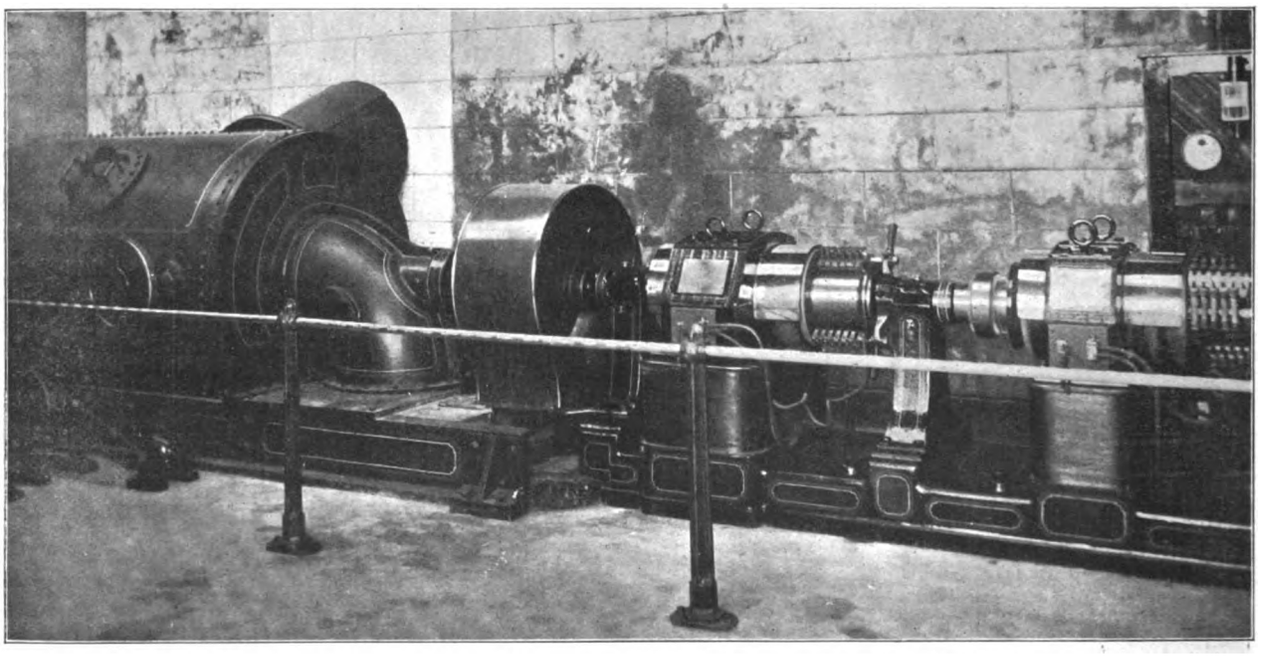
river. At one end of the weir are two masonry archways 5ft. wide by 5ft. high, each fitted with a sluice gate and the necessary gear for raising and lowering the gates. The two gates are separated from the river by means of an iron grating 55ft. long by 5ft. 6in. high. During floods a large amount of debris is washed down the river, and the gratings protect the gates from being blocked. Inside the gratings is a large settling tank for the sand, the tank being emptied by opening the gate nearest the weir, which is used as a bye-pass for flushing purposes. The other gate is at the commencement of the head race, which consists of 826ft. of trench 5ft. wide, followed by 474ft. of trench 3ft. 6in. wide, the depth of each being 4ft. 6in. The first of these two sections was made larger in area, to allow the water to travel slowly and settle any sand which might have passed through the first settling tank. At the end of the larger section of race another settling tank has been formed by dropping the bottom of the trench 6in. for a distance of 50ft., and providing it with a 12in. flushing valve. At the end of the second section of race is built a masonry head box 8ft. by 11ft. by 7ft. 9in. deep, from which the water is conveyed to the turbines by means of 820ft. of steel pipes 3ft. diameter. The head box has also been built to act as a settling tank, thus preventing any sand from entering the pipes. An overflow weir 20ft. long has been built about halfway along the race, the surplus water being conducted to the river through an underground conduit. Owing to the bad nature of the ground, the whole of the head race has been constructed of concrete, with the exception of one short length built of masonry. The pipe line, which had to be kept several feet above the ground, is supported on masonry piers. The pipes are made up of $\frac{1}{8}$in. steel plates with double-riveted



Isle of Man Electric Railway. Exterior of Water Power Station and Pipe Line.



Isle of Man Electric Railway. Interior of Water Power Station.

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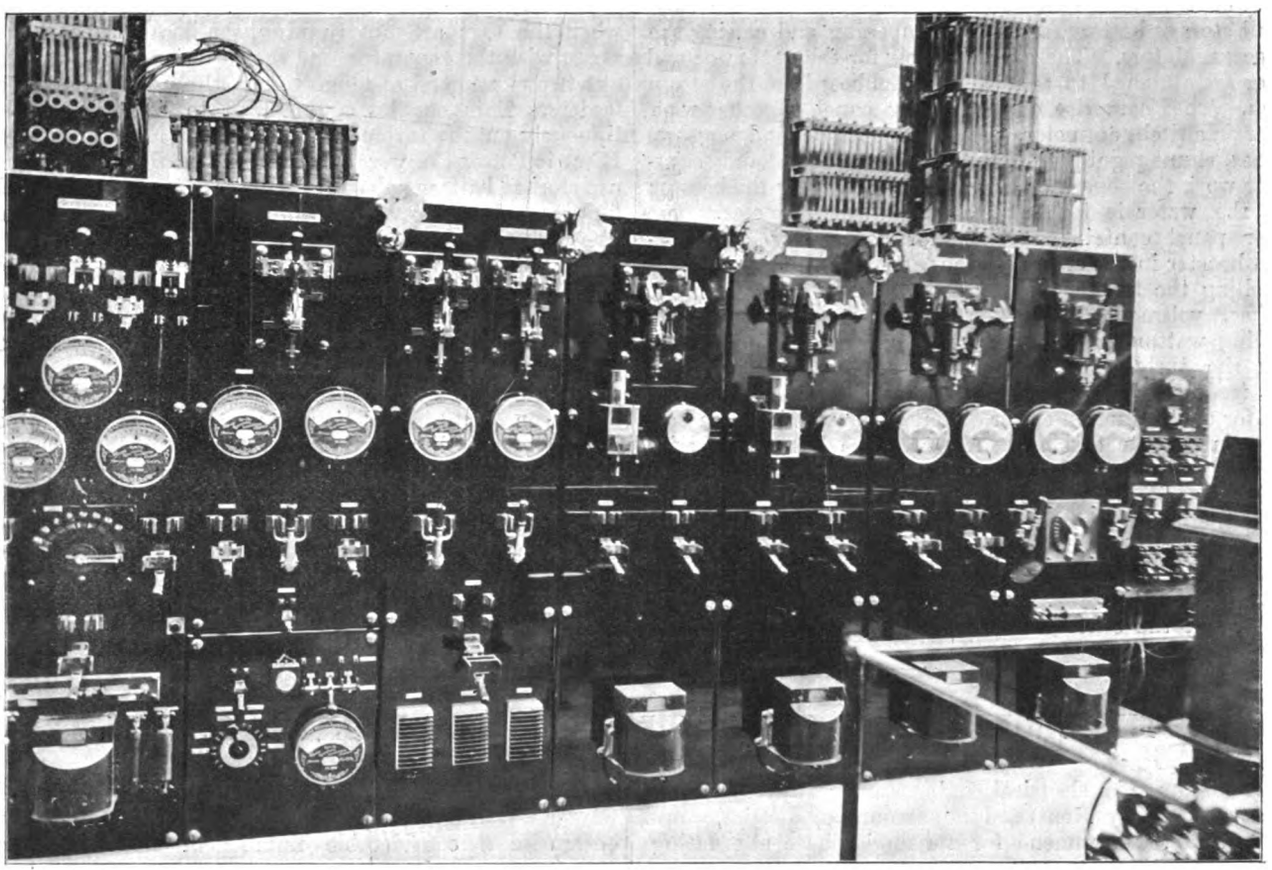
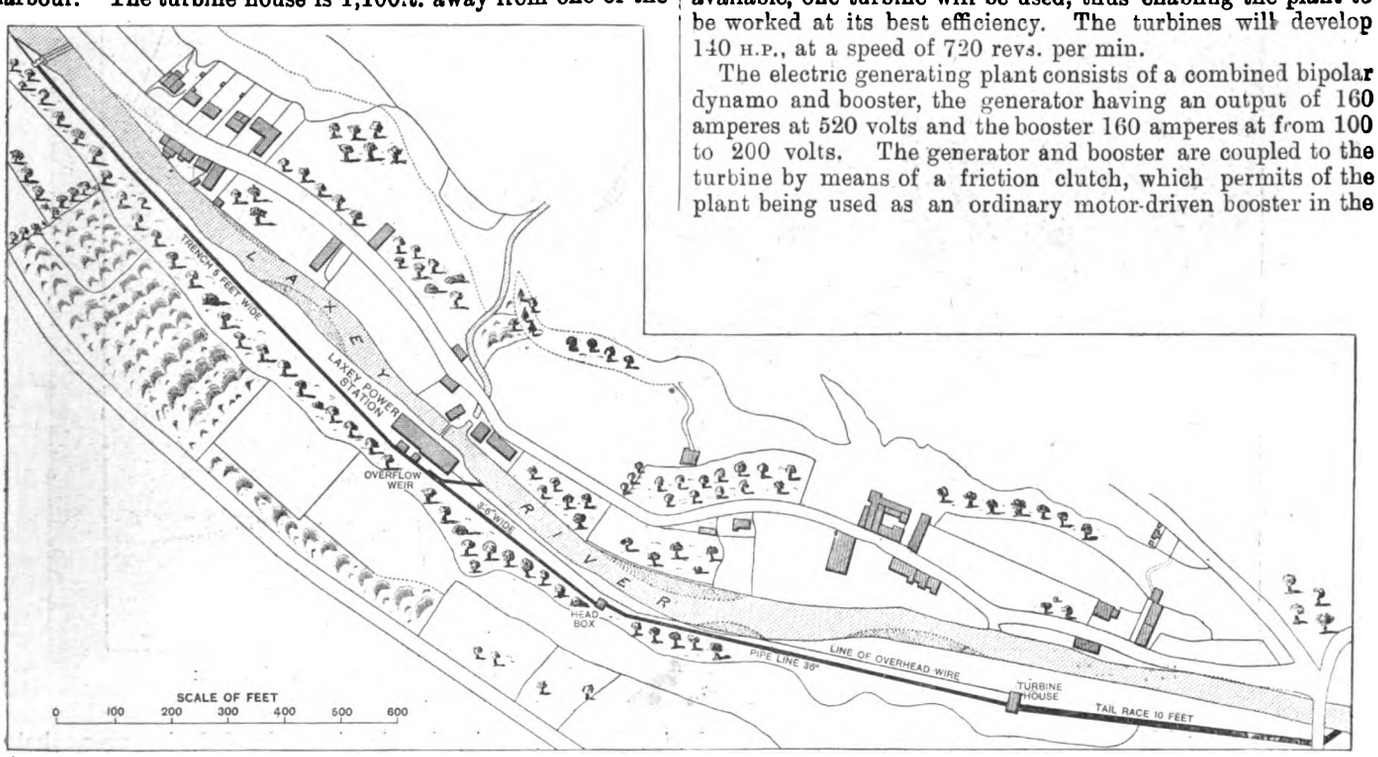
seams, and are fixed in 15ft. lengths. The joints are made with Kimberley collars run in with lead and well caulked.

The tail race is 624ft. in length, 10ft. wide, and 13ft. 3in. below the floor of the turbine house, and terminates in Laxey harbour. The turbine house is 1,100ft. away from one of the company's steam power stations, and is a stone building 30ft. long by 15ft. wide by 12ft. high. The fall from the level of the weir to the centre of the turbines is 26ft., the remaining 15ft. fall being obtained by means of draft tubes. The turbines are of the "Victor" horizontal type, and consist of two independent 12in. turbines in one casing with the shafts direct coupled; so that, when there is only a small amount of water available, one turbine will be used, thus enabling the plant to be worked at its best efficiency. The turbines will develop 140 H.P., at a speed of 720 revs. per min.



ISLE OF MAN ELECTRIC RAILWAY. SWITCHBOARD AT WATER POWER STATION.

The electric generating plant consists of a combined bipolar dynamo and booster, the generator having an output of 160 amperes at 520 volts and the booster 160 amperes at from 100 to 200 volts. The generator and booster are coupled to the turbine by means of a friction clutch, which permits of the plant being used as an ordinary motor-driven booster in the summer time when the river is very low. The turbines, generator, and booster are provided with self-lubricating bearings, and are capable of maintaining long continuous runs without



ISLE OF MAN ELECTRIC RAILWAY. MAP OF WATER POWER COURSES, &C., ON LAXEY RIVER, SHOWING POSITION OF TURBINE HOUSE AND LAXEY STEAM POWER STATION.

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heating. The mains from the generator and booster and the regulating wires are carried overhead to the steam power station previously referred to, from which the turbine plant is entirely controlled. Two Lundell ¼ H.P. motors, driven from a small storage battery, are used for opening and closing the turbine regulators. The switch panels for the generator and booster are attached to the main switchboard in the steam station. They comprise one generator panel, together with automatic switch, ammeter, voltmeter, positive and negative switches, shunt regulating switch, starting switch, and resistance to work the generator as a motor for driving the booster when the water is low, and a recording wattmeter. The booster panel contains switches for controlling a motor-driven booster in the steam station, and also the switches for controlling the turbine booster—viz., positive and negative switches, voltmeter, ammeter, shunt regulating switch, recording wattmeter, and change-over switches to connect either the turbine booster or motor booster to any of three feeders. Adjoining the generator panel is a small panel for controlling in either direction the two ¼ H.P. motors for regulating the turbines. A small pipe has been carried from the head race, and is attached to a gauge glass fixed in a prominent position near the switchboard, so that the attendant can see the height of the water in the head race.

The turbine plant is worked in connection with three battery sub-stations, each containing 250 cells of the Chloride "R" type, one at Laxey, at the foot of the Snaefell mountain railway, and the other two about five miles on each side, all three stations being worked in parallel. When the cars are taking current the turbine generator is assisting the batteries, but when the cars are descending the grades or standing the generator is charging the batteries. During the night time, when the cars are not running, the booster is connected in series with the generator, and the batteries are in turn charged at a heavy rate and at a high voltage through the underground feeders. This enables a full load to be maintained continuously on the turbines. The Isle of Man Tramways and Electric Power Co. were the first in the United Kingdom to use storage battery sub-stations for traction purposes, and they find these have proved exceedingly useful for working a long line with a minimum amount of steam plant.

The turbine plant described above has just completed a 240 hours continuous test, during which it maintained a steady load varying from ¾ to full load; and although the turbines are not provided with any governor, it was not once necessary to alter the regulation.

The turbines and pipes have been supplied by Mr. F. Nell, of Queen Victoria-street, London, and the generator and booster by the Electric Construction Co., of Wolverhampton. The construction of the weir, water courses, and buildings, and the erection of the plant were carried out by the company's staff under the superintendence of Mr. J. Shaw, general manager and engineer, to whom we are indebted and our thanks are tendered for the illustrations and particulars of this unusually interesting example of water power utilisation for electric supply.

THE BROMLEY AND CHISLEHURST ELECTRIC LIGHTING SYSTEM.

A few years ago an electrical engineer, after a mere glance at the map of Bromley (Kent) and the surrounding district, would have decided to recommend for it a single-phase alternating-current system, with transformers for the most part placed in consumers' houses, and sub-stations to supply the lines of shops where they occur. In the town of Bromley itself is a fairly compact load, chiefly from shops and a large hotel. There are a few private houses here, but large residential districts lie removed by distances from one to three miles from the centre of the town; and there is also the village of Chislehurst, 2¾ miles distant, divided around three points of maximum density—Chislehurst, Chislehurst West, and Lower Camden. Edmundsons' Electricity Corporation, to whose enterprise a considerable number of smaller towns are indebted for their electric light, decided, however, that a 2 × 210 volt three-wire system was the best adapted to the district in question, they being fortunate enough to obtain a site for their station in the very centre of the Bromley load, and actually adjoining the premises of the largest consumer—the Bell Hotel. At Chislehurst a sub-station has been erected, to which power is transmitted from Bromley by continuous current at 2,000 volts. Here it is

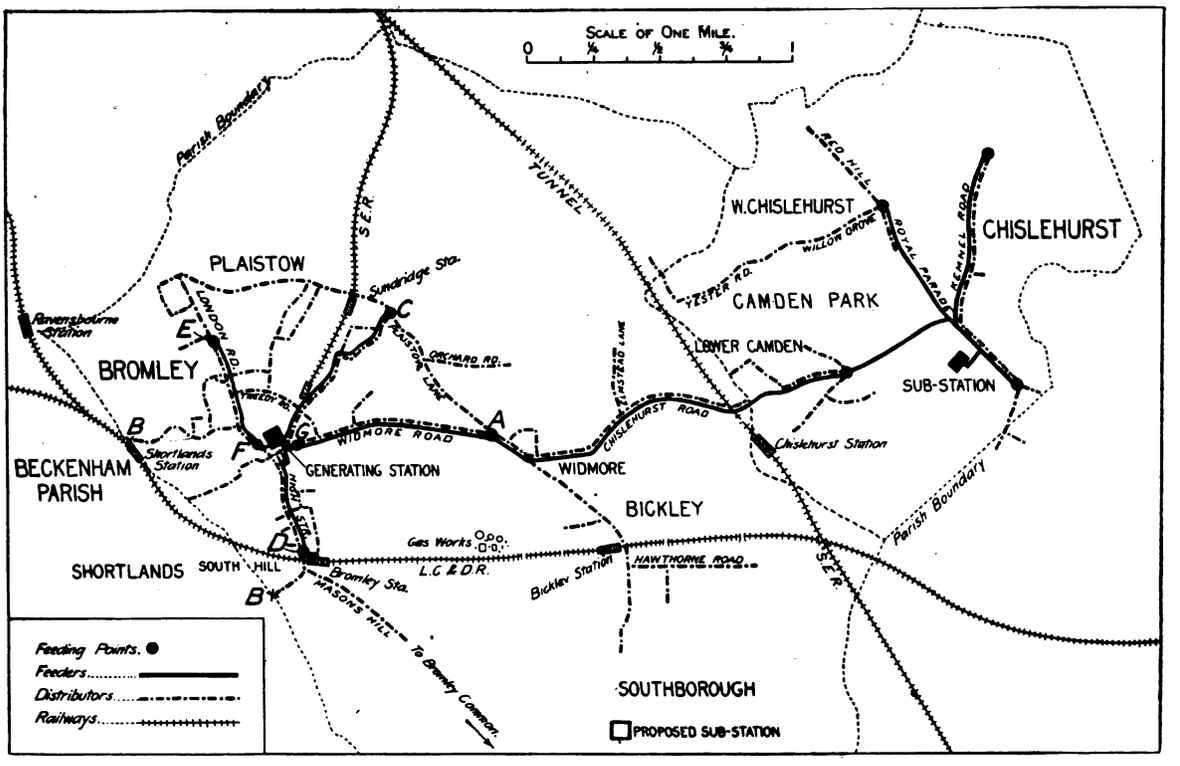

Fig. 1.—Map of Bromley and Chislehurst, showing Parish Boundaries, and Distributing Network.
The southern boundary of Bromley is 1½ miles further south.

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converted by variable-ratio continuous-current transformers to 420 volts pressure for distribution on a three-wire system, the converters being supplemented by a secondary battery of relatively large capacity. The powers held by the Bromley (Kent) Electric Light and Power Co. under its Provisional Order extend only within the limits of the Urban District, and the Chislehurst Electric Lighting Co. has an order applying to Chislehurst only. Both companies have been formed by Messrs. Edmundsons, who were the contractors for the entire system. In addition, the Beckenham District Council, who have already laid down an extensive distributing system but have not yet completed the alternating-current station they have in progress, are also taking a wholesale supply of electrical energy from the Bromley Co.

The Bromley Provisional Order was obtained by the Urban District Council in 1891. In 1895 several local gentlemen, backed by Messrs. Edmundsons (who provided practically all the capital), endeavoured to obtain the transfer of the order, and this was finally effected in 1898. As is customary nowadays in the case of all new electric lighting undertakings, the demand for electric light existed in an acute form before the station had been completed; in fact, at Bromley, owing to the rebuilding of the large hotel already mentioned, which relied entirely on electricity for lighting purposes, the company were under contract to supply current before even the foundations of the station were laid. The resourcefulness of Messrs. Edmundsons, and especially of Mr. R. L. Gamlen, the engineer-in-chief of the Bromley and Chislehurst companies, in successfully meeting this difficulty was remarkable. Adjoining the site of the works was a 6 H.P. nominal gas engine, employed to drive a chaff-cutting machine for about 20 hours a week. A second-hand 110 volt 8 kw. Siemens dynamo, which happened to be obtainable immediately, was placed in the loft above the gas engine (there being thus a directly vertical belt drive), and this was employed to charge the half battery of 114 cells which was hastily put up. The voltage for which the consumers were wired was 210 volts. It was taken directly from the cells, these being discharged continuously, and being divided up into three sets for charging by the low-voltage dynamo. In this manner, by running night and day, with the exception of the 20 hours a week during which chaff had to be cut, five consumers, with an aggregate lamp connection equivalent to about 1,000 8 c.p. lamps, were supplied without serious interruption from June to November, 1898. As soon as the foundations for one engine and dynamo were completed and the boiler plant was sufficiently advanced, but before the roof was up over the engine room, an 80 kw. Belliss-Parker set was erected, surrounded by a small wooden shed to protect it from the weather, a coke stove being placed inside the shed to keep the machine dry. While the necessary alterations were being made to the battery and switchboard, this machine was at first running at half voltage under the same conditions as the temporary one. By February last the station was in a fairly complete state, an 80 kw. 2,100 volt Belliss-Parker set, and an 80 kw. continuous-current converter having been erected in addition to the first machine, and serving both to supply Chislehurst and as reserve for Bromley. Finally, in November last a second 210-volt Belliss-Parker set, having a capacity of 160 kw., was put down; and, when the third 250 H.P. boiler now being erected and the new generating plant on order are in operation, the station will be prepared to meet all demands on it for some time to come.

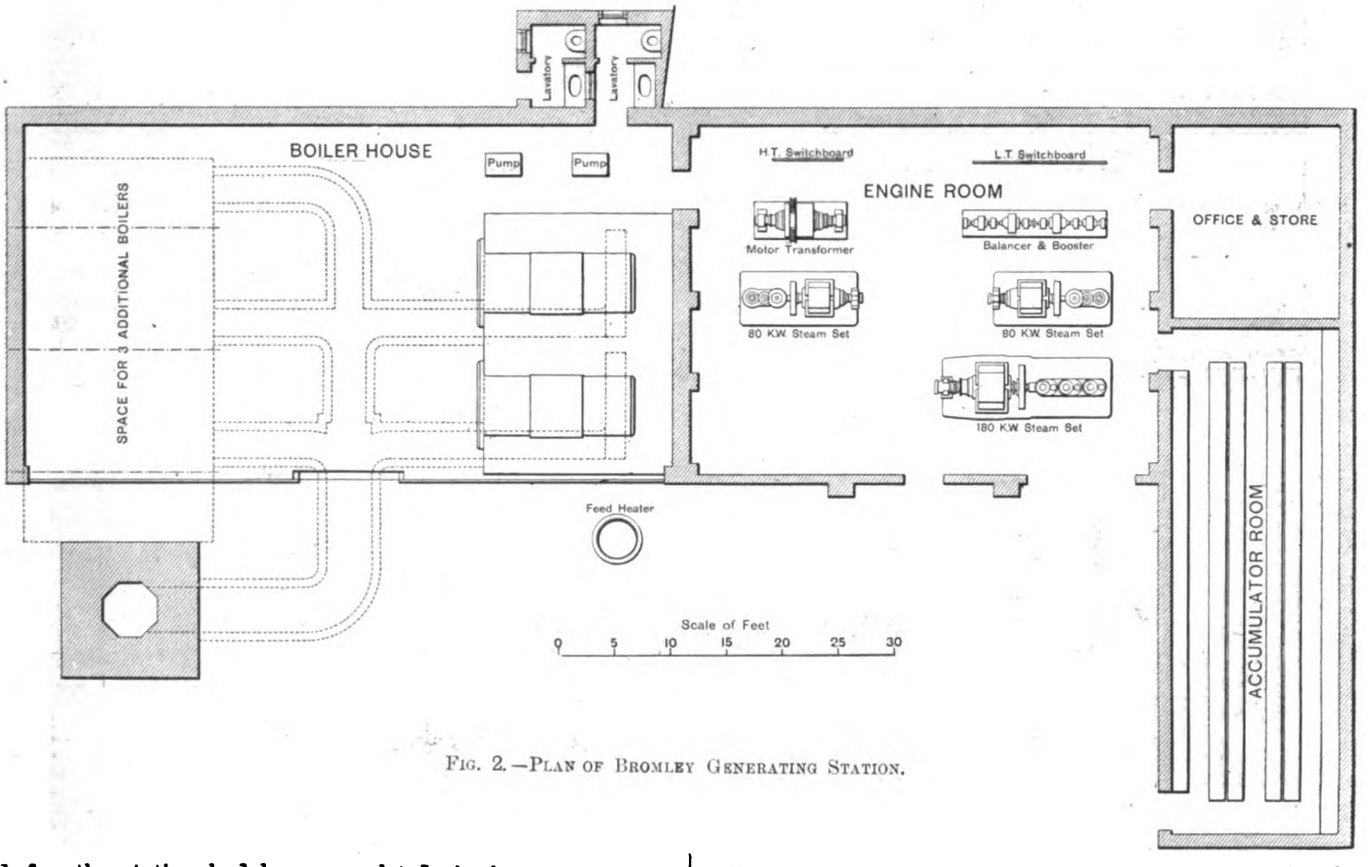

FIG. 2.—PLAN OF BROMLEY GENERATING STATION.

The general disposition of the station is shown in the plan. The Davey-Paxman "Economic" boilers have the usual characteristics of this type. Their dimensions are 14ft. × 8in., and each has a heating surface of 1,180 sq. ft. They are fed by two Worthington pumps, each capable of supplying 12,000lb. of water per hour, and no injectors have been fitted. A Boby-Chevalet feed heater (rated at 12,000lb. of water per hour) is employed to soften the feed water and to heat it with the exhaust steam; but the steam passing out of the feed heater is more than it should be in view of the central position of the station, and a surface condenser and cooling tower are included in the extensions projected. Water will have to be obtained from the water company both for feeding purposes and condensing. The boilers are hand-fired, and Durham "unscreened" coal is now employed, costing at present 22s. 6d. per ton. This includes carting and delivery in the bunkers, the works being about a quarter of a mile from the nearest railway station.

The steam piping is of wrought steel, with welded seams, the heavy forged flanges having been screwed on hot and brazed. The pipes are 7in. and 5in., and arranged on ring

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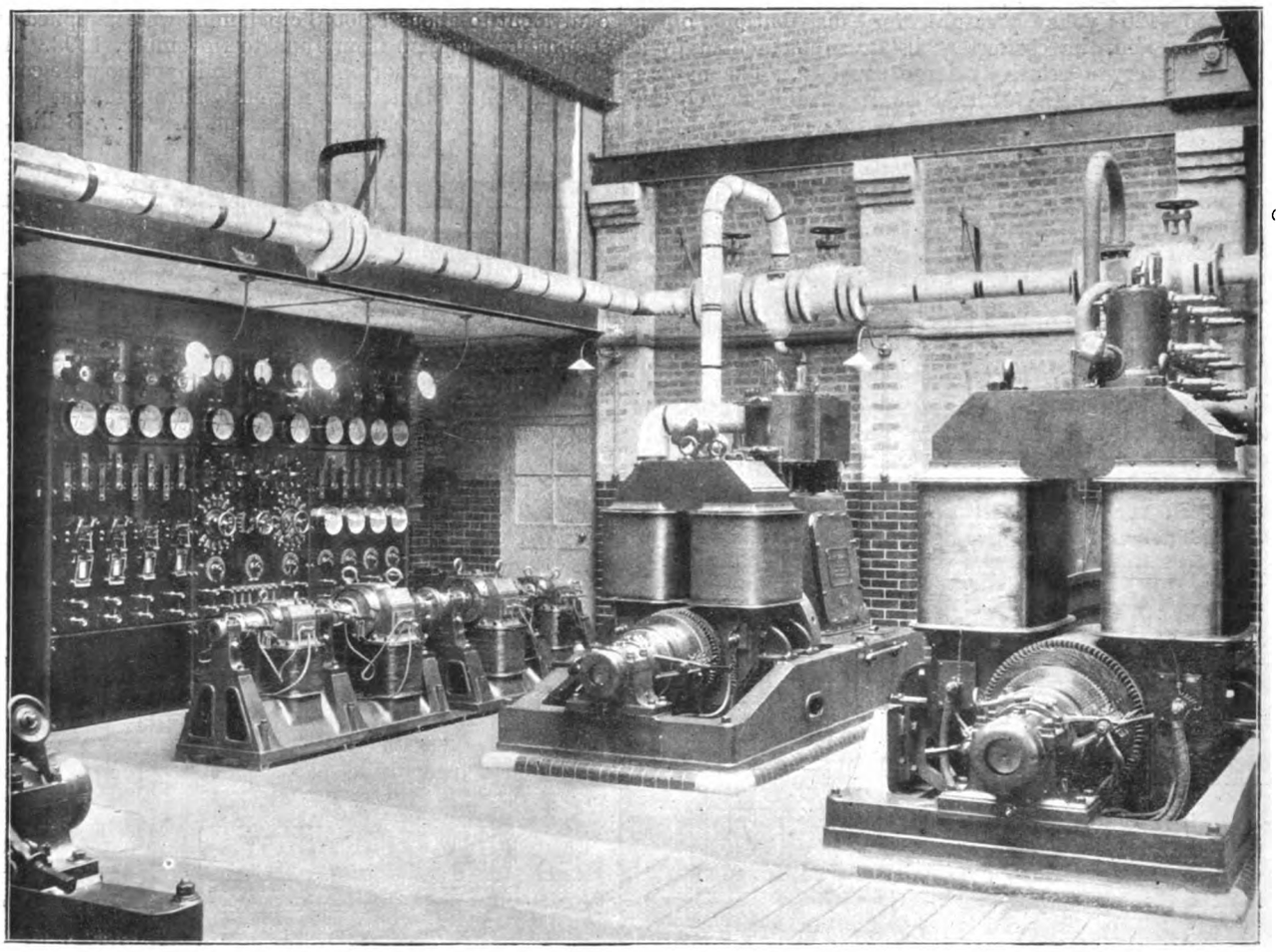

FIG. 3.—VIEW IN BROMLEY GENERATING STATION, SHOWING LOW-PRESSURE PLANT.

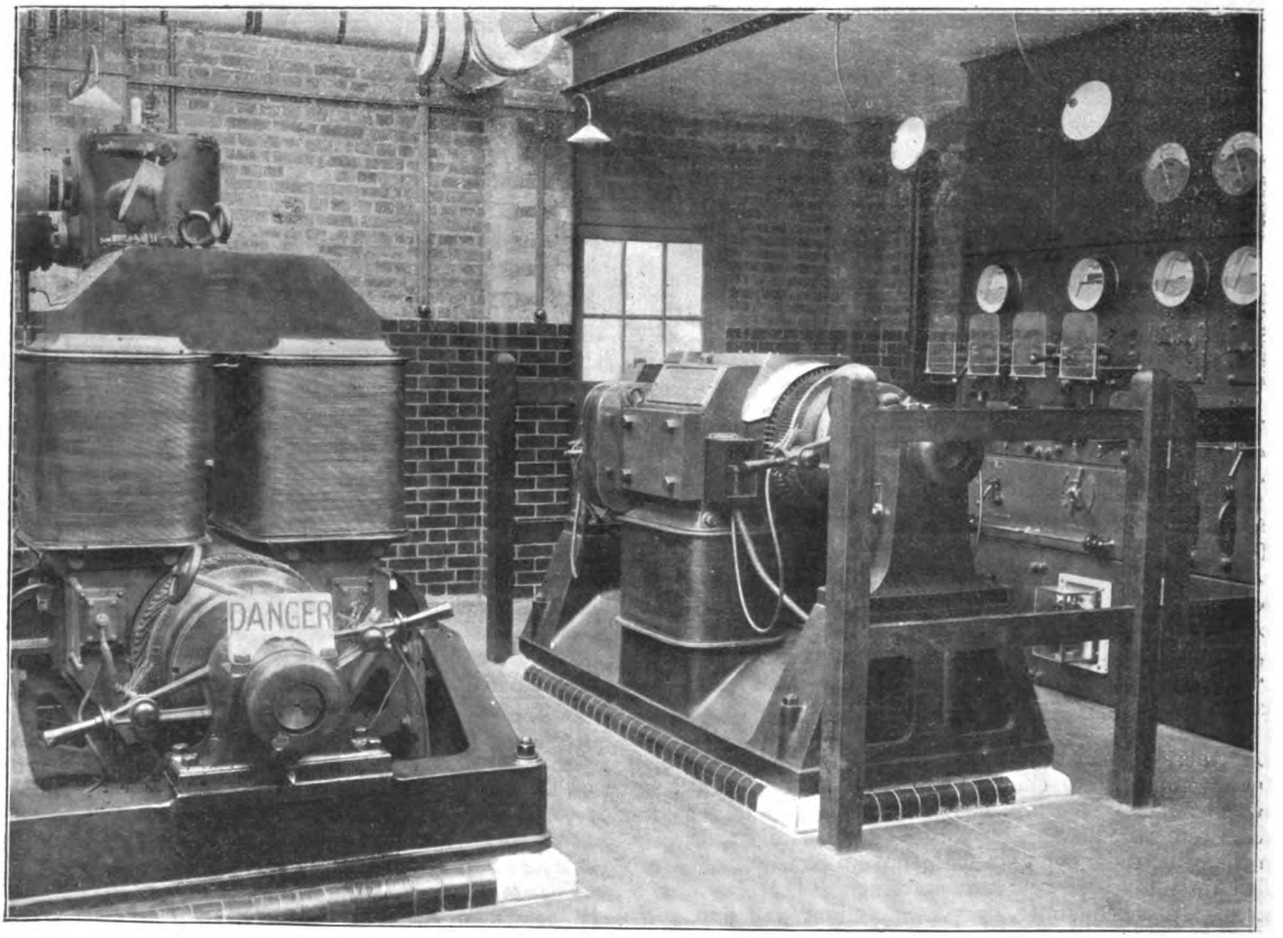

FIG. 4.—VIEW IN BROMLEY GENERATING STATION, SHOWING HIGH-PRESSURE PLANT.

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main system, with the usual number of valves and two Geipel steam traps. The exhaust pipes are of cast iron, and are laid in trenches under the floor of the engine house. The feed pipes are in duplicate, with the valves arranged so that either boiler can be filled by either pump with hot or cold water. The exposed parts of the boilers and pipes are covered with "Magnesia" non-conducting composition.

We have already referred to the three generating sets, which are of the usual Belliss-Parker fast-speed two-pole undertype design. A Parker combination balance and booster is employed, the two machines constituting the balancer and the two boosters being all on one shaft. The former can give a balancing current of 50 amperes, and each of the latter can raise the pressure by 70 volts and pass a current of 70 amperes. The overhead traveller is for a load of 5 tons.

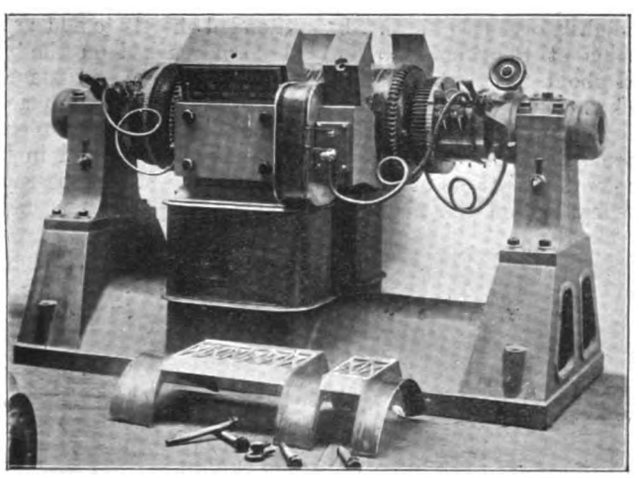

FIG. 5.—PARKER VARIABLE RATIO TRANSFORMER.

Another 160 kw. low-pressure Belliss-Parker set and a second high-pressure set similar to the one already in use are on order and will be put in in the autumn, the intention being to move the transformer now in Bromley to Chislehurst.

The low-pressure switchboard, made by Mr. Charrington to Messrs. Edmundsons' specification, is a facsimile of those in the other stations erected by the latter firm—*e.g.*, Salisbury, Folkestone, Wycombe, Alderley Edge, &c.—and duly described in our columns. For such a district as Bromley and Chislehurst, however, this stereotyped design, although excellent in many respects, has its disadvantages, the most noticeable of which is that there is no provision for adjusting the pressure at individual feeding points. All the feeders are brought to the same 'bus bars merely through ammeters and fuses, and no account can be taken of the varying drop of pressure along the feeders to different districts. This will probably be troublesome as the "residential load" increases, for its maximum will not coincide in point of time with the maximum load in the central and business quarters; and, moreover, the extent of the load from private houses is extremely difficult to foresee, so that the feeders to the various districts cannot possibly be calculated for equal loss in pressure. We understand that some modification of the switchboard to meet this difficulty is contemplated, possibly the addition of adjustable iron-wire resistances between the feeders and the 'bus bars. Pilot wires from the feeding points to the station will also be a necessary adjunct. Kelvin instruments by Messrs. J. White, and Thomson watt-hour meters are employed on the switchboard, and there are two large 18in. dial engine room voltmeters in a prominent position over the doorway. The minimum cut-outs are only employed when shutting down. They can be pinned up very easily.

The cells, 230 in number, are of the D.P. type, with a capacity of 650 ampere-hours at 80 amperes, and capable of discharging at 120 amperes without injury.

A new feature in both the Bromley and Chislehurst stations is the type of variable-ratio continuous-current transformer employed. This machine is seen both in one of the views of the Bromley station and also in our view of the Chislehurst station (Fig. 8), and a clearer idea of its general design is obtained from Fig. 5, which shows its hinged pole-pieces opened for the removal of the armature. In ordinary cases it is unnecessary to provide for a variable ratio of transformation, but where the high-pressure feeders are long, and where consequently there is a considerable fall of potential between the generating station and sub-station at full load, it is necessary to be able to increase or decrease the transformation ratio. For this purpose the arrangement illustrated is made use of. Fig. 6 is a diagram of the armature winding, from which it is seen that the high-pressure armature winding, connected to the left-hand commutator, extends over a shorter distance than the low-pressure winding, the latter being wound over the former, and there being a second core for the prolonged part of the low-pressure winding. Turning now to Fig. 5, or to the diagram, Fig. 7, it is seen that there are two auxiliary poles, diverted from the main field and covering the low-pressure but not the high-pressure armature. These poles have supplementary windings, in series with which a rheostat is connected. By adjusting this resistance, the relative number of lines of force passing through the two armatures is varied, and thus, as is easily understood, the transformation ratio is also varied. Both the machines at Chislehurst and the converter at Bromley are of this pattern, and we believe that this is the first time that it has been employed. Similar machines, but with the auxiliary poles rising independently from the bedplate, have been used before, however; and one of these, built by the Electric Construction Co. for the Charing Cross and Strand Electricity Supply Corporation, was described and illustrated in *The Electrician*, Vol. XXXVIII., p. 388. The Bromley and Chislehurst machines were built by Messrs. T. Parker. The

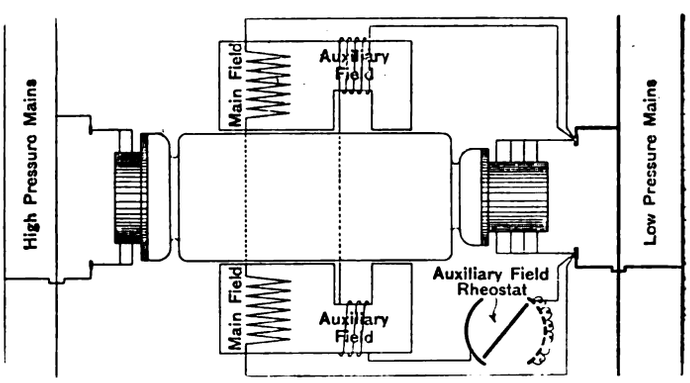

FIG. 7.—DIAGRAM OF CONNECTIONS OF VARIABLE RATIO TRANSFORMER.

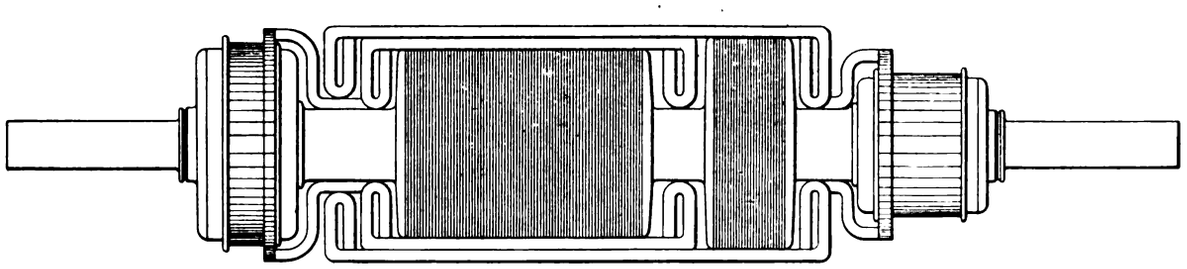

FIG. 6.—DIAGRAM OF ARMATURE OF VARIABLE RATIO TRANSFORMER.

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Bromley machine is capable of being used as a step-up or step-down transformer, its pressure ranging from 2,000 to 2,100 volts and from 420 to 450 volts, the maximum currents being 22 amperes at high-pressure and 105 on the low-pressure side. The speed is 600 revs. per min. The Chislehurst machines are, of course, only employed for stepping down, and are of the same size as the Bromley one. They are guaranteed to give the full pressure of 450 volts at the secondary with a primary pressure of 1,900 volts.

A good view of the Parker high-pressure switchboard is seen in one of our illustrations. Its arrangement is very simple, but it would be an improvement, in our opinion, if the breaks were longer and if the metal work of the board were better protected, for a 2,000 volt continuous-current shock may be fatal. The plates of glass in front of the switches are not sufficient, and an enclosure of the contacts would be far preferable. At the back also the distances between the bare fuses of opposite polarity and the iron frame of the board are too short, especially at the Chislehurst station. Some alterations, including the interposition of shields of asbestos card and the bringing out of some of the terminals farther from the board, have improved it somewhat, however. Another modification at Bromley has been the bending down of the spring of the zero cut-out, as this appliance was found unnecessary.

lamps connected will amply justify this policy. The largest and longest low-pressure feeder follows the course of the high pressure main from Bromley as far as the point A on the map at the little village of Widmore, a distance of about 1,800 yards. This is of 0·8 sq. in. copper. The other feeders are as follows:—

To feeding point	C, about	1,200 yards	.....	0·175	sq. in.
Ditto	D, do.	900 do.	.....	0·15	do.
Ditto	E, do.	900 do.	.....	0·15	do.
Ditto	F, do.	100 do.	.....	0·1	do.
Ditto	G, do.	150 do.	.....	0·1	do.

All the feeders are triple concentric, the neutral wire having of course a less section than the others; the distributors are three-core and all of the same size, 0·075, 0·05, 0·075 sq. in. copper. Both are armoured and laid directly in the ground. There are some 12 miles of distributors, and the distance of the farthest consumer on the Bromley network from the works is slightly over two miles. It is intended shortly to add a sub-station at Southborough, at the point marked on the map and about 2½ miles from the works. Here a self-starting 40 kw. continuous-current converter will probably be placed. In the course of time it will no doubt be necessary to erect more sub-stations, as large loads may be expected in the residential districts of Bickley and Plaistow, whose positions are marked on the map. At the points BB on the distri-

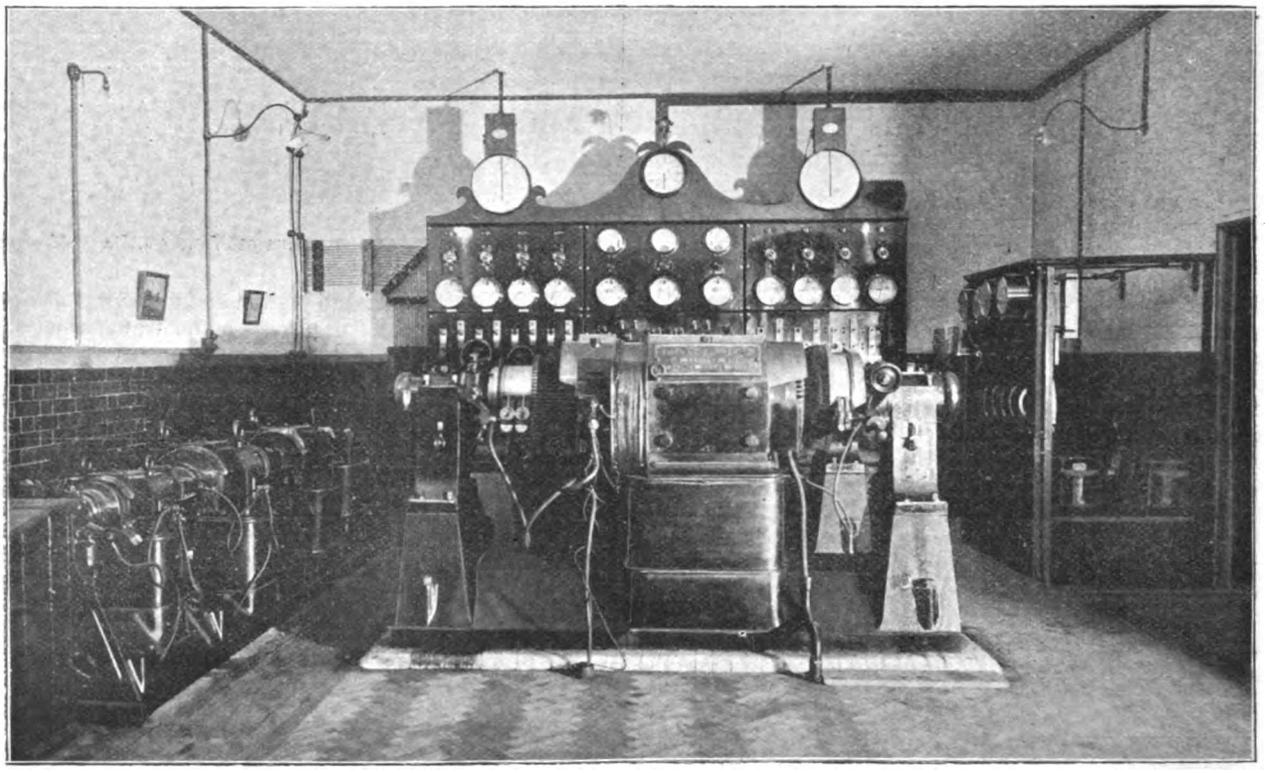

Fig. 8.—Chislehurst Sub-station.

Our map shows the boundaries of the Bromley and Chislehurst parishes, and gives a good idea of the configuration of the district. It should be added that the Bromley Urban District extends 1½ miles farther south than the bottom of the map, but this part has been omitted, as no mains have been laid there yet. Both the feeders and distributors are shown, and are distinguished by full and chain-dotted lines. A high-pressure feeder runs from Bromley to Chislehurst. It is two-wire, and duplicated. The four single cables are each of 0·05 sq. in. copper, insulated with Callender's vulcanised bitumen and laid in bridges in a cast-iron trough filled "solid" with bitumen. The low-pressure networks of the Bromley and Chislehurst stations are quite distinct, although in the course of time they will probably meet one another at several points. The directors adopted the policy of laying down mains in several streets before the houses were built, with the result that the majority of the houses that are put up are wired for electric light. There is no doubt that very shortly the number of

buting network is the temporary connection to the network of the Beckenham Urban District Council already mentioned. The feeders are provided with thick fuses on the switchboard, but are connected to the network through lighter ones, and the distributors are inter-connected through fuse links at all the crossing points. The link boxes and service boxes are, as the mains, of Callender's make, the boxes being of the usual cast-iron pattern for filling with compound, the cables being led in through pockets likewise filled in with compound. On the Chislehurst network there are four feeding points at an average distance of about half a mile from the station, the farthest consumer being about one mile from the station. The longest feeder has 0·175 sq. in. copper, and the shortest 0·075 sq. in. The Chislehurst distributors are also 0·075, 0·05, 0·075 sq. in.

We have already referred to the equipment of the Chislehurst sub-station, and little more remains to be said about it. It has the two continuous-current transformers already

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described, a combined booster and balancer set exactly similar to that at Bromley, a battery of the same size as the Bromley one, and high and low-tension switchboards designed on the same lines as those at the main station. In our illustration one of the two transformers is hidden by the other; the booster and balancer set is on the left, the low-pressure switchboard behind the transformers, and the high-pressure board on the right. A difficulty apparent at Chislehurst is that there is no provision for filing up the commutator, this part of one of the machines being in a far from healthy condition. Even if the transformer were run at a slow speed by connecting a few cells to the high-pressure side, no doubt sufficient E.M.F. would be generated in the low-pressure armature to cause sparks under the file, so that filing under those conditions might not improve matters. The shafts of the machines should have been extended, as the two transformers are ranged exactly behind one another, so that a pulley might have been put on each, and thus one be belted to the other for the purpose of turning it to file the commutator. The motor transformers are started from the low-pressure side, and there is no regulating apparatus on the high-pressure side—a telephone to the Bromley works answering more or less the same purpose when alteration of the high-pressure is necessary.

Originally a licence was obtained for Chislehurst in 1897. A provisional order was applied for in 1898 by some of the residents in Chislehurst, backed as in Bromley by Messrs. Edmundsons, who have found the whole of the capital for laying down the plant. There are just 4,000 lamps connected to the mains as the result of nine months' working. The average efficiency from the high-tension to the low-tension side of the transformers is stated to be as high as 90 per cent. The current is supplied from Bromley, charged at 3d. per unit at the Chislehurst end of the high-tension main. The trading for the nine months has resulted in a small profit.

In Bromley there are now connected 7,337 8 c.p. lamps, and about 1,000 more are being wired, exclusive of the 4,000 connected in Chislehurst, which are of course supplied from Bromley. We understand that a substantial profit has been earned during the year, although we are unable at the present time to give the analysis of the works costs.

Mr. R. L. Gamlen has been engineer-in-chief of the Bromley and Chislehurst stations since their start, and Mr. E. R. Hill is acting as his assistant at Bromley. Mr. F. T. Hanning is secretary and resident engineer at Chislehurst. To these gentlemen, to Messrs. Edmundsons, and also to Messrs. T. Parker, our thanks are due for the courtesy shown to our representative, and for assistance in supplying us with the drawings and photographs and much of the data given in this article.

STOCKPORT CORPORATION ELECTRICITY WORKS.

The Stockport Corporation obtained a Provisional Order in 1891, but it was not until November, 1896, that any serious steps were taken to utilise it. Then the Council authorised the Gas Committee to combine with its duties that of an Electricity Committee, and on Dec. 31st of that year the committee met for the first time and decided to investigate the systems in general use. A fortnight apparently sufficed to educate the committee sufficiently in this respect, for on Jan. 14, 1897, the chairman, Mr. Thomas Webb, presented his report; and at the same meeting it was decided to request Mr. Ernest Mountain, of Huddersfield, and Mr. J, N. Shoolbred, of London, to prepare reports and estimates. Visits by the full committee to Liverpool, Birkenhead, and Huddersfield, and by the chairman and engineer to other towns, followed, with the result that Mr. Shoolbred's scheme was accepted. Mr. Shoolbred had recommended a 2 × 230

VIEW OF ENGINE ROOM.

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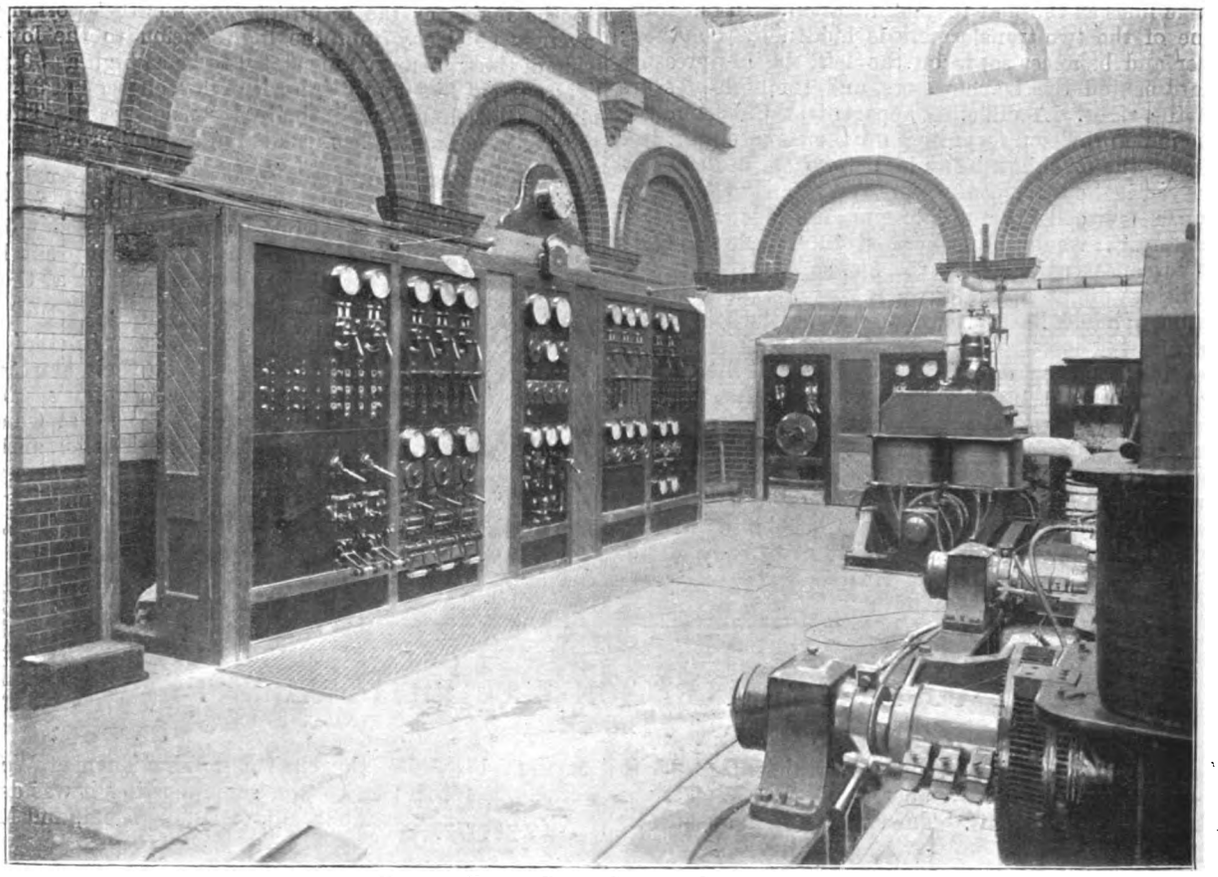
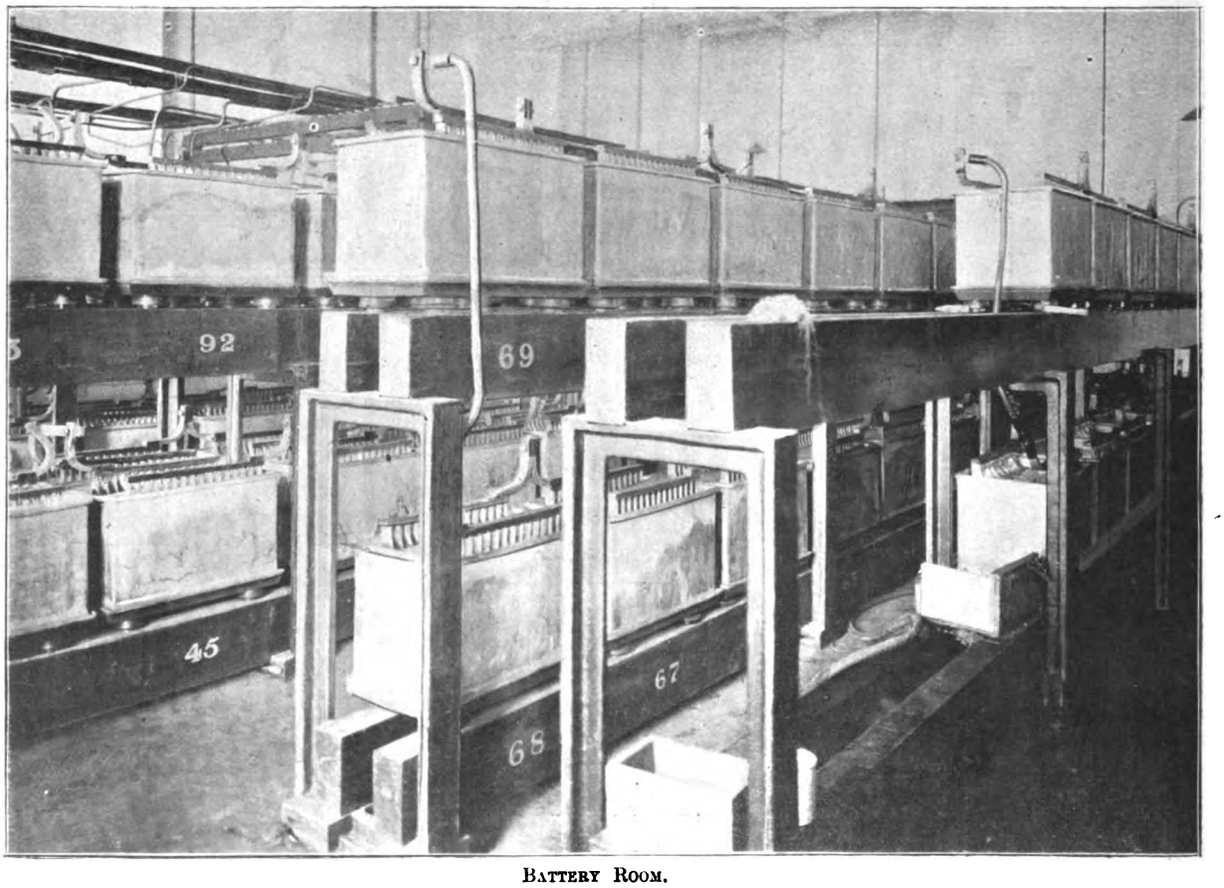
volts three-wire system, the generating station being built on land then occupied by the gas works, and he advised the Corporation to borrow a sum of £25,000 for electric lighting purposes. The Local Government Board inquiry was duly held in December, 1897, and the loan of £25,000 was sanctioned. Tenders were advertised for in the same month, and contracts let in February, 1898. As already announced in *The Electrician*, the station was started on Dec. 9, 1899, but the formal opening only took place on Thursday, Jan. 18th last, over a year after the supply was commenced. When the station started, the number of consumers was 30, with an equivalent of 1,596 8 c.p. lamps; and by Jan. 1st last the number of consumers



VIEW OF ENGINE ROOM, SHOWING SWITCHBOARDS.



BATTERY ROOM.

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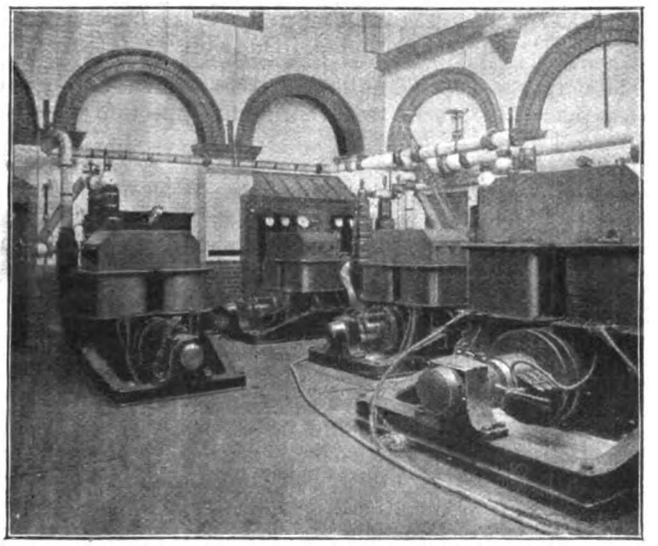
had increased to 120, with a lamp connection equivalent to 7,700 8 c.p. lamps, including 86 arc lamps for public lighting.

The following is a brief description of the plant :—

In the boiler house are two Lancashire boilers 28ft. × 8ft. 3in., supplied by Messrs. Tetlow Bros., of Hollinwood. They are fitted with Wilton's forced draught. Breeze dust, obtained at 2s. to 2s. 6d. per ton, is burned, and the stoking is by hand. The generating sets, five in number, are direct driven. Two of them have a capacity of 140 kw. each, and three a capacity of 56 kw. each, being driven by 240 H.P. and 90 H.P. Willans engines respectively. The dynamos were made by the local firm of McClure and Whitfield, and are of the shunt-wound undertype pattern. They are clearly seen in our views of the generating station. The main and two battery switchboards are also illustrated. They are of Messrs. Crompton and Co.'s manufacture, and present the usual features.

In the battery room are two sets of 133 "R" type Chloride accumulators of 750 ampere hours capacity, and designed for a maximum discharge current of 400 amperes. There is a



ANOTHER VIEW OF MACHINERY ROOM.

6 ton 33ft. span traveller in the engine room, manufactured by Messrs. Higginbottom and Mannock, of Manchester. The contractors for the buildings were Messrs. T. and W. Meadows, of Stockport; and for the roof, water tank, and ironwork, Messrs. Newton, Chambers and Co., of Sheffield.

The net area of the district is 3·4 square miles, and both feeders and distributors are armoured and laid directly in the ground. They are partly of Messrs. Glover's and partly of Messrs. Henley's manufacture. Ferranti meters are employed, and no meter rental is charged, the price for current being 5d. for lighting and from 3d. to 1½d. for power, and the arc lamps being paid for at the rate of £20 each lamp per annum. The same committee charge 2s. 3d. per 1,000 cubic ft. for their gas supply.

DISELECTRIFICATION PRODUCED BY MAGNETISM.*

Preliminary Note.

BY C. E. S. PHILLIPS.

The writer has found that, under certain conditions, an electrified body rapidly loses its charge when in the neighbourhood of a magnetic field. Nor does it, so far, appear essential that there be any relative motion between the lines of magnetic force and the charged body itself.

Preliminary experiments have been made with apparatus consisting of a glass tube 6in. long and 1in. in diameter, at the centre of which there was cemented upon both the inner and outer surfaces a strip of tinfoil 1in. wide. Suitable connections were then arranged for the purpose of charging either of these metallic layers by means of an electrical machine. The pole-pieces of a powerful electromagnet projected into each end of the glass tube through an air-tight flange, and in such a manner as to ensure the production of a strong magnetic field at the central portion of the tube. A Sprengel air-pump was used to rarefy the gas within the tube, and in the first instance the inner coating of tinfoil was charged positively.

This charge gave rise to the well-known free positive and a bound negative charge upon the outer tinfoil coating, the presence of the former being indicated by the divergence of the leaves of an electroscope connected to that coating. While the pressure of the gas within the glass tube was varied over a range of from atmospheric pressure to that represented by 0·2mm. of mercury, the charge upon the inner coating being either positive or negative, showed no appreciable indication of being affected by the turning on or off of the magnet. But at pressures lower than 0·2mm., and when the inner coating was positive, the sudden collapsing of the electroscope leaves pointed to the removal of the charge through the action of starting or stopping the magnetic flux. Although the effect was more powerful at the moment of making or breaking the magnet circuit, it persisted in a modified degree as long as the magnetic field existed. No such effect was observed when the inner coating was negatively charged, nor was there any action even in the first case when the magnetic pole-pieces, projecting into the tube, were magnetised so as to be either both north or both south.

The leaves of the electroscope were then connected to one of the internal pole-pieces, and it was seen that if sufficient positive electricity were supplied to the inner coating while the magnet was excited it became rapidly withdrawn, and ultimately resided upon the pole-pieces themselves.

* Abstract of a Paper read before the Royal Society, June 15, 1899.

FORMATION OF THE GLASGOW SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

Towards the end of last year a petition was signed by a number of Glasgow electrical engineers, and presented to the Institution of Electrical Engineers, asking that a local section should be formed on lines recently approved by the Council. The matter has been taken up very energetically by Prof. Magnus Maclean, D.Sc., of the Glasgow and West of Scotland Technical College; and having received the sanction of the Council, he called a meeting on Thursday, the 18th inst., to make the necessary arrangements for the formation of the section, and to appoint a provisional committee to draft local rules and to carry on the work of the section until next May.

At this meeting the parent Institution was represented by Prof. Perry, senior Vice-President, and by Mr. W. G. McMillan, secretary, and there was a goodly attendance of those interested in the matter. It was unfortunate, however, that the meeting should have clashed with a local lecture, by Prof. Oliver Lodge, on "Wireless Telegraphy," and the fascination of this subject caused serious diminution of the numbers who would have been present at the Institution meeting; notwithstanding which, however, there were about 150 present in the large hall of the Institute of Engineers and Shipbuilders.

Prof. Perry, having been unanimously voted to the chair, said that in the position in which he found himself it was generally expected that a speech should be made. After referring to his own early career and his connection with Glasgow, where he said that, at the time to which he was referring, there was situated the only college where electrical knowledge could be acquired, he stated that already local centres of the Institution had been started at Newcastle-on-Tyne and Dublin, and also at Cape Town. He referred to Lodge's work in wireless telegraphy, and also to his own work in the same field, and mentioned that as early as in 1889 he spoke of the possibility of telegraphing by means of Hertzian waves; and, while giving Signor Marconi full credit for being the first to fully recognise the possible commercial advantages of the system, he claimed that the theoretical possibilities had been fully recognised by several scientists in this country. The various and great changes that had taken place during the past ten years were briefly referred to, and then the recent Swiss trip came in for a share of notice. The

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visit had taught us a great deal: it had enlarged our ideas, seeing that they went from a country of cheap coal and no water power to a country of very dear coal and plenty of water power. It gave new problems to be tackled. One point, however, that Prof. Perry could not view with favour was the esteem in which slow-speed plant was held, as he thought that we were well ahead in this respect with our almost universal adoption of high-speed plant. This year, he said, the Institution hoped to go to Paris, where there would be much to interest and instruct. Referring to the objects of the meeting, he said that care must be taken to have a representative council, and not to elect upon it too many of any one class.

The first office to be filled being that of President, Lord Kelvin was unanimously elected, on the proposal of Prof. W. H. Watkinson, seconded by Prof. A. Jamieson. For the office of Vice-President three names were put forward, but the feeling of the meeting was clearly shown without the need of a poll, and on the proposal of Mr. E. George Tidd, seconded by Mr. John M. Munro, Prof. Magnus Maclean was elected to that post. The post of honorary secretary was undertaken by Prof. W. H. Watkinson. Selection of the remaining members of the council was a longer process, as 12 names were put forward, and it was considered that at the outside no more than eight members should be appointed. After an exciting poll, the eight ordinary members of council were duly elected, the Council thus completed being as follows:—

President.	*Vice-President.*
Lord Kelvin.	Prof. Magnus Maclean.

Members.

Wm. A. Chamen, Corporation electrical engineer, Glasgow.
Francis Teague, Corporation electrical engineer, Paisley.
Wm. Lackie, chief assistant electrical engineer, Glasgow.
W. B. Sayers, consulting engineer and electrician.
Thomas Young, consulting engineer, and engineer to the Glasgow International Exhibition.
Prof. Andrew Jamieson, consulting engineer.
Henry Mavor, manufacturer.
John M. Munro, contractor.

Honorary Secretary.

Prof. W. H. Watkinson.

Mr. McMillan then gave a short description of the requirements of the sub-section and of the method of working the same, referring also to the qualifications of candidates, &c. After the usual votes of thanks, the meeting terminated.

ELECTRICITY WORKS ACCOUNTS.

Derby Municipal Electric Supply Works.

The results of the operations of this undertaking during the year ended March 31st last are very gratifying. Not only in the increased business done and acquired, but in economy of working, these results indicate very material improvement over those of the preceding years.

The year's output at 491,063 units sold marks an advance of no less than 44·1 per cent., while the equivalent lamp connections have risen from 21,600 to 27,000, or 25 per cent.

Although the average revenue from supply has remained fairly constant, the total from all sources has diminished from 5·54d. to 4·91d. per unit sold. Happily, a considerably greater reduction in the costs has been effected, resulting in a drop in the ratio of the costs to revenue of from 59·1 per cent. to 55·6 per cent., a greatly improved working profit and a substantial balance to the good, even after meeting the deficit which was the result of the preceding year's operations.

The excellent improvement in the aggregate costs indicated by a drop from 3·28d. to 2·73d. per unit is almost wholly due to reductions in the works costs, or more particularly in the generating costs. The fuel item of 0·982d. per unit in 1897-8 certainly left room for the improvement which has taken place in this respect, and which has brought down the expenditure on this score to the average. "Oil, waste, water, stores" stand at a very fair average, while "wages at station" and "repairs and maintenance at station"—especially the former—show very low figures. The management charges have risen, but the rise is more than balanced by reductions in the property charges. Doubtless the improvement in the costs is no more than a natural effect of not only a largely increased output, but also of an increase in the load factor from an abnormally low figure to one slightly above the average—viz., 10·9 per cent. This latter cause is, however, in its turn a result upon which especially Derby is to be congratulated, and we hope to see the aggregate total costs soon reduced at least 0·25d. per unit from the present value.

Leicester Municipal Electric Supply Works.

In our second table the accounts of the Leicester undertaking are dealt with. Here, again, it is pleasant to mark the good progress which is being made in the accession of new business, and also in reduced costs, even under the adverse conditions of a low load factor. From the following table it will be seen that the load factor at Leicester has been comparatively very low, but that it is steadily improving:—

Year.	No. of consumers.	Lamp connections.	Output. Units sold.	Load factor. Per cent.	Total costs.	Working profit. Actual.	Working profit. Per cent. to mean cap. exp.
1895	133	10,184	77,797	5·0	5·72d.	£680	2·01
1896	220	16,864	169,668	5·4	3·78d.	2,048	5·70
1897	331	23,757	262,179	5·8	3·00d.	2,758	6·57
1898	435	37,240	386,186	6·6	2·43d.	4,974	7·78

The output of 386,186 units sold exceeded that of 1897 by no less than 47·8 per cent., while the lamp connections show an increase of nearly 57 per cent.

The average revenue received per unit has remained practically steady, but the aggregate costs have been reduced by 0·57d. The figure at which they now stand—viz., 2·43d. per unit—being well below the average under the existing conditions of output and load factor, this is an excellent result. Considering the load factor, the aggregate and the several items of generating costs are well within the average. The fuel item at 0·49d. per unit is quite 0·2d. below what we should have expected.

As the result of the year's operations the working profit reaches the excellent figure of £4,974, being at the rate of 7·78 per cent. of the mean capital expended. Owing to large additions to the capital expenditure, the interest and sinking fund charges were much heavier than in the year before; nevertheless, it is good to find that the deficit brought forward is being rapidly met, the net result of the year's operations being a profit of £691.

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

Aberdeen (Municipal)	Jan.	12,	1900
Ayr (Municipal)	Sept.	23,	1899
Bedford (Municipal)	May	19,	,,
Belfast (Municipal)	Sept.	15,	,,
Birmingham (Company)	Sept.	15,	,,
Blackburn (Municipal)	Jan.	19,	1900
Blackpool (Municipal)	Sept.	29,	1899
Bournemouth (Company)	April	28,	,,
Bolton (Municipal)	Nov.	24,	,,
Bradford (Municipal)	April	14,	,,
Brighton (Municipal)	May	12,	,,
Bristol (Municipal)	July	14,	,,
Burnley (Municipal)	Aug.	25,	,,
Burton-upon-Trent (Mun.)	April	21,	,,
Bury (Municipal)	Sept.	23,	,,
Cambridge (Company)	Mar.	10,	,,
Cardiff (Municipal)	Dec.	15,	,,
Charing Cross (Company)	Mar.	17,	,,
Chelsea (Company)	Mar.	31,	,,
Cheltenham (Municipal)	Nov.	10,	,,
Chester (Municipal)	June	23,	,,
City of London (Company)	May	12,	,,
Clerkenwell (Company)	Aug.	18,	,,
Derby (Municipal)	Dec.	9,	1898
Dewsbury (Municipal)	Nov.	24,	1899
Dover (Company)	June	2,	,,
Dundee (Municipal)	Jan.	12,	1900
Eastbourne (Company)	July	22,	1898
Edinburgh (Municipal)	Nov.	17,	1899
Exeter (Municipal)	Aug.	5,	1898
Glasgow (Municipal)	Sept.	1,	1899
Guildford (Company)	May	5,	,,
Halifax (Municipal)	July	21,	,,
Hammersmith (Vestry)	May	26,	,,
Hampstead (Vestry)	Aug.	25,	,,
Hanley (Municipal)	April	28,	,,
Harrogate (Municipal)	Oct.	20,	,,
Harrow (Company)	June	16,	,,
Hast'gs & St. Leonards (Co.)	April	29,	1898
H'use-to-H'useCo.(K'ns'gt'n)	Mar.	31,	1899
Hove (Company)	Mar.	10,	,,
Huddersfield (Municipal)	Oct.	6,	,,
Islington (Vestry)	Oct.	27,	,,
Kens'gton & Knightsbr'(Co.)	Mar.	3,	,,
Kingston-upon-Hull (Mun.)	June	9,	,,
Kingston-on-Thames (Mun.)	April	21,	,,
Lancaster (Municipal)	Jan.	19,	1900
Leeds (Municipal)	Dec.	1,	1899
Leicester (Municipal)	Jan.	20,	,,
Leyton (Municipal)	Sept.	8,	,,
Liverpool (Municipal)	June	9,	,,
Manchester (Municipal)	Aug.	11,	,,
Newcastle and District (Co.)	Oct.	6,	,,
Newcastle-upon-Tyne (Co.)	April	14,	,,
Newport (Mon.) (Municipal)	Dec.	15,	,,
Northampton (Company)	Oct.	20,	,,
Norwich (Company)	Nov.	17,	,,
Notting Hill (Company)	Mar.	17,	,,
Nottingham (Municipal)	July	21,	,,
Oldham (Municipal)	Dec.	1,	,,
Oxford (Company)	May	19,	,,
Pontypool (Company)	May	5,	,,
Portsmouth (Municipal)	July	14,	,,
Prescot (Company)	Dec.	8,	,,
Preston (Company)	Sept.	29,	,,
Reading (Company)	Oct.	13,	,,
Richmond (Company)	Oct.	13,	,,
Scarborough (Company)	Nov.	3,	,,
St. Helens (Municipal)	Dec.	8,	,,
St. James' & Pall Mall (Co.)	Feb.	24	,,
St. Pancras (Vestry)	May	26,	,,
Sheffield (Municipal)	Dec.	29,	,,
Shoreditch (Vestry)	Oct.	27,	,,
Southampton (Municipal)	Nov.	10,	,,
Southport (Municipal)	July	7,	,,
South Shields (Municipal)	July	7,	,,
Stafford (Municipal)	Dec.	29,	,,
Sunderland (Municipal)	July	28,	,,
Taunton (Municipal)	June	16,	,,
Tunbridge Wells (Mun.)	Sept.	1,	,,
Wakefield (Municipal)	Dec.	1,	,,
Walsall (Municipal)	June	23,	,,
Wandsworth (Company)	Aug.	18,	,,
Westminster (Company)	Feb.	24,	,,
Whitehaven (Municipal)	July	28,	,,
Windsor (Company)	Dec.	22,	,,
Woking (Company)	Dec.	22,	,,
Wolverhampton (Municipal)	June	30,	,,
Woolwich (Company)	Jan.	13,	,,
Worcester (Municipal)	April	7,	,,
Yarmouth (Municipal)	Nov.	3,	,,

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	DERBY.		LEICESTER.	
Undertaking Worked by	Derby Corporation.		Leicester Corporation.	
Date of Commencement of Supply	October, 1893.		December, 1894.	
System of Supply	Alternate-current transformer sub-stations.		Alternate-current transformer sub-stations.	
Chief Engineer	T. P. Wilmshurst.		Alfred Colson.	
YEAR ENDED	MAR. 31, **1898.**	MAR. 31, **1899.**	DEC. 31, **1897.**	DEC. 31, **1898.**
QUANTITIES—				
Units generated	383,601	533,214	349,433	£27,173
„ SOLD (TOTAL)	340,783	491,063	262,179	386,186
„ sold to consumers	210,758	351,074	262,179	386,186
„ sold for public lighting, &c.	130,025	139,989	—	—
„ used on works	9,544	12,582	—	—
UNITS SOLD PER 8 C.P. LAMP CAPACITY	17·4	14·6	12·4	7·73
Maximum supply demanded	691 kilowatts	512 kilowatts	515	670 kilowatts
Number of public lamps	77	77 arc, 70 (16 c.p.) glow	—	nil
Number of consumers	317	—	331	475
Connections to mains in 8-c.p. lamps	21,600	27,000	23,757	37,240
CAPACITY OF PLANT IN 8-C.P. LAMPS	19,580	33,750	21,080	50,000
CAPACITY OF PLANT IN KILOWATTS	627	1,080	675	1,600
CAPITAL—	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.
AUTHORISED (TOTAL)	— / —	£80,734 / £74·8	£76,467 / £113·2	£77,808 / £48·6
Share	— / —	— / —	— / —	— / —
Loan (including Debenture charges)	— / —	80,734 / 74·8	76,467 / 113·2	77,808 / 48·6
RECEIVED (TOTAL)	£60,734 / £96·3	60,938 / 56·4	42,748 / 63·4	77,808 / 48·6
Share	— / —	— / —	— / —	— / —
Loan (including Debenture charges)	60,734 / 96·3	60,734 / 56·2	42,748 / 63·4	77,808 / 48·6
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	— / —	20,000 / 18·5	33,719 / 50	nil / —
Share (unissued)	— / —	— / —	— / —	— / —
Share (uncalled)	— / —	— / —	— / —	— / —
Loan (including Debentures)	— / —	20,000 / 18·5	33,719 / 50	nil / —
REPAID (TOTAL)	4,451 / 7·10	5,506 / 5·10	— / —	400 / 0·25
RESERVE OR SINKING FUND	1,772 / 2·83	2,698 / 2·50	3,741 / 5·54	5,593 / 3·49
DEPRECIATION FUND	— / —	— / —	— / —	— / —
EXPENDED (TOTAL)	65,909 / 105	76,565 / 70·9	45,853 / 68·0	82,079 / 51·3
Lands and buildings	11,941 / 28·3	11,972 / 11·1	5,566 / 8·25	5,566 / 3·48
Plant	28,096 / 44·8	35,931 / 33·3	22,173 / 32·9	48,714 / 30·4
Mains	25,321 / 40·4	28,112 / 26·0	17,814 / 26·4	25,758 / 16·1
Miscellaneous	550 / 0·877	550 / 0·509	300 / 0·44	2,040 / 1·28
BALANCE OF CAPITAL ACCOUNT	−5,175[a] / −8·25	−15,597[a] / −14·4	−3,105[a] / 4·60	−4,271[a] / −2·67
REVENUE—	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.
TOTAL	£7,877 / 5·543d.	£10,052 / 4·910d.	£6,040 / 5·530d.	£8,888 / 5·520d.
Revenue from supply	4,955 / 3·488d.	7,222 / 3·530d.	5,446 / 4·985d.	8,044 / 5·000d.
„ meters, &c.	21 / 0·015d.	21 / 0·010d.	164 / 0·150d.	234 / 0·145d.
„ public lighting	2,408 / 1·695d.	2,440 / 1·192d.	— / —	— / —
„ sale of lamps, &c.	461 / 0·325d.	347 / 0·169d.	430 / 0·394d.	611 / 0·380d
„ miscellaneous sources	33 / 0·023d.	22 / 0·011d.	— / —	— / —
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	£4,656 / 3·277d.	£5,587 / 2·731d.	£3,282 / 3·005d.	£3,916 / 2·434d.
WORKS COSTS	3,541 / 2·493d.	4,009 / 1·960d.	2,551 / 2·335d.	3,133 / 1·948d.
Generation of electricity	*2,971 / 2·092d.*	*3,153 / 1·540d.*	*2,243 / 2·053d.*	*2,585 / 1·607d.*
Fuel (including cartage, &c.)	1,394 / 0·982d.	1,491 / 0·729d.	578 / 0·529d.	786 / 0·489d.
Oil, waste, water, stores	227 / 0·160d.	284 / 0·139d.	192 / 0·176d.	243 / 0·151d.
Wages at station	803 / 0·569d.	701 / 0·343d.	1,047 / 0·959d.	1,069 / 0·665d.
Repairs and maintenance at station	535 / 0·377d.	655 / 0·320d.	426 / 0·390d.	487 / 0·303d.
Distribution of electricity	*109 / 0·077d.*	*335 / 0·164d.*	*308 / 0·282d.*	*548 / 0·341d.*
Wages, &c.	42 / 0·030d.	66 / 0·033d.	182 / 0·167d.	350 / 0·218d.
Repairs, renewals of mains, &c.	67 / 0·047d.	269 / 0·132d.	126 / 0·115d.	193 / 0·123d.
Public lighting	*461 / 0·325d.*	*521 / 0·255d.*	— / —	— / —
Attendance	223 / 0·157d.	385 / 0·188d.	— / —	— / —
Renewals	238 / 0·168d.	136 / 0·067d.	— / —	— / —
MANAGEMENT AND PROPERTY CHARGES	1,115 / 0·786d.	1,578 / 0·771d.	731 / 0·669d.	783 / 0·487d.
Royalties	— / —	— / —	— / —	— / —
Rent, rates, taxes	*217 / 0·153d.*	*216 / 0·106d.*	*236 / 0·271d.*	*305 / 0·190d.*
Management	*898 / 0·633d.*	*1,362 / 0·666d.*	*435 / 0·398d.*	*478 / 0·297d.*
Salaries	631 / 0·444d.	852 / 0·416d.	200 / 0·183d.	250 / 0·155d.
Stationery, &c.	56 / 0·039d.	37 / 0·018d.	15 / 0·014d.	18 / 0·011d.
Establishment charges	118 / 0·083d.	283 / 0·139d.	216 / 0·198d.	206 / 0·128d.
Law charges, &c.	93[b] / 0·066d.	190[c] / 0·093d.	4[b] / 0·004d.	4[b] / 0·003d.
FINANCIAL RESULTS—	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded
WORKING PROFIT FOR YEAR	£3,221 / 5·17%	£4,465 / 6·27%	£2,758 / 6·57%	£4,974 / 7·78%
Sum carried to Depreciation Fund	— / —	— / —	— / —	— / —
Sum carried to Reserve or Sinking Fund	1,817 / 2·97%	1,928 / 2·71%	1,164 / 2·77%	2,136 / 3·34%
Net interest on loans (incl. Debenture charges)	1,749 / 2·81%	1,732 / 2·43%	1,360 / 3·24%	2,144 / 3·35%
BALANCE FROM LAST ACCOUNT	— / —	−374 / 0·525%	−1,603 / −3·82%	−1,370 / 2·14%
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	— / —	537 / 0·754%	— / —	— / —
Deficit	*374 / 0·601%*	— / —	*1,370 / 3·26%*	*679 / 1·06%*
ORDINARY DIVIDEND PAID	— / —	— / —	— / —	— / —
PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE	59·1%	55·6%	51·3%	44·1%
Expenditure per kilowatt capacity	£7. 8s. 6d.	£5. 3s. 6d.	£4. 17s. 2d.	£2. 8s. 11d.
REVENUE PER KILOWATT CAPACITY	£12. 11s. 0d.	£9. 6s. 2d.	£8. 19s. 0d.	£5. 11s. 0d.
Expenditure per 8-c. lamp capacity	4s. 9d.	3s. 3½d.	3s. 1¼d.	1s. 6¾d.
REVENUE PER 8-C.P. LAMP CAPACITY	8s. 0½d.	5s. 11½d.	5s. 8¾d.	3s. 6½d.
REVENUE PER 8-C.P. LAMP CONNECTED	7s. 3½d.	7s. 5¼d.	5s. 1d.	4s. 9¼d.
Price charged for lighting, per unit	6d. to 3d.[c]	6d. to 3d.[c]	5d.	5d.
Price charged for power, per unit	3d. to 1d.[d]	3d. to 1½d.	5d.	2d.
Price charged for public lighting	—	2d. per lamp-hour.	—	—

DERBY.—REMARKS—*a* Over-expended. *b* Being insurance charges. *c* On maximum demand system (½ hours). *d* 3d. for first 8 hours of maximum demand per week, 2d. for next 18 hours, and 1d. per unit after. *e* Includes £177 to insurance and £11 stamp duty.

LEICESTER.—REMARKS—*a* Over-expended. *b* Auditing.

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The Electrician.

The Oldest Electrical Journal (established as a weekly Journal 1861—1878)

Published every Friday, Price Sixpence; Post Free, Sixpence-Halfpenny.
Editorial, Publishing and Printing Offices,

1, 2 & 3, SALISBURY COURT, FLEET ST., LONDON,

Telephone: 949 Holborn. *Telegrams:* "Electrician Newspaper London."

All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher "The Electrician," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "The Electrician" *Printing and Publishing Company, Limited, and be crossed "Coutts and Co."*

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All letters for insertion in "The Electrician," *or containing questions, must be accompanied by the name and address of the writer as evidence of good faith. No notice whatever is taken of anonymous communications.*

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SPECIAL NOTICE.

With this issue of "THE ELECTRICIAN" is published a Supplement Sheet Table of ELECTRIC RAILWAYS AND TRAMWAYS IN THE UNITED KINGDOM for 1898-99, which all purchasers of the Paper should receive gratis. Complaints of non-receipt should be promptly made to THE PUBLISHER.

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PROGRESS IN ELECTRIC TRACTION DURING 1899.

Our annual supplement sheet table of electric railways and tramways of the United Kingdom is published with this issue, and, we hasten to say, it marks substantial progress during the past year. The first casual glance will suggest such progress, the length and breadth of the sheet being considerably augmented by comparison with the sheet issued a year ago. It is only in its length, however, that increase in the number of undertakings is shown, the other axis of the two co-ordinates having been elongated on account of the numerous additional columns of useful data. Dealing first with the growth in the actual undertakings, we may say that the present sheet deals with a total of 180 lines in all stages of development, while the corresponding number in the previous sheet was only 154. There is thus an increase of 26 lines of all classes, or some 17 per cent. Of these 180 lines, 41 are in actual operation, and 28 are in progress of construction; while the remainder include 12 underground railways projected for construction in London, together with 99 projected light railways and tramways in various parts of the United Kingdom. There are seven more lines in operation than there were last year; the number of lines under construction has grown from 27 to 28; and the number of projected schemes now stands at 99, as against 93: besides which many of the lines working a year ago have greatly increased in mileage. It will be borne in mind, of course, that lines have passed from one class to another during the year, so that the new-comers are far more numerous than is indicated by the difference between the figures for the two years; also in spite of the fact that many of the projected schemes in our sheet last year have been postponed indefinitely or abandoned altogether. With regard to the aggregate mileage of single track of all the lines now in operation, this item would appear to have grown from 240 to 422 miles, of which nearly half the increase is due to extensions to already existing lines. In the frequency of car service, also, many lines show great advance, as indicated by the growing number of cars and the increased power at the generating stations; and doubtless our readers

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will discover other and similar indications of progress in the comparison between the columns for the present and the previous year.

With regard to the new columns which appear in our Supplement this year, we have hoped that, by the introduction of these, new data might be presented in a form convenient for comparison, while data that have previously appeared are now thrown into a still more convenient form. It is our belief that, wherever data of a numerical nature are to be presented for comparison, nothing is so convenient as the arrangement of such data in columns aligning all the undertakings in alphabetical order. For non-numerical or uncodified data, a paragraph of remarks serves well enough; but the paragraph form, when used for a series of numbers, is an exasperating weariness of the flesh, besides directly conflicting with the main object of the table. We have therefore removed, so far as has been possible, all numerical data from the "Remarks" column; and, further to facilitate reference, we have subdivided this column into two, besides splitting many of the other columns into two or more sub-sections. It only remains for us to express our thanks to the engineers and others who have so ably and loyally assisted us in compiling the vast quantity of information for these tables. If any of them have felt this service a burden, we trust they will find ample compensation in the ready means now afforded for them to compare their own lines with every other existing line. It is only by hearty co-operation on the part of engineers and others in charge of lines that such a compilation can be rendered of real service, as well to themselves as to the general electrical public. We trust our traction supplement this year will be found fully as useful, and meet with as cordial a reception, as on previous occasions.

REVIEWS.

Copies of any of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price.)

Electric Lamps and Electric Lighting. By Dr. J. A. Fleming, F.R.S. (London: "The Electrician" Printing and Publishing Co.) 1899. 6s.

It is satisfactory that a second edition of Dr. Fleming's book is needed so soon. A set of Royal Institution lectures developed into a decent-sized book, and the book has developed into a second edition, with about 50 extra pages. It would be difficult to find a general treatise on electric lighting, scientifically correct and yet not too specialised, which could compare with this work. It is easy to find books on the dynamo for dynamo makers, and books on various branches of electrical engineering; and inaccurate popular treatises on general electrical engineering are very common. But Dr. Fleming has discovered a "long-felt want"—itself an achievement—and has most ably filled it.

The new edition is the original book, as published four years ago, with additions inserted wherever necessary. The chapter on arc lamps, for example, now includes the treatment of the enclosed arc. Very little is known by the average electrician of the ways of this curious lamp, and Dr. Fleming's new edition is therefore all the more welcome.

Dr. Fleming is at present indulging in an electrical unit orgie, and it is therefore the more disappointing to find him writing about the "candle-foot," efficiency in "watts per candle," and "strength of current." We have not noticed "rate of speed," or "specific resistance in microhms," or "megohms per mile" in connection with cables, but would not be surprised to find them. The criticism of these small points in nomenclature may be rather pedantic; but if you want to enjoy an author, you must read him for information and feel confidence in him. These common little inaccuracies make you feel he is sometimes a slatternly thinker, and if he thinks crookedly where it is obvious, you feel he may also think crookedly where it is not; you therefore lose confidence, and feel you have to read with the uncomfortable tension of the critic, instead of the satisfying absorption of the pure imbiber.

Finally, all that can be said is that the book is so good that the best thing Dr. Fleming can do is to write another. A subject may be suggested—namely, the Arc Lamp. This is generally discussed solely as to the arc itself, and the curious physical phenomena connected with it; or else we have nothing but descriptions of mechanisms. There is, we believe, no book dealing with the mechanism rationally, showing the conditions necessary for sensitiveness and the avoidance of hunting, and the elimination of humming in alternating mechanisms. Dr. Fleming might well enlarge his chapter on the arc into a special treatise on arc lighting.

J. Swinburne.

Le Phénomène de Zeeman. By A. Cotton. (Paris: George Carré et C. Naud.) 2fr.

This little monograph is another of the series edited by a strong committee of French physicists, dealing with various branches of pure physics in such a manner as to assist students engaged in making investigations in these or associated subjects. The work already done is in each case carefully summarised, the position of that science is impartially stated, and a fairly exhaustive bibliography of the subject is appended either as footnotes, at the ends of the chapters, or at the end of the book. We might suggest, however, that the usefulness of a book of this nature and with these objects might be considerably increased if references were in every case collected at the end of each chapter, or even at the end of the book, so that they might be the more handy for reference. The book before us gives a brief, yet ample, statement of the experiments which have been conducted in France and elsewhere on the relation between magnetism and optics. An historical summary is also given in which numerous magneto-optic phenomena, distinct in general character from the Zeeman effect, are referred to. These include the experiments of Faraday, Tait, Chautard, and Fiévez. The discovery of the widening of the sodium line in a strong magnetic field by Zeeman, of the multiplication of the normal spectral lines, and the reversal and polarisation phenomena consequent on this multiplication, discovered by later workers in every part of the world, are entered into in greater detail and occupy the larger portion of this little book. Every student engaged in magneto-optic work will not fail to find this book of invaluable assistance.

"THE BREAKDOWN OF THE ELECTRIC LIGHTING ACTS."*

A Gas Journal's Criticisms.

The disappointment of the West End population with the public electric lighting is quite pathetic to witness, especially from the safe 'vantage ground of a gas-lit interior. We have dealt in another column with some of the features of the existing situation, with special regard to the interests more immediately concerned. It is permissible, however, to discuss it here in a general way. Matters have come to a climax with the particular electric lighting company implicated, the London County Council having just triumphantly brought off a prosecution for default, and secured a penalty. This kind of thing cannot long be borne by any supply undertaking; so that, unless the Metropolitan Electric Supply Co. can pull themselves together in time, they will find their prospects gravely affected by their vicissitudes of the autumn. The recent deputation to the President of the Board of Trade, sufficiently dealt with elsewhere, was not remarkably disingenuous; but, unfortunately for themselves, the directors of the company had not been quite straightforward in their excuses for the undeniable shortcomings of their system. Apart altogether from these petty and interested considerations, there stands the main question of whether electricity supply from a central station—the term is no longer to be used in any topographical sense—is suitable for anything else than a "fancy" trade. It is admitted by *The Times* that, "of all the lights in use, the electric light is the most irritating and depressing when the supply is insufficient. Deficiency of other lights causes obscurity, but leaves things in their normal

* From the *Journal of Gas Lighting*, Jan. 23. [We refer to this article in our editorial comments this week.—Ed. *E.*]

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relations. Electric light with insufficient voltage acquires an abominable orange tinge, which may be warranted to give the most tastefully decorated drawing-room the aspect of a dungeon. But if the companies choose to supply electricity three or four volts below standard, there is apparently nothing to be done except by strong-minded people who switch off the whole thing and light a few cheerful lamps." The writer then goes on to gibe at the Board of Trade for its failure to deliver the public from a worse tyranny than that of the gas companies—"these miserable relics of dark ages in which the public was sacrificed to monopolists." The gas companies have simply been succeeded by traffickers in a system in which "the badness of the light makes no appreciable difference in the bill." There is sufficient lucidity in the mind of the writer to enable him to perceive that neither competition nor municipalisation is a remedy for the evil. Two electric lighting companies are not together more reliable than one; and municipalised supplies are certainly no better than others.

The important point to be laid hold of, and kept in remembrance, is that the much-vaunted Electric Lighting Acts have completely failed to protect the interests of the consumers all along the line. The cardinal feature of the Acts, in which they departed most signally from gas legislation, was their construction on the principle of limited time of exploitation. In addition, the undertakers were not to be allowed to introduce into their systems anything to the prejudice of the consumer. These statutory arrangements have now been in operation long enough to enable the public to see how the theory has worked itself out in practice. The result is not flattering to the experimentalists in legislation who imagined they were going to put in the shade the Gas Acts from 1847 onwards. Whatever effect the principle of limited duration may have on the finances of an electric light company—and this has not yet been fully disclosed—it absolutely fails to benefit the consumer in the smallest degree. That electric lighting company would be happiest who should so contrive all their plant of every kind that the whole would tumble into dust, like the wonderful "One-Hoss Shay," on the day after the expiration of the provisional order. With regard to the enactment against doing anything to the prejudice of the consumer, the recent increase of voltage of the current sent out is a violation of the spirit, even if not the letter, of the Act. Indirectly, consequentially, and remotely, the change may be to the ultimate advantage of the consumer, as tending to reduce the capital burden of the undertakers. But this benefit, such as it is, will only begin to reach the consumer in the shape of a reduction of a halfpenny per unit, or so, on the price of current after the proprietors have had their full and back dividends. That is to say, a change of system to the highest legal voltage to-day will possibly benefit the consumer ten or a dozen years hence—if the economy is not meanwhile absorbed in the charge for depreciation, which is more than likely. The immediate difference, whatever it is, is all against the consumer. We recently published an article describing the state of the incandescent electric lamp industry, and have nothing to change from. The natural and necessary improvement of the manufactured article, which follows from the development and expansion of the trade under the forcing of commercial competition, has in this case no reference to the needs of the lamp user. The march of improvement has been in the direction of the production of a lamp to suit the high-voltage current and to sell at a reasonable price. It is so difficult to do this, that economy of current, which was being sought after ten years ago, has been ignored by common consent.

The consumer, however, suffers not only from broken lamps and a high consumption of current at the fashionable increased voltages. He is also victimised by the enhanced effect of variations of pressure at the higher limits. When central-station lighting was starting at 52 volts, variations of this pressure were of comparatively little importance to the lamp user. This original voltage, by the way, was the best all round for the incandescent electric lamp. When the supply companies put up their pressure to double this figure, it was a little hard on the lamp makers; but the latter rose to it, and met the demands on their skill and resourcefulness. Meanwhile, the consumer was made to feel that a variation of 5 per cent. in the voltage was a matter of some importance to him. Still, the different parties to the connection rubbed along fairly well. The regulation of generating machinery kept pace with the advance of pressure; and as no customers of an electric lighting company in the United Kingdom knew anything better, they had no legitimate grievance on this head. Nowadays all is changed, and for the worse. A drop of a few volts in the high-pressure terminals reduces the lamps to the irritating condition described by *The Times*; and the meter registers all the same. The *Pall Mall Gazette*, commenting on this state of things electrical, declares that, if it is not mended, "indignant heads of families will be compelled to fall back on the dull but constant ministration of the Gas Light and Coke Co." The alternative is not so bad as all that. These ministrations are not necessarily "dull," although they are virtuously constant. This is an age that is pleased with change; and a change from electric light to gas will not be a reversion, but a step forward into greater brightness.

MODEL TELEPHONE LICENCE.

The Postmaster-General has issued a model form of telephone licence for local authorities. A form has also been prepared for companies, differing in some respects from that for local authorities. The following is a reprint of the local authority licence:—

Dated ——— 19—.

TELEPHONE LICENCE.

Form A.—Local Authority.

POST OFFICE TELEGRAPHS.

HER MAJESTY'S POSTMASTER-GENERAL

and

This indenture, made the ——— between the Most Noble Henry Duke of Norfolk, Earl Marshal and Hereditary Marshal of England, K.G., Her Majesty's Postmaster-General (who and whose successor in the office of Her Majesty's Postmaster-General for the time being are intended to be hereinafter included in the term "the Postmaster-General"), on behalf of Her Majesty of the one part, and ——— (who and whose successors for the time being are intended to be hereinafter included in the term "the local authority") of the other part.

Whereas the local authority are desirous of carrying on the business of constructing, manufacturing, maintaining, working, and using within the area defined in the schedule hereto (which area is hereinafter referred to as "the licensed area"), telegraphs, the transmitting and receiving instruments of which consist of telephones, and of letting on hire such telegraphs as aforesaid, for the purposes of such working and user as aforesaid (which business is hereinafter referred to as "telephonic business").

And whereas, by reason of the provisions of the Telegraph Acts, 1863 to 1897, such part of the telephonic business as is intended to be hereby licensed cannot be carried on without the licence or sanction of the Postmaster-General:

And whereas, at the request of the local authority, and in order to enable them to carry on telephonic business in manner hereinafter authorised, the Postmaster-General has agreed to grant to the local authority the licences, powers, and authorities hereinafter expressed and contained for the period upon the terms and subject to the stipulations and conditions hereinafter appearing:

Now this indenture witnesseth that, in consideration of the premises and of the matters hereinafter appearing, it is hereby agreed and declared between and by the parties hereto, and the local authority (as to the covenants and agreements hereinafter contained on their part) do hereby covenant and agree with the Postmaster-General, and the Postmaster-General (as to the covenants and agreements hereinafter contained on his part) in exercise of all powers and authorities enabling him in this behalf, doth hereby covenant and agree with the local authority in manner following (that is to say):—

1. *Interpretation Clause.*—In these presents the following words and expressions shall have the several meanings hereinafter assigned to them, unless there be something either in the subject or context repugnant to such construction (that is to say):—

The word "telephone" means and includes any telegraphic transmitting or receiving instrument, used or intended to be used at any office for the purpose of transmitting or receiving spoken messages or communications by means of electricity.

The expression "telephonic message" means a spoken message or communication transmitted by telephone.

The word "office" means and includes any building or part of a building, or any place which is telegraphically connected or intended to be connected, either permanently or temporarily, by a telegraph wire or telegraph wires with some other building, part of a building, or place (whether such buildings, parts of buildings, or places respectively be occupied or used by any person solely or jointly with any other person), and in which telephones are or are intended to be used for the purpose of enabling any person to transmit from and receive at such building, part of a building, or place such telephonic messages as are hereinafter authorised.

The word "exchange" means and includes any building telegraphically connected or intended to be so connected with two or more offices by telegraph wires, and used or intended to be used for the purpose of enabling telephonic messages to be transmitted direct between such offices by means of or with the aid of such wires and by appliances placed in the exchange.

The expression "exchange subscriber" means any person with whom the local authority, the Postmaster-General, or any other person working an exchange has entered into an agreement for the purpose of enabling such person to communicate with other persons through the medium of an exchange.

The expression "exchange system" means an exchange or group of exchanges worked by the Postmaster-General or situate within an area within which the Postmaster-General has licensed telephonic communication to be carried on by some other person, together with the lines connecting any such exchange with the offices of subscribers or call offices, or in the case of a group of exchanges connecting such exchanges with each other.

The expression "exchange area," used in connection with the National Telephone Co. (Ltd.), means an exchange area as defined by an indenture dated March 25, 1896, and made between the Postmaster-General on behalf of Her Majesty of the one part and the National Telephone Co. (Ltd.) of the other part.

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The expression "trunk wire" means a telegraph wire used for telephonic communication and connecting the exchange system of the local authority with another exchange system no part of which is within the licensed area.

The expression "trunk line" means and includes a trunk wire and all posts, cables, tubes, or other works supporting or containing such wire.

The expression "call office" means an office open to the public for the purpose of the transmission therefrom of telephonic messages over an exchange system or over trunk lines.

The expression "establish telephonic communication" between two offices means to connect such offices with each other by telegraph wires, and the telephones connected therewith, in such manner that telephonic messages may be transmitted from one of such offices to the other, and such expression includes the maintenance of such communication where it already exists.

The expression "on an exchange" when used in relation to an office means that such office is telegraphically connected with such exchange for the purpose of enabling telephonic messages to be transmitted direct between such office and other offices similarly connected with such exchange or with any other exchange in the same exchange system.

The word "plant" includes works, materials, and plant.

The word "person" includes the local authority and also any other corporation, and any joint stock company and any other association or aggregate of individual persons.

2. *Licence to carry on telephonic business.*—(1) Subject to the provisions of this indenture, the local authority shall, during the term or period commencing on the —— day of———and terminating on the——— day of ——————— have licence and permission from the Postmaster-General (subject as hereinafter provided) to work and use, within the licensed area, telegraphs of which the transmitting and receiving instruments shall be telephones (but no other kind or description of telegraphs) for the purpose of enabling any person to transmit direct and receive at any office to and from any other person, at any other office, telephonic messages (but no other description of telegrams) relating to the business or private affairs of such persons respectively or one of them; and the local authority shall (subject to the provisions of this indenture) have licence and permission to receive from all such persons, for or in respect of the purchase or hire or maintenance or working or use of the said telegraphs, or any part or parts thereof, for the purpose aforesaid, or for or in respect of the right or permission to transmit or receive, or otherwise in respect of the transmission or receipt of such telephonic messages as aforesaid by means of the said telegraphs, such sums of money or other valuable considerations as shall be agreed upon between the local authority and the said persons respectively.

(2) The term "business" used in this Article shall not be construed or held to mean or include the business of collecting, receiving, or delivering messages or other communications transmitted or intended for transmission by telegraph, or any other business of a like kind.

(3) All telegraphs used for the transmission of telephonic messages under this indenture shall consist of complete metallic circuits, and shall be of such character and so constructed in all respects as the Postmaster-General may from time to time direct or approve.

(4) The local authority may establish telephonic communication between an exchange of the local authority within the licensed area, and an exchange subscribers' office situate outside that area, provided that such office is in the opinion of the Postmaster-General situate within a reasonable distance of the licensed area.

(5) The local authority shall not establish any exchange, or, save as provided in the sub-clause immediately preceding, transact any other kind of telephonic business outside the licensed area.

3. *No Written Messages to be Conveyed.*—(1) Neither any office, whether in the occupation of the local authority or of any other person, nor any such telegraphs as aforesaid, nor any part thereof, shall be used by the local authority, or by any other person either on their behalf or by their permission, for the transmission or receipt of telegrams of any kind, except such telephonic messages as are hereinbefore expressly authorised.

(2) No office, or part of any office, in the occupation of the local authority, either solely or jointly with any other person, shall be used by the local authority or any other person, or be permitted or suffered by the local authority to be used by any other person, for the purpose of making any copy, transcript, memorandum, or note of any telephonic message, or of the contents, substance, purport, or effect of any such message received at such office by means of the said telegraphs or any part thereof, it being the express intention of these presents, and of the licence and permission hereby given, that no written message or communication, or any written copy, memorandum, or note of any message or communication, or of the contents, substance, purport, or effect of any message or communication transmitted to any such office as aforesaid by means of the said telegraphs, shall be made or taken at or conveyed from any such office by any person whomsoever for any person whatsoever.

(3) The local authority shall make due provision and take all necessary and proper precautions for the observance of the conditions contained in this article by each and every person who may be from time to time or at any time entitled or permitted to use any office in the occupation of the local authority or any part thereof, or the said telegraphs or any part thereof.

(4) Nothing in this article contained shall prevent either the sender or receiver of any telephonic message from making a note or memorandum of the purport of such message for the purposes of the business or private affairs of such sender or receiver.

4.—*No Messages to be collected or delivered.*—(1) No office, whether in the occupation of the local authority or of any other person, shall be used by the local authority or any other person for the collection or delivery of telegrams of any kind.

(2) No written message or communication, or written copy, memorandum, or note of any message or communication, or of the contents, substance, purport, or effect of any message or communication transmitted to any office by means of the said telegraphs shall be delivered from such office or any other office.

(3) Subject to the provisions of this indenture, no money or other valuable consideration shall in respect of the transmission or receipt of any telegram, by means of the said telegraphs or any part thereof, be or be promised to be paid or given to any person (other than the local authority) entitled or permitted to use the said telegraphs by any other person whomsoever.

(4) The local authority shall take all necessary and proper precautions for the observance of the conditions stated in this article, and shall in entering into every contract or agreement with any person or persons in relation to the aforesaid business of the local authority make due provision for the summary determination by the local authority of such contract or agreement on breach of any of such conditions by any such person or persons.

5. *Public Use of Telephone.*—Where the charges for the establishment of telephonic communication with the office of any exchange subscriber are made with reference to the number of messages transmitted, such subscriber may (notwithstanding anything contained in this indenture) allow the telephones supplied to him to be used by any other person, and may charge for the use of such telephones.

6. *Provisions as to Breach of Conditions.*—In case any person or persons with whom the local authority may make any contract or agreement in relation to telephonic business, or who may be for the time being permitted by the local authority to use at any office the said telegraphs or any part thereof for the purposes hereinbefore authorised, shall at any time during the continuance of these presents, use any office or the said telegraphs, or any part thereof respectively, for any purpose or by any means or in any manner other than as hereinbefore expressly authorised and according to the conditions hereinbefore declared, the following provisions shall apply:—

(1) The local authority shall forthwith determine any such contract or agreement with, or withdraw such permission from, any and every such person so using such office or the said telegraphs, or any part thereof;

(2) If such office belong to or be occupied by such person either solely or jointly with any other person or persons, the local authority shall forthwith disconnect such office from any other office which is or may be telegraphically connected therewith by means of their aforesaid telegraphs;

(3) The local authority shall give notice forthwith to the Postmaster-General of such determination of contract or agreement or withdrawal of permission, as the case may be, together with full particulars of the reasons for the same; and

(4) The local authority shall not without the special licence and authority of the Postmaster-General re-establish telephonic communication between such office and any other office, or enter into any other contract or agreement with such person in relation to telephonic business, or permit him to use the said telegraphs at any other office.

7. *Unlicensed Telegraphs not to be used for Local Authority Business.*—(1) The local authority shall not at any time use, or permit, or suffer to be used for any of the purposes of these presents or any of the licences, powers, or authorities hereby granted, any telegraph of the kind or description hereby licensed or any part of any such telegraph

(*a*) which has been supplied to or has come into the possession of any person otherwise than by purchase, hire, or loan from the local authority, or

(*b*) in respect of which, or of the purchase or hire or maintenance or working or user or right of user of or permission to use which, any money or other valuable consideration has been given or agreed to be given to the local authority, before such telegraph or part of such telegraph as aforesaid was telegraphically connected with the aforesaid telegraphs of the local authority or has been given or agreed to be given to any person other than the local authority, either before or after the execution of these presents

unless and until the local authority shall have given notice in writing to the Postmaster-General of their desire to use such telegraph, or part of such telegraph, as aforesaid, three clear days at least before the user thereof.

(2) Until such notice has been given, no such telegraph or part of such telegraph shall be deemed to be within the licence and permission granted by these presents, and from and after the expiration of such notice the local authority may work and use such telegraph, or part of such telegraph, as aforesaid, in the same manner as any other telegraph, or part of any telegraph, hereby licensed, subject on the part of the local authority to the payment of the royalty hereinafter mentioned in respect thereof, and to the observance and performance of the several covenants and conditions herein contained affecting the same.

8. *Connection of Post Offices and Exchanges.*—(1) Unless unable (after exercising all powers in that behalf vested in them) to execute and maintain the necessary works in that behalf, the local authority shall at any time, and from time to time at the request of the Postmaster-General, and at the cost and expense of the local authority, establish telephonic communication between any exchange of the local authority and any post office (situate within a radius of one mile from such exchange (which the Postmaster-General may from time to time specify in that behalf) which post office is hereinafter referred to as a "prescribed post office"), and shall maintain such communication until otherwise requested by the Postmaster-General.

(2) The number of telegraph wires and of telephones necessary to establish telephonic communication under the preceding sub-clause of this article shall be such and telephonic communication shall be established in such manner as the Postmaster-General may from time to time prescribe.

(3) The Postmaster-General may at any prescribed post office establish a call office on any exchange of the local authority, provided that the use of such call office for communications to subscribers to the exchange of the

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local authority shall be subject to such charges as are for the time being made at other call offices of the local authority.

9. *Telephonic Communication through Post Offices.*—(1) Where and so long as telephonic communication is established between an exchange and a prescribed post office, the Postmaster-General and the local authority shall respectively do all such acts and things as may be necessary to enable telephonic messages to be transmitted—

(*a*) between any two offices on such exchange, and

(*b*) by means of the trunk wires of the Postmaster-General between any office on such exchange and any office on any other exchange system (whether belonging to the Postmaster-General, to the local authority, or to any other licensee of the Postmaster-General).

(2) Where and so long as telephonic communication is established between an exchange and a prescribed post office, the Postmaster-General will receive a telephonic message from any office on such exchange—

(i.) At the prescribed post office, for any of the following purposes (that is to say):—

(*a*) for transmission over the postal telegraphs and delivery as a telegram; or

(*b*) for delivery as an express letter; or

(*c*) for conveyance and delivery as an ordinary letter; and

(ii.) At any post office with which the prescribed post office is telephonically connected for delivery as an express letter.

and the local authority and the Postmaster-General will respectively do all such acts and things as may be necessary to enable such telephonic messages to be recieved at such post offices as aforesaid, and to be so transmitted, conveyed, and delivered as aforesaid.

(3) Where and so long as telephonic communication is established between an exchange and a prescribed post office, the Postmaster-General will receive at such post office any message from an exchange subscriber calling for the service of a post office express messenger; and the local authority and the Postmaster-General will respectively do all such acts and things as may be necessary to enable such messages to be received and to comply with such requests respectively.

(4) Where and so long as telephonic communication is established between an exchange and a prescribed post office, the local authority shall, if and when required by the Postmaster-General, and on such conditions as may from time to time be prescribed by him, do all such acts and things as may be necessary to enable telegrams received at the prescribed post office over the postal telegraphs, and addressed to an exchange subscriber to be telephonically transmitted (in lieu of delivery by messenger) through the medium of the exchange to the office of such subscriber, provided such subscriber desire such transmission, but the Postmaster-General shall not be bound to transmit any such telegrams in manner aforesaid.

10. *Post Office Regulations.*—The transmission of all telephonic messages over trunk wires or exchange systems of the Postmaster-General, or over any other postal telegraphs; the receipt of telephonic messages at post offices in accordance with the provisions of this indenture for the purposes therein specified; the transmission and delivery of telephonic messages, whether as telegrams or as letters; and the supply of Post Office express messengers in compliance with telephonic messages in that behalf, shall be subject in all respects, both as to charges and otherwise, to the regulations made by the Postmaster-General with the consent of the Treasury and in force for the time being in respect to the several matters aforesaid, and to such other rules and conditions not inconsistent with such regulations as the Postmaster-General may from time to time prescribe.

11. *Maximum and Minimum Rates.*—The prices to be charged by the local authority for the services hereinafter in this article mentioned shall not exceed the maximum sums or fall below the minimum sums hereinafter mentioned with respect to such services respectively (that is to say):

SERVICE.	Maximum charge.	Minimum charge.
For the establishment of telephonic communication between any exchange and the office of any exchange subscriber		
For the transmission of messages of the subscriber to any office on an exchange in the exchange system of the local authority—		
For the first messages		
For every subsequent message		
For the transmission of a message from a call office to any other office on an exchange in the exchange system of the local authority.....		

Provided always that the local authority may, with the consent in writing of the Postmaster-General, charge other prices than those specified in this article.

12. *Intercommunication with National Telephone Co.*—If the local authority at any time under the powers conferred by the Telegraph Act, 1899, and the order of the Postmaster-General made thereunder with the approval of the Treasury, and dated September 25, 1899,* requests the National Telephone Co. (Ltd.) to afford facilities for the transmission of messages between persons using the system of the local authority and persons using the system of the company in the licensed area, or between persons using the system of the local authority and persons using the system of the company in the whole of the company's exchange area of which the licensed area is part (as the case may be; then—

(*a*) The local authority shall afford similar facilities for such transmission; and

(*b*) The local authority may make such terminal charges where the message originates on an exchange of the company as are prescribed by the aforesaid order of the Postmaster-General, but shall not make any higher charges.

* See *The Electrician*, Oct. 27, 1899, p. 19.—ED. *E.*

13. *Corporation to Afford further Intercommunication in Certain Events.*—In case the Postmaster-General should hereafter establish an exchange system within any part of the licensed area, and the Postmaster-General should request the local authority to afford facilities for the transmission of messages between persons using the system of the local authority and persons using the system of the Postmaster-General, the local authority shall afford such facilities on such terms and conditions as may in case of difference be settled by arbitration.

14. *Terminal Charges on Trunk Wire Messages.*—(1) Where a telephonic message is transmitted over the trunk wires of the Postmaster-General between an office on an exchange of the local authority and an office on an exchange of the National Telephone Co. (Ltd.), such message shall be subject to the following charges (hereinafter called "terminal charges"), in addition to the Postmaster-General's charge for the use of the trunk wires, viz.:—

(*a*) Where the message originates on the exchange of the local authority, to such charges (if any) as the company may from time to time fix; and

(*b*) Where the message originates on the exchange of the company, to such charges (if any) as the local authority may from time to time fix.

Provided that the charges fixed by the local authority shall in no case exceed the following charges (that is to say):—

Where the Postmaster-General's charge for the use of a trunk wire does not exceed 1s. 6d., a charge of 3d.

Where the Postmaster-General's charge for the use of a trunk wire exceeds 1s. 6d. but does not exceed 3s., a charge of 4d.

Where the Postmaster-General's charge for the use of a trunk wire exceeds 3s., a charge of 6d.

And provided that if at any time the National Telephone Co. (Ltd.) abstain from making terminal charges on messages originating on the exchanges of the local authority, the local authority shall, so long as such abstention continues, make no terminal charges on messages originating on the exchanges of the company.

(2) Where a telephonic message is transmitted over the trunk wires of the Postmaster-General between an office on an exchange of the local authority and an office on an exchange of the Postmaster-General, no terminal charge shall be made by the local authority or by the Postmaster-General in respect of such transmission.

(3) Where a telephonic message is transmitted over the trunk wires of the Postmaster-General between an office on an exchange of the local authority and an office on an exchange of some licensee of the Postmaster-General other than the local authority or the National Telephone Co. (Ltd.), no terminal charge shall be made by the local authority in respect of such transmission.

15. *Repair and Renewal of Telephones.*—(1) Where, in establishing telephonic communication between an exchange of the local authority and a prescribed post office, the local authority have erected any wires upon or supplied any wires or apparatus for use within such post office all such wires and apparatus shall be under the sole care and management of the Postmaster-General; but the local authority shall reimburse the Postmaster-General the expense of all such repairs of such wires and apparatus as he in his discretion may think necessary from time to time, and the local authority shall, at the request of the Postmaster-General, from time to time renew such apparatus.

(2) The Postmaster-General shall make no charge to the local authority for working the wires and apparatus of the local authority placed in prescribed post offices for the purpose of establishing telephonic communication with exchanges of the local authority.

16. *Collection of Charges.*—(1) Except where such sums as hereinafter mentioned are in the first instance paid at a prescribed post office, the local authority shall pay to the Postmaster-General all sums due to him in respect of telephonic messages transmitted through an exchange belonging to the local authority to a post office, and thence transmitted, conveyed, or delivered as telegrams or letters, and in respect of the use of the Postmaster-General's trunk lines and of communications with any subscriber on an exchange of the Postmaster-General, and of the services of Post Office express messengers rendered in pursuance of any such messages, and shall also pay to the Postmaster-General all sums due to any licensee of the Postmaster-General, other than the local authority, in respect of telephonic messages transmitted from an office on an exchange belonging to the local authority.

(2) The Postmaster-General shall collect and account to the local authority for all charges payable at any call office established at a prescribed post office, so far as such charges relate to communications with subscribers to the exchange of the local authority, and the Postmaster-General shall also collect and account to the local authority for all sums payable by any subscriber on an exchange of the Postmaster-General, or by any licensee of the Postmaster-General other than the local authority, in respect of telephonic messages transmitted from an office on an exchange of the Postmaster-General or of such licensee to an office on an exchange of the local authority; but the Postmaster-General shall not be responsible for any such charges or sums as aforesaid which he is unable to collect.

(3) The Postmaster-General shall allow to the local authority and the local authority shall allow to the Postmaster-General (as the case may be) a commission of 5 per cent. upon all sums paid by the local authority to the Postmaster-General, or collected by the Postmaster-General on behalf of the local authority respectively, as provided by this article.

(4) Any such sum of 5 per cent. may be deducted either by the Postmaster-General or by the local authority from any sums payable to the local authority or to the Postmaster-General, as the case may be.

(5) In reckoning the commission payable to the local authority, every telephonic message transmitted as a foreign telegram shall be reckoned as though it were an inland telegram not exceeding 12 words in length, and the sum upon which commission is allowed to the local authority in the case of a telephonic message transmitted to any place abroad shall be the

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sum to which the Postmaster-General is entitled in respect of such message in account with any foreign Government.

(6) All accounts between the Postmaster-General and the local authority relating to the provisions of this article shall be rendered and settled monthly, and the first accounts shall be rendered at the expiration of the first calendar month after the ——————day of——————, and shall include the whole period which has elapsed from that day until the end of such month.

17. *Royalties.*—In addition to all other moneys which may become payable to the Postmaster-General under these presents, the local authority shall pay to the Postmaster-General the following moneys, hereinafter called royalties (that is to say):—

(1) The local authority shall pay to the Postmaster-General a royalty equal to 10 per cent. of the gross amount of every sum of money paid or payable by any person to or on behalf of the local authority for or in respect of any telegraph of the kind or description hereby licensed, or for or in respect of any office occupied by the local authority, or otherwise in respect of telegraphic messages transmitted by means of any such telegraph or otherwise howsoever in relation to any such telegraph, and whether such sum of money be a gross sum or be payable periodically or by instalments; and every such royalty shall become due so soon as the sum of money in respect of which it is payable or by the amount of which it is regulated shall be paid, or shall by virtue of any express or implied contract or otherwise be payable, whichever event shall first happen.

(2)—(*a*) In case any person should give to or confer upon the local authority any valuable consideration or benefit (not being money or a contract solely for the payment of money) for or in respect of any such telegraph, or for or in respect of any office occupied by the local authority either solely or jointly or otherwise in respect of telegraphic messages transmitted or received by means of any such telegraph or otherwise howsoever in relation to any such telegraph, the local authority shall pay to the Postmaster-General a royalty equal to 10 per cent. of the value in money of such consideration or benefit.

(*b*) For the purpose of estimating the amount of such last-mentioned royalty, the value in money of such consideration or benefit shall be determined by the certificate of such officer of the Post Office as the Postmaster-General shall appoint for that purpose, or in case of dispute by arbitration as hereinafter provided.

(*c*) Such royalty shall be payable, and paid at such time or times, and by such instalments, and generally in such manner as the Postmaster-General shall appoint, and shall be payable in addition to such royalty or royalties (if any) as shall be payable in respect of such person under the stipulations hereinbefore contained.

(3) In case any sum of money be paid or payable to or other valuable consideration or benefit be given to or conferred upon the local authority by any person or persons for or in respect of any telegraph maintained or used solely for the transmission of telegrams which are by law excepted from the exclusive privileges of the Postmaster-General (hereinafter for brevity styled a "private telegraph"), in addition to any sum of money paid or payable, or other valuable consideration given to or conferred upon the local authority by the same person or persons for or in respect of any telegraph of the kind or description hereby licensed, the Postmaster-General may at his option apportion such sums or other valuable considerations respectively, either in whole or in part, between the said private telegraph and such other telegraph as aforesaid, in such manner or in such proportions as he may deem fit and proper; and thereupon such sums or other valuable considerations respectively as he shall apportion accordingly shall as between the local authority and the Postmaster-General for the purposes of these presents be deemed to be the sums or valuable considerations respectively paid or given by such persons as aforesaid in relation to such private telegraph and such other telegraph as aforesaid respectively, in lieu of the sums or valuable considerations actually paid or given by such persons in relation to such telegraphs respectively.

(4) In case the local authority shall, as hereinbefore provided, use or permit or suffer to be used for any of the purposes of these presents, or any of the licences, powers, or authorities hereby granted, any telegraph of the kind or description hereby licensed or any part of any such telegraph

(*a*) which has been supplied to or has come into the possession of any person otherwise than by purchase, hire, or loan from the local authority; or

(*b*) in respect of which any money or other valuable consideration has been given or agreed to be given to the local authority before such telegraph or part of such telegraph as aforesaid was telegraphically connected with the aforesaid telegraphs of the local authority, or has been given or agreed to be given to any person other than the local authority, either before or after the execution of these presents

the local authority shall pay to the Postmaster-General such a royalty in respect thereof as under all the circumstances of the case shall be fair and reasonable, and the amount thereof shall be determined by the certificate of such officer of the Post Office as the Postmaster-General shall appoint for that purpose, or in case of dispute by arbitration as hereinafter provided, and shall be payable and paid at such time or times and by such instalments and generally in such manner as the Postmaster-General shall appoint.

(5) Nothing herein contained shall entitle the Postmaster-General to receive any royalties from the local authority on any money or other valuable consideration received by the local authority on the sale of any telegraph which the local authority, after such sale, do not work or use under this indenture it being the intention of these presents that all royalties payable to the Postmaster-General in respect of any such telegraph shall be paid by the person working or using the same, provided always that the local authority shall, seven days at least before any such sale of any such telegraph as last aforesaid, deliver a notice in writing of such intended sale at the General Post Office in London; and such notice shall contain the name and address and occupation of the intended purchaser or purchasers of such telegraph, and also full particulars of the offices intended to be connected by means thereof.

(6) In this article payments made or considerations or benefits given "for or in respect of any telegraph" mean and include payments made or considerations or benefits given for or in respect of the purchase or hire or maintenance or working or user or right of user of or permission to use any such telegraph or any part thereof, and payments made or considerations or benefits given "in respect of an office" mean and include payments made or considerations or benefits given in respect of the user or right of user of or permission to use any such office or any part of such office.

18. *Accounts of Business to be Kept by Local Authority.*—The local authority shall at all times keep all such books of account as the Postmaster-General may from time to time reasonably require of and relating to their telephonic business and their aforesaid telegraphs (including all private telegraphs worked or used by persons respectively entitled or permitted to use any other telegraphs of the local authority, and also all telegraphs sold by the local authority, which the local authority after the sale thereof do not work or use as aforesaid), and all moneys and other valuable considerations received by them in respect thereof, as aforesaid, and such books of account shall contain all such particulars as the Postmaster-General shall from time to time reasonably require, and the local authority shall preserve all vouchers of the said accounts and all contracts and agreements between them and all or any such persons as aforesaid respectively, and the local authority shall from time to time, and at all reasonable times produce for the inspection of the Postmaster-General and his officers, at the chief office for the time being of the local authority, all or any such books, accounts, vouchers, contracts, agreements, and other documents as aforesaid, and all other books, accounts, vouchers, contracts, agreements, and other documents in any way relating to any telephonic business carried on by them, and the Postmaster-General and his officers may make copies of and extracts from all or any of such books, accounts, vouchers, contracts, agreements, and other documents.

19. *Account's to be furnished to Postmaster-General.*—(1) Subject to the provisions of this indenture respecting sums received by the local authority for the Postmaster-General, and commission allowed by the Postmaster-General to the local authority and by the local authority to the Postmaster-General, the local authority shall within 28 days after March 31, June 30, Sept. 30, and Dec. 31 in every year render to the Postmaster-General a statement or statements of account in writing in such form or forms as the Postmaster-General may from time to time require, showing the amounts of all sums of money and the nature of all other considerations and benefits which from the date hereof, or from the date up to which the last statement or statements of account (if any) shall have been rendered, have been paid or become payable, or been given or conferred by all such persons as aforesaid, in respect of all the matters aforesaid, or any of them respectively, or which have either before or since the execution of these presents been paid or become payable, or been given or conferred in respect of any telephones, telegraphs (including such private telegraphs as lastly hereinbefore mentioned), or other telegraphic apparatus or appliances which from the date hereof, or from the date up to which the last statement or statements of acccount (if any) shall have been rendered, have been placed at any office or between any two offices, together with all such particulars in each case as the Postmaster-General shall or may from time to time require, and the local authority shall pay to the Postmaster-General within six weeks after each of such days of account the amount due to the Postmaster-General in respect of the preceding quarter of a year.

(2) The local authority shall also, on or before the——day of —— in every year, prepare and render to the Postmaster-General an annual statement of accounts of the telephone business transacted by them, made up to the——day of —— then next preceding, and such statement shall be in such form and shall contain such particulars as may be from time to time prescribed by the Postmaster-General.

20. *Power to Postmaster-General to Inspect Telegraphs at all Offices.*—The Postmaster-General and his engineers and agents may from time to time, and at all reasonable times, enter upon all or any office or offices in the possession or occupation of the local authority, either solely or jointly with any other person or persons respectively, for the purpose of inspecting, and may inspect the telephones and other telegraphic instruments and appliances fixed or being in such places respectively, and the working and user of such telegraphs respectively; and the local authority shall from time to time upon the request of the Postmaster-General procure from any person permitted by the local authority to use the said telegraphs at any other office or offices which may be occupied by them either solely or jointly with any other person, his consent to such entry and inspection so far as regards such office or offices of such person and the telephones and other telegraphic instruments and appliances fixed or being in such office or offices.

21. *Local Authority to Supply Telephonic Communication without Favour or Preference.*—(1) The local authority shall, at the request of any person within the licensed area, supply the means of telephonic communication to such person on the same terms on which they supply the like means of communication to any other person in such area under similar circumstances—it being the intention of these presents that no preference or special advantage of any kind be shown to any person by the local authority in the transaction of telephonic business of any kind.

(2) The local authority shall not as a condition of supplying the means of telephonic communication to any person require from such person the grant of any facility except for the purpose of supplying telephonic communication to such person.

22. *Authority to Exercise Wayleave Powers.*—The Postmaster-General will from time to time, at the request of the local authority, authorise

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the local authority to exercise within such parts of the licensed area as are within or adjoining to any urban district all such powers of executing works (other than works under, in, upon, over, along, or across any railway or canal) as are conferred upon the Postmaster-General by the Telegraph Acts, 1863 and 1878, and by section 2 (but not by any other section) of the Telegraph Act, 1892.

Provided nevertheless as follows:—

(1) Any authority given by the Postmaster-General under this article shall have effect only so long as the licences, powers, and authorities granted by this indenture are in force, and within such area only as is specified in the instrument giving or evidencing the grant of such authority.

(2) In exercising such powers and executing such works the local authority shall be subject to the several restrictions and provisions in the said Acts or any of them contained, and particularly and without prejudice to the generality of this provision the local authority shall be subject to the provisions of the following sections of the said Acts—that is to say, sections 42 and 48 to 52 inclusive of the Telegraph Act, 1863, and sections 5 and 7 of the Telegraph Act, 1892.

(3) The local authority shall not be entitled under the authority hereby conferred to exercise any power or enjoy any right, benefit, or advantage conferred upon the Postmaster-General by the Telegraph Act, 1863, the Telegraph Act, 1878, or the Telegraph Act, 1892, otherwise than in relation to the execution of works.

(4) Section 4 of the Telegraph Act, 1892, shall not apply to the local authority.

(5) Nothing in this indenture shall be construed to give the local authority any wayleave or right of way under, in, upon, over, along, or across any railway or canal, or any right to execute any work under, in, upon, over, along, or across any railway or canal, or to call upon the proprietors or lessees of any railway or canal, or the directors or person having the control thereof, to execute any such work.

23. *Local Authority's Telegraphs not to Interfere with Postal Telegraphs.*—All telegraph posts, wires, and telegraphic appliances used, or intended to be used, as part of or in connection with the telegraphs of the local authority shall be so erected, fixed, placed, and used as not, either directly or by reason of the working or the user thereof, to interfere with the efficient or convenient maintenance, working, or user of any telegraph posts, wires, or telegraphic appliances of the Postmaster-General which may from time to time exist, or which it is probable that the Postmaster-General may have occasion to erect, place, fix, or use, or to expose any such posts, wires, or appliances to risk of damage or to risk of interference with the efficient or convenient working or user thereof.

24. *Removal of Injurious Telegraphs.*—In case any telegraph post, wire, or telegraphic appliance used, or intended to be used, as part of or in connection with the telegraphs of the local authority, or the working or user of any such post wire or appliance, shall in the opinion of the engineer-in-chief for the time being of the Post Office, certified by writing under his hand, directly or indirectly damage or interfere with the efficient or convenient maintenance, working, or user of any telegraph post, wire, or telegraphic appliance of the Postmaster-General for the time being existing, or expose any such post, wire, or appliance to risk of damage or to risk of interference with the efficient or convenient working or user thereof.

(*a*) The local authority shall, within 24 hours after service on them of notice in writing by the Postmaster-General, complaining of such damage or interference or apprehended damage or interference, either remove the post or posts, wire or wires, or telegraphic appliance or appliances complained of in such notice, or refix, alter, or repair the same to the satisfaction of the engineer-in-chief for the time being of the Post Office; and

(*b*) If the local authority shall make default in so doing within the time aforesaid, it shall be lawful for the Postmaster-General to remove, alter, or repair the post or posts, wire or wires, or telegraphic appliance or appliances complained of in such notice; and the local authority shall on demand pay to the Postmaster-General the cost of any removal, alteration, or repair by the Postmaster-General of the posts, wires, and telegraphic appliances complained of in such notice or any of them.

25. *Local Authority to Pay Cost of Repairing Damage done to Postal Telegraphs by their Telegraphs.*—In case any telegraph post, wire, or telegraphic appliance of the Postmaster-General shall be damaged, or the efficient working or user thereof shall be wholly or partially interrupted or otherwise interfered with, and the engineer-in-chief for the time being of the Post Office shall certify by writing under his hand that such damage, interruption, or interference has been caused directly or indirectly by any telegraph post, wire, or telegraphic appliance used or intended to be used as part of or in connection with the telegraphs of the local authority, or by anything done by or on behalf of the local authority in relation thereto, the local authority shall on demand pay to the Postmaster-General all costs that shall be reasonably incurred by him in repairing such damage, and in removing or altering such post, wire, or telegraphic appliance so as to restore the same to efficient working order, and in adding thereto, or substituting therefor, either temporarily or permanently, any other posts, wires, or telegraphic appliances if the said engineer shall certify that such addition or substitution is reasonably required.

26. *Licence not to be Assigned.*—Except with the consent in writing of the Postmaster-General, the local authority shall not—

(1) assign, underlet, or otherwise dispose of the benefit of the covenants herein contained, or of any of such covenants, or the licences, powers, or authorities hereby granted, or any of such licences, powers, or authorities; or

(2) sell, assign, transfer, or deliver or underlet, to any other licensee of the Postmaster-General any plant used by the local authority in supplying the means of telephonic communication under these presents, or allow such licensee in any manner to have the use, benefit, or enjoyment of any such plant in connection with his undertaking; or

(3) purchase, lease, or acquire any interest in the business or plant of any other licensee of the Postmaster-General, or any part of such business or plant, or enter into any working or other agreement with such other licensee.

27. *Further Assurance.*—The local authority and the Postmaster-General shall from time to time do and execute, or cause to be done and executed, all such acts, deeds, and things whatsoever as may be required by the Postmaster-General or the local authority (as the case may be) to give effect to the covenants and agreements in this indenture contained.

28. *Provisions for Determination of Licence in Certain Events.*—In any of the following cases (that is to say):—

(*a*) In case the local authority do not within two years from the date of this indenture establish an exchange system, and so long as the licences, powers, and authorities hereby granted shall continue maintain such system in effective working to the satisfaction of the Postmaster-General; or

(*b*) In case any sum of money which ought to be paid by the local authority to the Postmaster-General under or by virtue of these presents shall be in arrear and unpaid for one calendar month after the time at which the same ought to be paid under or by virtue of the covenants herein contained, or

(*c*) In case of any breach, non-observance, or non performance by or on the part of the local authority of any of the covenants (other than a covenant for the payment of money) or conditions herein contained and on the part of the local authority to be observed and performed,

then and in any such case the Postmaster-General may, by writing under his seal, revoke and determine these presents and the licences, powers, and authorities hereinbefore granted, and each and every of them, and thereupon these presents and the said licences, powers, and authorities, and each and every of them, shall absolutely cease, determine, and become void.

Provided always that no such revocation or determination as aforesaid shall prejudice or affect any right of action or remedy which shall have accrued or shall thereafter accrue to either of the parties hereto under the covenants herein contained.

Provided also that in case of any such revocation or determination as aforesaid the local authority shall, if so required by the Postmaster-General, sell and convey to the Postmaster-General all such plant as was immediately prior to such revocation or determination in use by the local authority for the purpose of supplying the means of telephonic communication under these presents, and as the Postmaster-General may desire to purchase.

29. *Purchase of Plant by Postmaster-General.*—(1) On or so soon as may be after the ——— day of ——— aforesaid (unless these presents shall have been previously revoked and determined as in this indenture provided) the Postmaster-General shall buy and the local authority shall sell and convey all such plant as is at the date aforesaid in use by the local authority for the purpose of supplying the means of telephonic communication under these presents, and as is suitable for the actual requirements at the date aforesaid of the telephonic service of the Post Office within the licensed area.

(2) No plant shall in any case be considered suitable for the requirements of the telephonic service of the Post Office which has been brought into use without the sanction in writing of the Postmaster-General, but subject as aforesaid, if any question arises as to the suitability of any of the plant of the local authority for the requirements of the telephonic service of the Post Office within the licensed area, such question shall in case of difference be determined by arbitration.

30. *Valuation of Plant.*—The value of all plant purchased by the Postmaster-General under the foregoing articles shall be deemed to be its fair market value at the time of the purchase, due regard being had to the nature and then condition of such plant and to the state of repair thereof, and to the circumstance that it is in such a position as to be ready for immediate working, and to its suitability to the purposes of a telephonic service, and no addition shall be made to such value in respect of compulsory purchase or of goodwill or of any profits which might have been or be made by the local authority from the use of such plant. In case of difference such value as aforesaid shall be determined by arbitration.

31. *Arbitration.*—All matters which, in pursuance of the provisions herein contained, are to be determined by arbitration, shall be referred to arbitration in accordance with the provisions of the Arbitration Act, 1889, or any then subsisting statutory re-enactment or modification thereof.

32. *Agreement not to affect Postmaster-General's Rights.*—Nothing in these presents contained shall prejudice or affect the right of the Postmaster-General from time to time to establish, extend, maintain, and work any system or systems of telegraphic communication (whether of a like nature to the telephonic business of the local authority or otherwise) in such manner as he shall in his discretion think fit; neither shall anything herein contained prejudice or affect the right of the Postmaster-General from time to time to enter into agreements for or to grant licences relative to the working and user of telegraphs (whether of a like nature to those worked and used by the local authority or otherwise) or the transmission of telegrams in any part of the United Kingdom with or to any person or persons whomsoever, upon such terms as he shall in his discretion think fit. And (save as in this indenture provided) nothing herein contained shall be deemed to authorise the local authority to exercise any of the powers or authorities conferred on or acquired by the Postmaster-General by or under the Telegraph Acts or any of them.

33. *Notices, &c.*—Any notice, request, or consent (whether expressed to be in writing or not) to be given by the Postmaster-General under these presents may be under the hand of any one of the secretaries or assistant-secretaries for the time being of the Post Office, and may be served by sending the same by registered post letter to the local authority; and any notice to be given by the local authority under these presents may be

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served by sending the same by registered post letter addressed to the Secretary of the Post Office, at the General Post Office, London.

In witness whereof the above-named, Postmaster-General hath hereunto set his hand and seal and the
have caused their common seal to be hereunto affixed, the day and year first above written.

Signed, sealed, and delivered by the above-named Henry Duke of Norfolk, Her Majesty's Postmaster-General, in the presence of

The common seal of the local authority was hereunto affixed in the presence of

THE SCHEDULE.
[Description of licensed area.]

Form B.—Local Company.

The first 27 clauses of the model licence for companies are in every respect similar to the above, except that the word company is substituted for the words local authority. The 28th clause is the same, with the omission of the last paragraph. Clause 29.—(1) is as follows:—

29. *Purchase of Plant by Postmaster-General in Certain Events.*—(1) In case of any such revocation or determination as in the last preceding article mentioned, or upon the expiration by effluxion of time of the licence granted by these presents, the company shall, if so required by the Postmaster-General, sell and convey to the Postmaster-General all such plant as was immediately prior to such revocation, determination, or expiration in use by the company for the purpose of supplying the means of telephonic communication under these presents, and as the Postmaster-General may desire to purchase.

Clause 29.—(2) is the same as clause 30 of the local authority form, and clauses 30, 31, and 32 of the company form are the same as clauses 31, 32, and 33 respectively of the local authority form, except that in all cases the word company is substituted for the words local authority.

CORRESPONDENCE.

ELECTRICAL ENGINEERS AND THE WAR.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I enclose you herewith copy of a letter I have written, as treasurer of the Electrical Engineers' Dinner Committee, to Mr. McMillan; and I shall be glad if you will insert it either wholly or in part in your journal.—Yours, &c.,

London, S.W., Jan. 25. HENRY EDMUNDS.

P.S.—You might also say that Mr. Edmunds would be pleased to receive subscriptions, as treasurer, at 2, Queen Anne's-gate, S.W.

[Copy.]

W. G. McMillan, Esq.,
Secretary of the Institution of Electrical Engineers,
28, Victoria-street, S.W.

ELECTRICAL ENGINEERS (R.E.) VOLUNTEER CORPS.

DEAR MR. MCMILLAN: As you are probably aware, some 53 members of this corps will shortly leave for South Africa; and it has been suggested by several members of the Institution that it would be well to give the corps a good send-off in the shape of a dinner at some early and convenient period before they start. To this end I have been asked to become one of the committee, and to act as treasurer in connection with the scheme. Feeling that many members of the Institution would probably like to take part in this gathering, I write to you as secretary, to ask you to bring this matter before the Council meeting to-morrow, in order that they may consider in what way notice should be given to the members and associates in regard to the proposal, which is this: that a dinner should be given, and tickets charged at £2 each, part being for payment of the dinner as for the members and guests, and the balance to be applied to a fund for the corps.

If you will kindly bring this forward, you will greatly oblige

Yours faithfully,

Westminster, Jan. 24, 1900. (Signed) HENRY EDMUNDS.

PARSONS STEAM TURBINES AT CAMBRIDGE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your notice of the new Parsons plant in use at this station (*The Electrician*, Jan. 12, p. 390) you state that the guarantee of 27lb. of steam per kw. was with superheated steam. The fact, however, is that no such conditions were required from any of the contractors. The guarantee was to be for saturated steam at 140lb. pressure, and the engines to be condensing. Superheated steam has not been used at this station for the last 6½ years, owing to difficulty with the superheater; and we are not aware that at any of the numerous stations employing Parsons turbines superheated steam is employed. As a matter of justice to Messrs. C. A. Parsons and Co., we should be obliged if you would make this correction in an early issue.—Yours, &c.,

Cambridge, Jan. 20. JOHN H. BARKER.

LEGAL INTELLIGENCE.

Rücker v. London Electric Supply Corporation (Ltd.).

This action was commenced, before Mr Justice Farwell, in the Chancery Division, on Monday. Mr. Bousfield, Q.C., Mr. A. J. Walton, and Mr. Grey appeared for the plaintiff; and Mr. Fletcher Moulton, Q.C., Mr. Cripps, Q.C., Mr. Graham, and Mr. Moulton, jun., for the defendants.

Mr. BOUSFIELD said the action was brought for infringement of a patent for a system of distributing electricity for electric lighting by means of transformers in a certain combination. Counsel said he could only recall one similar kind of patent contrived by Gaulard and Gibbs. There was another by Dr. Hopkinson which came before Mr. Justice Romer, and was somewhat similar. Many years ago, of course, the distribution of electricity was almost unknown. For example, whenever the electric light was used in a lighthouse, a dynamo would be placed at the bottom of the tower, and there would be a light above. Since then, however, great strides had been made, and he hoped to be able to prove that it was greatly due to the patentees under the patent in question in this action. The patent * was known as Thompson's patent, but Thompson was only the agent of Carl Zipernowsky and Max Déri (of Budapest), to whom this invention was due. Zipernowsky and Déri made this improvement in 1885, and patented it in various countries on the Continent. These gentlemen were connected with Messrs. Ganz and Co., who have a very large business on the Continent, and have had a great amount of litigation on the Continent with regard to this particular patent. They were unfortunate at first, but finally they succeeded, counsel thought, in Italy and France in their litigation. He did not intend going into any detail about it, but that would explain why this action was brought so late in the life of the patent. During that time Messrs. Ganz were extending their business on the Continent, and their hands were very full.

His LORDSHIP: You cannot ask for an injunction now, or for delivering up.

Mr. BOUSFIELD agreed. It was simply a question of account. A curious element in the case was that in 1886, when the patent was exhibited, the leading electricians condemned the system and said that successful distribution could not be made on those lines. Counsel said he thought the present-day electricians would have known it would have succeeded, but in 1886 it was a very different thing. There were contemporary discussions by electrical engineers and electrical newspapers, and then they said it would be a failure. He (counsel) mentioned that, for the purpose of pointing out that they had had initial difficulties to encounter, and also the difficulty that the people interested in the matter were people on the Continent in a large business way, and it was not until they had practically overcome their difficulties abroad that they were able to turn their attention to the infringements which were going on in England. Three or four years ago the patent was amended and bought by the plaintiff in this action. The amendment was simply the cutting out of the specific apparatus. He did not think it could be suggested on behalf of the defendants that in cutting that out as regarded the original specification there was any want of good faith. The amendment was dated April 3, 1897, and was on the face of the specification. Of course it was amended solely in view of the litigation, in order to remove matters of not much importance. The matter was now reduced to simple form. He thought his learned friends would have great difficulty in finding anything which anticipated the portions of the invention which were deleted. The invention had reference to the distribution of electricity by transformers. By means of that system they were generally enabled to use electric currents of high potential, and to carry them near to the points of consumption, and then transform the high-potential currents into currents of low potential, so that they were able to save in the cost of conductors—which was important in the case of electric distribution.

His LORDSHIP pointed out that he was not a master of the science of electricity, and hoped that the learned counsel engaged would give him as much assistance as possible by explaining technical terms, and so on. He understood some of the elementary terms.

Mr. BOUSFIELD said in that case his lordship had mastered the terminology of the case, and he thought that he would be able to come to a judgment on the specification. It was no doubt a difficult subject, but the principle involved was really simple. Although in the course of his opening speech he might have to go into matters outside the subject of controversy in order to make himself clear, he did not think that the evidence in the case ought to be of any great length. It was alleged that this patent was anticipated by something done by Gaulard and Gibbs and by something done at the Royal Aquarium; but that would have to be inquired into. Perhaps his learned friends on the other side would agree not to call more than two experts on each side.

Mr. MOULTON: I shall not call more evidence than I can possibly help.

His LORDSHIP: Generally speaking, two experts ought to be enough.

Mr. BOUSFIELD, continuing, said the problem they had to deal with was the distribution of the flow of electricity through wires, and therefore

* No. 3,379 of 1885. See *The Electrician*, Vol. XLII., p. 899.

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it was analogous to the distribution of gas or water through pipes, and the analogy of sending a flow of liquid through pipes helped them very much. Of course, a flow of water depended upon the differences of pressure or the differences of level. Therefore there was an analogy in the case of the flow of water and in the case of an electric current. In electricity they were not concerned with absolute pressure, but with differences of pressure. He would take his lordship to the beginning of the question of electric lighting, and for this purpose it was absolutely necessary to look at how things stood at the date of this patent and what had been done with reference to electric lighting. He had told his lordship that the oldest method for distributing electric light was to have a machine to a light. The first thing was to light the lamp by a machine; the second was to have machines of higher pressure, and to light three, four, five, or six lamps, by that means passing the current through the lamps in series. One of the little diagrams which had been made for the assistance of his lordship showed a simple series arrangement. In a series arrangement they had everything arranged on the same circuit. By that arrangement they would require a pressure of 100 volts for each lamp, or a pressure of 600 volts to light six lamps. When you put out one lamp, say, on a series circuit, you wanted 500 volts to drive the rest. If two lamps were put out, the pressure had to be reduced to 400, and three lamps to 300, and so on. If there was only one lamp in, there would be wanted a pressure of 100 volts, but in each case they had got round the circuit a half ampere of current. That was referred to as the constant-current system of distribution. That was the earlier system used with arc lights. The learned counsel then referred to the constant-pressure system, and said that as a matter of fact by that system constant differences of pressure which ought to be had were not got at all the different points along the line. In passing through a long distance it was necessary to have the conductors of a size so as to prevent the fall of potential. The learned counsel next referred to Edison's system with a circuit of feeders adapted to it. In that system the object was to have the potential constant, and that was done by the help of feeders. In that system it was wanted to get a constant potential in the mains. That was called the constant-potential system. That was a good system for comparatively small areas, but not for large areas. The next great step in the matter was Hopkinson's three-wire system, by means of which the saving of practically three-quarters of the copper previously required was effected. That enabled them with a given capital to cover a much wider area, and that was an important matter in connection with this case. That helped them to see what people were driving at for years. Supposing they had a certain area, say of 1,000 lamps, each lamp took half an ampere at a pressure of 100 volts, so that the whole system required 50,000 ampere volts—50,000 units of work per second. Now, in distributing this 50,000 units of work, the question was how to do it most economically; and it was obviously having regard to the question of current and of waste of current from resistance, that they, instead of sending the current from the station 500 amperes to 100 volts, sent out 100 amperes at 500 volts. They were sending out the same amount of work, but the conductor would be so much smaller and the expenditure would be so much less. It was therefore seen to be desirable to send out at a higher potential, and that having been attained, Ruhmkorff's apparatus was the earliest method and the simplest form of transformers for the purpose. Speaking of the plaintiff's patent, counsel pointed out that the object of the invention was to make all individual points of consumption of electrical energy quite independent from one another. Lord Kelvin might say that that was a simple thing to do, and that there was nothing in it. He (counsel) assumed that Mr. Moulton would say that the thing depended upon such elementary electrical principles that it required no application of skill to make it effective. He should point out, however, that so little did it appear obvious to electrical authorities in the past, that the principle was condemned all round—viz, at discussions, in the courts, and in papers read at meetings, and so on. It was received with discredit and disbelief in the electrical world. In the three-wire case it was said that anybody would know that if two conductors were put together, in one of which there was a current flowing one way and another the other, the two currents would be naught. Of course that was so. Two currents of that sort neutralised one another. Although the principle of the plaintiff's invention might be obvious, it did not follow that there was no application required to make it effective. The plaintiff's case depended on the fact that the patentee had put together and applied all these elements of knowledge and applied them to a practical system of electric lighting. The learned counsel then read the complete specification, No. 3,079 of 1885, and said that the claim made by patentee was the application of induction coils or transformers for alternating electric currents, the arrangement of several stations of second order as branch circuits of the main line—viz, in connecting up the local centres with the main line in multiple arc—to which main line is supplied an alternating electric current of a tension as constant as possible. The defendant's system was on the following plan: At Deptford they generated their electricity at a tension of 10,000 volts, and brought it into London. Their mains were carefully guarded against leakage. The defendants made a double use of this system. But the important thing to observe was what they did when they got the current to Trafalgar-square. The defendants got it as electrical energy for distribution at 2,000 volts. As a matter of fact the defendants made double use of the transformer system. They applied this system for distributing throughout the district they supplied. They had got their mains laid down in the streets at a pressure of 2,400 volts, then they had the sub-station, where they had the transformers.

In answer to the judge, counsel said on the question of infringement the defendants said that the tension of the plaintiff's system varied from time to time in order to fit the best results. That was merely a quibble. This was a constant-tension system as opposed to a constant-current system. The specification was amended three years ago, and in that respect there was also an analogy to the case of Hopkinson, whose specification also was amended, and who had to satisfy the Court, in order to obtain damages, that before the amendment the original claim was framed in good faith and with reasonable knowledge. In these cases they had to satisfy the Court that the original claim was framed in good faith and with reasonable knowledge,, instead of getting the better of the public by first making a broad claim and then cutting it down. In the present case he would show that those familiar with the knowledge of the time would see nothing against the good faith or reasonable skill and knowledge required by the Act; and the object in making the amendment had been simply to lighten the ship by getting rid of points of dispute.

Mr. JAS. SWINBURNE, in answer to Mr. Walton, said he was an electrical engineer, and for many years had closely associated himself with the development of electric lighting. He laid down his first transformers at the end of 1882. Formerly each arc lamp had its own dynamo. In the year 1878 the newspapers were full of the subject as to the subdivision of the electric light. Electrical power was got by multiplying the current by the pressure. Each lamp took a given amount of power. It was really very important to get high pressure for distribution. The importance of high pressure for distribution had been realised for a long time. It was wanted ever since electric light was talked about at all. As regarded the question of the independence of the lamps, they must either have the whole going at that time or all the lamps out. It could be used in public restaurants and shops, where the lights were all put out together; but that was not convenient where the consumer desired to be free to turn out what lamps he pleased. The Hopkinson patent was taken out in 1882. Gaulard and Gibbs' was another system of distribution with transformers. The main object of a transformer was to fulfil its name. It transformed the current, and the current of electricity flowing in one wire was made to have effect in another wire by inducing a current in that second wire. The Gaulard and Gibbs invention (exhibited in diagram before the court) was used at several of the metropolitan railway stations. It was not a system of distribution for extinguishing individual lamps at all. What was wanted in a system of distribution was constant tension or pressure on the lamps and a small amount of copper on the mains. That involved other things. A small loss of copper in the mains involved sending out at high pressure. The incandescent lamp involved low pressure. As regarded any system of electric distribution, the lamps ought all to be perfectly independent, and each customer ought to have his supply as he wanted it, independent of anybody else. The invention described in the specification now under consideration dealt with the difficulty of requiring low pressure on the lamps and constant tension upon them. They wanted high pressure at the station, and they wanted an arrangement by which the lamps could be turned out one at a time. The inventor had solved that difficulty, and no previous system of distribution had met it in his way. The invention enabled an extended system of distribution to take place; and under it it would be possible to distribute over large districts from the central station. The specification showed that the inventor had thoroughly understood transformers. The invention which was claimed was precisely as described in the specification.

Was it really useful and novel?—Yes, I think it was.

And was it properly described in the specification?—Yes, it was quite clear.

Continuing, witness said he was acquainted with the system of distribution of the defendant company. In his opinion it was exactly the same as that of the specification. They had additional means of transforming because of the distance from Deptford. They had the 10,000 volts there and 2,400 volts at the stations in London, and from these high-pressure stations the electricity was distributed by transformers in parallel as under the system in the specification.

Do you know whether this system was received at once, in 1885, as a system that was satisfactory?—It took some time. The transformers attracted some notice at the Inventions Exhibition, but he himself did not pay attention to it until 1887. It was now used for half, or perhaps more than half, the electric lights in use in this country. He had carefully read the documents referred to in the particulars of objections in this case, and he did not find the invention described in this specification in any of the earlier publications. He considered that the specification gave sufficient instructions to enable the invention to be carried out. He did not know what further instructions could be given.

It is alleged that the knowledge which existed at the time was such that no invention was required to arrive at this invention?—The knowledge of transformers at the time was practically nil. But since 1886 there had been an enormous jump in knowledge of the whole subject.

Cross-examined by Mr. FLETCHER MOULTON, witness said that ever since 1878, or at least before 1881, the question of electrical distribution had been before the public.

Mr. FLETCHER MOULTON: It was so prominently before the public that legislation took place with regard to it as early as 1882?—Yes, the first Electric Lighting Act; and there were a large number of companies formed for the purpose of distributing electricity on a large scale.

By electrical distribution was meant supplying to the public electrical energy at their houses?—Yes.

And the common way of doing it was just as we supply gas and water to individual houses?—That is so, in a qualified sense.

Mr. FLETCHER MOULTON, referring to section 18 of the Electric Lighting Act of 1882, said that the form of distribution therein recognised was the parallel system of distribution.

Witness assented, adding that in the parallel system of distribution there were two mains which ran side by side throughout the town, and in each of the consumers' houses there was a metallic piece called a pole connected therewith.

Mr. FLETCHER MOULTON: And the company's work ended at those poles, and its duty was to keep the one pole with an electric pressure higher than the other?—Yes; I do not remember for the moment whether the Electric Light Act contemplated parallel distribution.

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And the customer drew off the electric energy from these poles by straddling the machine across them, and what that machine was nobody had a right to prescribe?—No, I think not.

I had a right to use it for one machine, and my neighbour for the same kind of machine?—Yes.

Mr. FLETCHER MOULTON then called attention to the manner in which that was provided for in the provisional orders of 1883, and explained to the court that he was now cross-examining the witness on the state of public knowledge. He wished to show that this was a claim for something which was perfectly well known before. It was a particular claim for drawing off electrical energy by transformers. The parallel system was a system under which the electricity used by each consumer was drawn off from a double series of mains; and in the provisional order it was referred to as positive and negative poles.

In further cross-examination, witness said that the two poles in a consumer's house were the substitute for a machine for producing electricity with constant tension.

Mr. FLETCHER MOULTON: In other words, the consumer, instead of starting his own little machine, had an equivalent to his machine in these two poles?—Yes.

Anything which could be done by a machine of constant tension could be done in the consumer's house by a substitute for a machine?—Oh yes.

That was public knowledge in the eyes of the whole world?—Certainly.

Then when I am considering the state of public knowledge at that time, I am considering the two poles at the man's house as being, to all intents and purposes, an electrical machine?—Yes; anything with regard to constant potential work.

Suppose we take the position of a consumer then: it was not novel to work an induction coil or transformers by machines?—Oh no.

Therefore it was not novel to work transformers by the poles in a man's house?—I think it was, because there were no poles in a man's house.

Do you tell his lordship that it was novel to put an induction coil on to a machine?—No.

It had to be worked by a machine?—Yes.

And what novelty would there be in putting an induction coil on to the poles in a house?—There is nothing to prevent it.

I put it to you that there was no novelty in it?—The poles are there, the equivalent to the machine for constant pressure.

There was no novelty?

His LORDSHIP: As I understand Mr. Swinburne, he says there is no novelty in it, but that he never knew it to be done.

Mr. FLETCHER MOULTON: Now, Mr. Swinburne, I want to go to the question of the transformers. Perhaps you will kindly look at the opening words of the specification with regard to that: "For some time past induction coils, consisting of two coils or layers of insulated copper wires, with a common iron core, similar to the Ruhmkorff apparatus, have been used for the transformation of alternating electric currents. By means of such transformation electric energy can be cheaply conveyed from lines of considerable length and be utilised in a number of local circuits for lighting and other purposes." You see that?—Yes.

I may take it that that is of course put by the patentee as being common knowledge—that is not part of his invention?—That was common knowledge.

So that sending of alternateing currents through the primary coil of a transformer and using the secondary was known?—Yes.

I do not know what you will say was known at this time with regard to transformers. There are no directions given in this patent with regard to the manufacture?—No.

Aye or no, was there enough knowledge to enable transformers to be made at the date when the patent came out?—Transformers had been made since 1882.

Precisely, and you could produce any effect desired?—I do not say that, but to do effective work.

Aye or no, was there enough knowledge to make transformers to produce a desired result?—There was.

Now the result of transformers is that they transform either up or down the tension of the circuit?—Yes.

If I may put it so, it either increases or diminishes in certain proportions, dependent on the transformer, the tension of the circuit?—Yes, or it leaves it as it was.

And a transformer was a known instrument for the purpose?—Yes.

Well, it is a little wandering in the by-ways, but I think there was a well-known rule of thumb called ratio of turns?—No, that was not known.

Now I just want to cite against you the authority of Mr. Jas. Swinburne?—All right.

You remember the Gaulard and Gibbs litigation?—Yes; I was a witness in that case.

And I believe you gave your evidence in July, 1888?—Yes.

I believe I had the pleasure of cross-examining you on that occasion?—That is so.

Mr. MOULTON then read several questions and answers put to and from by the witness, during the Gaulard and Gibbs trial, to show that it went in contradiction to Mr. Swinburne's present evidence as to the state of knowledge prior to 1885, and to show further that the witness had stated that the rule of thumb had been known as far back as 1882.

Mr. MOULTON, having read the passage, said: Speaking in 1888 you, say you think this was old; it must have been, and older than 1882?—Yes.

And now you say it is later than 1885?—Yes. The question asked me in 1888 was asked not so much as regarded transformers, but induction; and I made a slip there, and what is more remarkable, Lord Kelvin did so also.

Mr. MOULTON: But the whole of that evidence was treating the transformer as an induction coil?—So far as it did that, it was wrong; it was far from accurate. I do not think that the relation between the pressure and the number of turns was understood in 1883.

Well, having got a known instrument, which would raise, multiply, or divide the tension of a current, go back to the case of the customer with the poles in his house. He could make a circuit for himself?—Yes, he could make what was wanted.

So that any legislatively-protected customer, though obliged to take the supply of energy at the potential prescribed, could then divide it if he liked?—Yes.

And that was known at that time?—It could have been done if anybody had wanted it.

In answer to his lordship, Mr. MOULTON said that the witness had surprised him by saying that nobody would then put an induction coil across the poles of a parallel main; and he wanted to point out that at the time the induction coils were used in even higher power than that.

The witness said that what he meant was that the only electric light induction coils existent in practical engineering at the time were Gaulard and Gibbs'. If one of their coils in use in 1885 were taken, it could be used without alteration for this invention.

Mr. MOULTON then referred the witness to an article in *The Times*, describing Fuller's invention prior to the patent now in question. Fuller's invention, the article stated, involved an alternating current in parallel distribution with induction coils.

To witness: There Fuller proposed to have induction coils with their primaries in multiple arc?—No, not in multiple arc, but in series.

And in this patent it is proposed to have a series of induction coils also put across the poles?—Yes.

Therefore I may take it that parallel distribution taken off at any house by means of primary coils across the mains was not new?—No, it was not new.

We have got it that it was not new to tap parallel mains by the transformer, whose primary was in multiple arc?—It was not new to propose it.

While the secondary circuit was utilised?—Yes, while it was utilised or proposed to be utilised. But they were not useful proposals which had been made.

I am not on the point of whether they were commercially useless if they chose to go from high to low tension.—People understood transformers, but they did not understand the difficulties.

On the question of the meaning of high and low tension Mr. Moulton said they might take the simile of water. (To witness): A small waterfall of great height might be as good as a large waterfall of lesser height?—Yes.

If you send electricity at low pressure, you require to have large conductors but weak installations?—Yes.

And if you send it at very high pressure, you have small conductors but a strong installation?—Yes.

And in any case the proper tension in practice is getting, by balancing, the cost of conductors and the cost of installation?—Yes, I will take it so.

That was known in 1878 or longer ago than that?—Yes; I think there were proposals made for using transformers in mains.

Supposing your generating station to be a long distance from the place you wanted to utilise the electricity from, you would have the tension as high as possible?—Yes.

On the other hand, when you are utilising—especially on a small area—the increased convenience of safety of low pressure makes you inclined towards low pressure?—Yes.

I have used the words "high" or "low" as if they had the same absolute meaning. The real fact is that you always have to choose that in which you get the best economical results by balancing the cost of conductors against the cost of installation?—Yes.

Supposing you were distributing throughout a very large building, which was large enough to make the conductors of considerable cost dropping down to 100 or 200 to utilise?—Yes, 10,000 is very largely used.

On the other hand, if you were going to send the electricity for 30 miles, you would probably have the 1,000 very low and send at 20,000 and drop down?—Yes.

The defendants use 10,000 to send up to Deptford, and then drop down to 2,400 for another section, and then drop down again to 100?—Yes.

Now, that idea of economy by long distance at high pressure and the convenience by short distance at low pressure was a very important rule of practice in electric distribution?—Yes.

That is not due to this patentee?—The desirability was certainly known.

It had been proposed to transform up in order to send at high tension, but to transform down to send at a low?—Yes. As I have said, it had been thought of. It had been recognised.

The learned counsel then took the witness to Edison's patent.

There are advantages and disadvantages in choosing continuous or alternating currents for mains?—Yes.

At the date of Edison's patent continuous currents could be used for all purposes?—Yes, just the same for arc lamps and fitted motors and electrolytic work, other things being equal on the supply terminals.

For instance, alternating currents at that time would not drive motors?—Well, no. They have not succeeded much.

Of course they could not be used for plating?—No.

And there was a suggestion that they were dangerous to human life?—Yes.

Further cross-examined, the witness said he was aware that Edison was a strong partisan of the direct current. He thought that Edison never had a patent for the distribution of alternating currents. But Edison realised that they could transform down our alternating current and also that a low-tension current would be suitable for lamps in parallel.

The witness was then referred to an article in a French technical paper describing a prior discovery.

Mr. MOULTON: What is there in this patent other than what is in that article?—Nothing that I can think of.

Turning to the plaintiff's complete specification, Mr. Moulton (reading) said: "For some time past induction coils consisting of two coils or layers of insulated copper wire, with a common iron core similar to the Ruhmkorff apparatus, have been used for the transformation of alternating electric

currents. By means of such transformation electric energy can be cheaply conveyed over lines of considerable length, and be utilised in a number of local circuits for lighting and other purposes. The distribution of electrical energy by such means has, however, not succeeded in such a manner as to satisfy the requirements of everyday practice, because it was not possible to increase or diminish the number of points of consumption in operation without affecting the working of the others in a marked degree, and it was therefore necessary to use mechanically-acting regulating devices at the different points of consumption to compensate for the variations caused by the changes in quantity of electrical energy used." To the witness: Now, Mr. Swinburne, that refers to Gaulard and Gibbs?—Yes.

Now, Gaulard and Gibbs required a special form of circuit, and things were put on in series?—Yes; it is not that they required it, but they used it.

Now, in the case of transformers in parallel. They can be put on an ordinary parallel system?—Yes.

The consumer could put them on?—Yes. I have got one at my house.

Mr. MOULTON, reading from the specification: "Now, the object of this invention is to make all individual points of consumption of electrical energy quite independent from one another, all necessary regulations being made by or at the generator of electricity. We group the induction coils or transformers so as to constitute secondary distributing stations or local centres." To witness: Do you consider that to be an essential part of the patent?—It is not essential. It is not confined to sub-station distribution, but to transformers in a house, for instance.

Mr. MOULTON (reading): "The primary coils of the several transformers of such a local centre may be arranged either in series or in multiple arc circuits." To witness: The "series" refers to transformers in series?—Yes.

Mr. MOULTON: "In the former case the secondary or induced spires of all the transformers of the respective stations form a single local circuit, irrespective of whether these induced spires are connected up in quantity or in series. In the second case, however—viz., when the primary coils of the several transformers constituting a local centre are connected in multiple arc—either each individual induced coil may form a separate secondary circuit, or any number or all of the induced coils of the transformers of a local centre may be connected to form a single local circuit." To witness: That would include the case of a single transformer and a single secondary circuit?—I cannot agree with that suggestion. The plaintiff's invention was for transformers used in a particular way in a system of distribution.

Mr. MOULTON, addressing his lordship, said one of his defences was that there was nothing in the plaintiff's specification to patent. If a man told you how to judiciously use a thing, that could not be the subject matter of a patent.

His LORDSHIP said he could see the learned counsel's point.

In further cross-examination by Mr. Moulton on the complete specification, the witness said it was perfectly well known that with induction coils or transformers you could transform either up or down.

Mr. MOULTON: I believe the words high tension and low tension do not occur in the provisional specification at all? No, it appears not.

And they do not occur in the claim?—No.

Supposing a man wanted a high-tension alternating current and he put transformers on his poles and transformed up and put his lamps which required a high tension in parallel: is that within the patent? No, I should not think it was.

Transforming up and transforming down were both equally well known?—Yes.

The dangers of high tension and of low tension in connection with conductors of certain lengths were well known?—Yes.

Now, it had been pointed out before this patent that it was advisable to send from long distances at high tension?—Yes.

And to send at high tension for the purpose of turning to low tension?—Yes.

Mr. MOULTON, reading from the specification: "Now, the electromotive forces of the two coils of a transformer bear a constant ratio to one another." To the witness: Do you suggest that that is put forward by the patentees as being their discovery?—No; I think it was their discovery, but I do not think they realised it.

Further cross-examined, the witness said that what the inventors claimed was a scientific arrangement of the transformers to solve the distribution question.

Mr. MOULTON: In what respects do you say we infringe?—In that you have a system of distribution with transformers with alternating currents, with high-tension primaries coupled in parallel, on about 2,400 volts, and secondaries supplying lamps, the lamps being in parallel on 100 volts.

And do you consider the high tension of the main and the low tension of the consumption circuit both essential?—Yes.

We send 10,000 from Deptford, and transform down to 2,400. What do you call these?—They are both high tension.

Mr. BOUSFIELD: But we do not know at present whether what is sent from Deptford is all transformed by one transformer which brings it down to 2,400, or whether there is a series of transformers.

Mr. MOULTON: I do not care whether it is by one or twenty. I want to know whether it is within the patent or not. To witness: Do you tell his lordship that the electricians of 1885 did not know that a machine which was sending out current, and that was transformed down, would work if you kept it at the constant potential?—They knew it would work if kept at the constant potential, but they did not know that in certain circumstances it would keep the constant potential.

Re-examined by Mr. Bousfield, Mr. SWINBURNE said, with reference to Mr. Fuller's article in *The Times*, that he did not agree that there was any nice principle involved in Mr. Fuller's invention.

Mr. MOULTON: Does Mr. Swinburne say that this article is absurd?

WITNESS: No; I say his transformers are absurd. What Fuller wanted was to fit a transformer which would transform up and work on each lamp separately on a secondary.

Mr. BOUSFIELD: Has Fuller got anything to do with a system of distribution?—Not so far as I can see.

Mr. J. K. D. MACKENZIE was called (to enable him to depart for America) to rebut the allegations in the defendant's particulars of objections. In answer to Mr. Bousfield, witness stated that he was now an engineer, and in 1882 he practised as an electrical engineer, and in that year was engineer to the Metropolitan Brush Electric Light Co. of London. He first became acquainted with Gaulard and Gibbs' system in 1882. In 1883 there was an electrical exhibition at the Royal Aquarium, and there he met Messrs. Gaulard and Gibbs, who were showing something there, and he went thoroughly into it. Mr. Gaulard himself explained everything to witness, who joined Mr. Gaulard to help him carry out his work at the Royal Aquarium. Witness was also engaged in the electric lighting of the Grosvenor Gallery. That installation was completed about the time of the exhibition of March or April 1885.

When did the idea of making the Grosvenor Gallery a distributing station for supplying people with electricity first occur?—That was mooted about the end of 1884 or beginning of 1885.

Did that require a much larger installation?—Yes, it grew. It began with something like 200 H.P., but grew a great deal. They ceased using the Gallery as a distributing station at the end of 1885.

It is suggested that prior to the date of this patent—March, 1885—this system was somehow being used at Valerie's premises. Was it possible for Valerie's premises to have been connected with the Grosvenor Gallery installation before the date of this patent?—No.

Cross-examined by Mr. MOULTON: Gaulard and Gibbs' system of electric lighting was shown at the exhibition at the Royal Aquarium. It was only running at the time of the exhibition. The exhibition was only on two or three months. After the closing of the exhibition Gaulard and Gibbs' system was not used at all in the Royal Aquarium. The plant began to run at the Grosvenor Gallery in February, 1885.

After you lighted Grosvenor Gallery you supplied current to neighbouring houses?—Yes.

Among them to Messrs. Valerie?—Yes.

But you think that that supply was later than March, 1835?—Oh yes.

When do you say it was?—I do not think that Valerie was one of the earliest consumers. He could not have come on until quite at the end of 1885.

You say it was quite at the end of 1885?—Quite, undoubtedly.

In further cross-examination witness said he knew an electrician of the name of Fesquet, who was working with Gaulard and Gibbs. Fesquet, however, did not take charge of the installation at the Aquarium. Witness did not remember seeing Fesquet until the Grosvenor Gallery work was well on the way.

Was he not in the employ of Gaulard and Gibbs from 1883 onwards?—No, I think not. Fesquet had nothing to do with the installation at the Aquarium, but he assisted at the Grosvenor Gallery in the beginning of 1886. In that year Gaulard and Gibbs undertook to supply transformers at the Grosvenor Gallery, and Fesquet was their manager for that work. Transformers were used up and sometimes used down, but it was transforming down as a rule.

Mr. W. M. MORDEY, examined by Mr. Bousfield, said that his practical work for transformers for distribution began in 1886. With the exception of Gaulard and Gibbs, no one had done anything practical with transformers before 1886. He had kept himself practically acquainted with all that was being done to solve the question of distribution, and he was familiar with the history of transformers from the time they were first suggested as a means of distribution, and even farther back than that. At the date of this patent there was the low-tension system of Edison, which was admirable for small areas but was not practicable for large ones. A great many people were trying to work out systems for high-tension supply. The only successful attempt to get the advantages of high tension for large areas was the series system. It was the only practical high-tension system. Electrical engineers were at the time anxious to find out a system giving high-tension distribution and low-tension supply. Gaulard and Gibbs were working in that direction. Practical engineers, however, looked almost with contempt at that time on the work then being done. Even when it was proposed by the plaintiff's system to solve the question of high-tension distribution and low-tension supply, it was not generally accepted. Alternating currents were not understood at the time at all, and engineers did not think that any practical solution would be attained by alternating currents. He had heard the evidence of Mr. Swinburne and agreed therewith.

Cross-examined by Mr. MOULTON, witness said that low-tension alternating currents were known to be suitable for electric lighting for incandescent lamps and had been commonly used for the purpose in 1833. Both Siemens and Ferranti had used them. It was true that transformers transformed from constant potential to constant potential, but only on proper construction. That, however, was not true as a general statement.

Mr. MOULTON: I put it to you that there are no directions in this specification as to which transformers will stand the work and which will not?—The specification gave clear instructions to skilled persons in the art of electric lighting.

So far as the arrangement of the transformer is concerned, is there anything more told us in the plaintiff's specification than is told us in Brush's Fig. 9?—Plaintiff's specification showed them how two, three, or more transformers could be placed in parallel.

In the transforming down many transformers are used?—Yes.

And according to the load, you switch out transformers?—Yes, the transformers are used in parallel.

That is what is called banked?—Yes.

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And as the demand falls you switch out transformers, and it is not left automatically to regulate itself?—The arrangement was self-regulating but in order to save a litt'e energy the transformers might be cut off Otherwise there would be a loss of power.

You cannot put transformers in parallel without their being suitable in size and so on?—The transformers must be suitable, of course.

Is there any information as to that in the specification?—There did not require to be. The patentee gave particulars generally. At that time everything electrical had to be got out as the result of experiment.

In other words, you could not use what was there described without experimenting with the transformers?—At the time electricians had all been working to find out a system of distribution which would work. The inventor gave them particular instructions as to the way in which they should continue their experiments.

Re-examined by Mr. BOUSFIELD: There was no difficulty in making a transformer which would work according to what was told them in the specification.

Referring to Edison's patent, witness did not see any sign there that Edison would get any constancy of potential on his lamp circuit by using transformers of low resistance.

Mr. BOUSFIELD: In the original amended specification do you see any signs (taking it as it stood with the original claim) of any want of good faith or reasonable skill and knowledge?—No; I think it shows great skill and knowledge.

Mr. MOULTON: The part struck out related to means for supplying alternating electric current of a tension as constant as possible?—Yes.

Some documents having formally been put in, Mr. Bousfield closed the plaintiff's case, and the hearing was adjourned.

Cardiff Corporation v. S. Z. de Ferranti and Others.

In the Queen's Bench Division, on Friday last, Mr. Justice Mathew resumed the hearing of this action. The first day's proceedings were reported in our last issue.

During the course of the case his lordship observed that multiplying the letters did not strengthen the evidence of delay. It would be well to state the character of the correspondence and refer merely to those letters which were of importance.

Mr. LAWRENCE, Q.C. (for the plaintiffs), said that through 1897 and all through 1898 the correspondence went on in the same way. The defendants wrote thanking the engineer for the leniency which had been shown to them, and the engineer replied complaining that the defendants were practically experimenting with the Corporation's order, and were not really supplying them with an engine according to contract.

Mr. WALTON, Q.C. (for the defence): There is a letter of Dec. 23 stating that the erection was completed at Cardiff on Dec. 23, 1897; and if you look at your report of the electrical engineer, you will find that that is so.

Mr. LAWRENCE: Yes, it may have been erected by that time, but it did not go.

Mr. WALTON: Yes, it went.

Mr. LAWRENCE: Only for a short time, by way of experiment. It only ran satisfactorily for a very short time.

His LORDSHIP: And then, Mr. Walton, we have the melancholy complaints renewed in 1898.

Mr. WALTON: Yes, my lord; and there were alterations made in the machine.

Mr. LAWRENCE: On Jan. 21, 1898, a letter was written by the engineer to the defendants, in which occurred the following passage: "Unless your plant is in better condition when the Southport Corporation visits the works this week, I suggest that you will have it standing still, as nobody will be able to make himself heard" (laughter). The correspondence went on all through April, May, June, July, August, and September, 1898.

Mr. WALTON: Read your reply of July 20: "Your plant has run to-day in a fairly satisfactory manner for about six hours."

His LORDSHIP: I should like to know what it is all about. Here is a definite contract for a certain time, and we have had three years of correspondence because the contract has not been fulfilled.

Mr. WALTON: We say that, although no doubt in many respects alterations had to be made, still the machinery was erected and worked on Dec. 23, 1897.

His LORDSHIP: That I gathered from the letters; but it had a most unprosperous and short career.

Mr. WALTON: We admit there was delay as regards the time at which the machine was to be handed over ready for use, but the question is up to what date did the delay run? That is to say, when did the delay cease so far as concerned satisfying the contract? We say it was on Dec. 23, 1897; our opponents say November, 1898. And then there is a question of law. The penalty is £31. 10s. a week, and the penalties now amount to £5,000 or £6,000. The question is whether that is recoverable as damages, or whether the plaintiffs could recover more than the actual damage they had suffered. The defendants had paid into court £1,500, which they considered was more than enough to satisfy any actual damage the Corporation had sustained.

His LORDSHIP: Do you say they are not entitled to penalties?

Mr. WALTON: We say these penalties are in the nature of damages.

His LORDSHIP: There is no doubt about the machine having been taken over?

Mr. LAWRENCE: No; it is not taken over.

Mr. WALTON: Well, it has been working since 1898. I believe the defendants have spent about £7,000 upon it to make it do its duty. They have been spending money freely, and now the plaintiffs want £31. 10s. a week!

His LORDSHIP: But, apart from the question of penalty, will the Corporation be able to make out pecuniary loss?

Mr. LAWRENCE said it was one of the things difficult to prove. The Corporation had an enormous custom for the electric light, and it was very important that its character should be maintained in face of a growing competition from the incandescent gas light all over Cardiff at the expense of the Corporation's electric light enterprise.

Mr. WALTON said he might admit that up to the end of 1897 there were difficulties, but there was no correspondence showing similar defects in 1898. However, he hoped they would be able to make some arrangement about the case.

His LORDSHIP: Mr. Lawrence, this looks like a case which might be adjusted.

Mr. LAWRENCE said he would endeavour to take a reasonable view of it. His lordship knew that a body like the Corporation of Cardiff, after being treated in this way for years, were likely to be difficult to deal with. He would do all he could.

In the result it was arranged that the record should be withdrawn on terms which could be embodied in an order if necessary, the £1,500 in Court being paid out to the plaintiffs. The other terms of the settlement were not stated in Court.

Turner and Sons v. Brinsmead.

In the Queen's Bench Division, on Tuesday, Mr. Justice Mathew (with him Prof. A. B. W. Kennedy) heard an action in which the plaintiffs, Messrs. Turner and Sons, Electrical Engineers, Denton, Manchester, sought to recover from the defendant, Mr. Brinsmead, money alleged to be due for the supply and erection of an electric automatic lift on some flats, property of defendant. Defendant admitted the claim, but counterclaimed for damages for breach of contract. Defendant's case was that in November, 1897, he arranged with plaintiffs to erect on flats, then in course of erection at Maitland Park, N.W., an electric lift, to be completed by Jan. 1, 1898, to the satisfaction of defendant's consulting engineer, the Vestry officials, and the insurance company's inspector. Defendant alleged that the lift was not completed by Jan. 1, 1898, nor in fact till November, 1898, and that it was so defective in design and construction as to be useless and dangerous, and such that neither defendant's consulting engineer nor the Vestry officials nor the insurance company's inspector would pass it. The work was too fragile to stand the strain of constant work. Parts of the apparatus were so exposed as to be liable to injury from damp, dust, and fire. Owing to these and other deficiencies, defendant had been obliged to employ another contractor to erect a lift.

Mr. ROBERT A. SMITH, consulting engineer, said he examined the lift carefully on March 3, 1899, and found the speed of the winding drum was comparatively slow, while that of the motor was high, and on account of this gearing had to be used. While the lift was still the motor was also still, and required some mode of starting. The whole idea of the plant was automatic. To work the lift the passenger had to press certain buttons. One button had to be pressed to bring the lift to the floor where the passenger was waiting, and another was pressed to mark the floor to which the passenger wished to go. When the lift reached the floor where the passenger was waiting, the gate automatically opened. This gate could not be opened unless the lift was behind it. When the passenger got into the lift he pressed another button, which set the lift in motion. Witness did not see any indicators to show what buttons had to be pressed. The passenger had to find out whether the lift was above or below him. Apparatus was placed on each floor so that the lift could be worked from any floor, and the apparatus connected with these buttons was in the basement. There was a pendulum which regulated the direction in which the lift was to travel. It swung to each side according to the button pressed. On swinging in this manner it came in contact with pieces of metal. Witness said that this was not, in his opinion, a good idea, as the pendulum was likely to stick, and the pendulum only had the force of gravitation to bring it back to the perpendicular. When the pendulum came into contact with the side piece of metal it sent a current through a pilot motor. This worked other apparatus and started the larger motor. The apparatus, of which the pendulum was part, was leaning against the wall at a considerable angle. This was not the proper way to leave it. The voltage was 200. This he considered too high. He did not consider that that part of the apparatus would work more than a few times. The diameter of the winding drums (6in.) was too small for the size of the ropes. They should have been 18in. There were no grooves on the drums. This was dangerous, as the ropes might pile up, and might even have come right off the drum. The ropes were §in. in diameter. He did not consider the apparatus for arresting the progress of the lift if the ropes broke would have had any effect whatever. It was an iron instrument which was supported by a cord. If the ropes broke, the lift coming down would break this cord, and the iron would, it was assumed, then drop, and the other end, which was sharpened, would fix itself into the wooden runners. This, he thought, would not be the case in action, as the iron would only enter one side of the runner, and would be broken out by the weight of the lift. He thought that if there were another piece on this apparatus, so that it would grip the runners on two sides, it might succeed. Under the present conditions he considered that there was absolutely no protection for human life, nor against fire or dust, and the whole thing was exceedingly fragile.

Mr. MORGAN WILLIAMS said he made three inspections. He had heard Mr. Smith's criticism of the lift, and considered it was very well expressed. He agreed with it entirely. He said that the lift was liable to over-run. This was due to the fact that wooden pulleys were used. Witness thought that the lift had the appearance of a laboratory experiment. The design was an exceedingly clever and ingenious one, but was too fragile for practical use.

Mr. QUICK, defendant's consulting engineer, gave corroborative evidence.

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Mr. FRANCIS A. WILKINSON, inspector to St. Pancras Vestry, said that on Nov. 15, 1898, he made an inspection with Mr. Quick. They moved the pendulum to one side, and the lift rose to the roof of the building and jammed there. Witness then left.

Mr. T. BRINSMEAD (defendant) gave evidence concerning the contract. He wished to open the buildings in March, and wanted to advertise the lift with the buildings. This he was unable to do, and had to employ another contractor.

Mr. GEORGE AVEYARD said that he was electrician to the plaintiffs. He designed the lift erected on defendant's flats. He had designed other automatic lifts before, but not one worked on the "push-button" system as this one was. He was often present while the lift was being erected. His firm met every objection raised by defendant's. He had made many trials of the lift, and had found it worked perfectly. On Nov. 15 he was present with defendant when the test was made. The lift worked all right, and defendant seemed pleased with it. He handed the "fuses" to defendant so that he might work the lift when the inspectors came to see it. They had procured all the best materials for the work. After the lift had been jammed in the roof, witness asked defendant for particulars of any defects in the lift, but he could not supply any. He did not think it was possible for the pendulum to stick as suggested by Mr. Smith, as there was only a very small current running through. The strength of the current was half an ampere.

Mr. JOHN HEWARD, consulting engineer, said he went with last witness in January, 1899, and examined the lift thoroughly. It worked very well. It stopped within an inch or an inch and a half of the proper levels. It was a very clever design, and he considered it quite practical. The general workmanship was good, but there were little things which might have been improved. The pendulum switch worked very well. It returned to its position very quickly. The springs helped it considerably. He saw no reason why the pendulum contacts should stick. There would have been no difficulty in putting in carbon instead of the metal, but it required the addition of another magnet to make the pressure sufficient. The main motor worked very well. The box of black grease used for lubricating the worm-wheel was a rather rough device; he had never seen it used except on cranes.

Mr. ALBERT TURNER said that on April 11 he went with Mr. Quick to the works. They had the apparatus put into operation. In July, 1898, he visited the flats and saw the lift working. It was very satisfactory, except that the wheels made a noise. Apart from that the lift worked well. They could feel the vibration in one of the rooms. They therefore decided to remove the wheels and work it directly from the motor. He thought it was very satisfactory, except that it was rather slow. The speed was according to the contract: it travelled at 30ft. per second. A lift he had since had erected had a speed of 60ft. per second.

CHARLES BAYMAN, lift attendant, said he, his wife and little girl all worked the lift. Indeed, it never failed at any time. He thought it must have been used hundreds of times by the workmen, but witness had never received permission to allow the tenants to use it.

His LORDSHIP said the assessor (Prof. Kennedy) would consider the technical question, and his opinion would be communicated to both sides. After that a day could be fixed for discussion. The assessor would personally inspect the lift on Friday.

TRADE NOTES AND NOTICES.

[Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.]

READY IN A FEW DAYS.

"The Electrician" Electrical Trades' Directory and Handbook for 1900.—The New Edition of the "Big Blue Book" will be ready shortly. See important announcement on page xxx.

TENDERS INVITED.

The *Keighley* Corporation invite tenders for the supply of two Lancashire boilers, with mechanical stokers, economisers, feed pumps, &c., and a 120-kw. and 200-kw. high-speed direct-coupled steam dynamos for continuous current. Copies of specification, &c., may be obtained from the borough electrical engineer (Mr. J. M. Smyth), Bridge-street, Keighley. An advertisement contains further particulars, and tenders, addressed to the chairman of the Electricity committee, must be delivered not later than Saturday, Feb. 3.

The Town Council of the Royal Burgh of *Inverness* invite tenders for the supply and erection of generating-plant for their proposed electricity supply station. Further particulars are given in an advertisement, and copies of specifications, &c., may be obtained at the offices of the town clerk (Mr. Kenneth MacDonald). Further information may be obtained from the consulting engineer (Mr. E. G. Craven), 36, Academy-street, Inverness, and tenders must be sent to the town clerk before Thursday, Feb. 8.

The *Coatbridge* Town Council invite proposals for constructing a tramway in the town. An advertisement contains some further particulars, and additional information can be obtained from the town clerk (Mr. John M. Alston).

The *Horsham* District Council invite tenders for the supply and erection of generating plant for their proposed electricity supply works. Further particulars are set out in an advertisement, and copies of specification, with forms of tender, &c., may be obtained at the offices of the clerk to the Council (Mr. S. Mitchell) after Feb. 1. The work will be carried out in accordance with the plans and specifications of the consulting engineer (Mr. W. C. C. Hawtayne), 9, Queen-street-place, London, E.C., from whom further information can be obtained.

The *York* Corporation invite tenders for the conversion of the wiring of the Guildhall and the public library to suit the higher voltage of the mains. Tenders must be sent to the city electrical engineer (Mr. C. A. Midgley) by Feb. 15. See advertisement.

The *Dudley* Electric Light committee invite tenders for the supply and erection of pumps and feed-water heaters and pipework. An advertisement contains further particulars, and specifications, &c., may be obtained from the consulting engineer (Mr. Reginald P. Wilson), 66, Victoria-street, London, S.W. Tenders must be sent to the town clerk (Mr. Henry C. Brattall) not later than noon of Thursday, Feb. 8.

The *Kingston-upon-Hull* Corporation invite tenders for the supply of 35 double motor equipments and 10 car bodies (double-decked) to seat about 51 passengers. An advertisement contains further particulars. Specifications, &c., may be obtained from the city engineer, and tenders, addressed to chairman of Works committee, must be in by Monday, Feb. 19.

The *Bedford* Electric Light committee invite tenders for the supply and erection of a surface condenser, with air-circulating pumps, &c. Specifications may be obtained from the town clerk (Mr. T. S. Porter), Town Hall, Bedford, to whom tenders must be sent by Feb. 6. See advertisement.

The *Bootle* Corporation require tenders for supplying and laying underground electric cables. Specifications, &c., can be obtained from the borough electrical engineer (Mr. W. R. Wright), electricity works, Pine-grove, Bootle, after Monday next. An advertisement contains further particulars, and tenders addressed, Chairman Electric Power and Lighting committee, must be delivered at the Town Hall, Bootle, not later than Feb. 17.

The *Glasgow* Corporation invite tenders for the supply of (1) 200/300 motor car trucks, (2) 200/300 motors and equipments, (3) supply, delivery and erection of overhead trolley constructional work. Specifications, &c., can be obtained on application to the general manager (Mr. John Young), 83, Renfield-street, Glasgow, and tenders must be sent to the town clerk (Sir J. D. Marwick), City Chambers, Glasgow, not later than Saturday, Feb. 17. An advertisement contains additional information.

The Corporation of *Hastings* require tenders for the supply and delivery of twelve 20 kw. alternating-current transformers and high and low-tension switch gear. Specifications, &c., can be obtained of Mr. Lenoards Andrews, M.I.E.E., borough electrical engineer, Electric Light Works, Hastings, and tenders must be sent in to Mr. B. F. Meadows, town clerk, Town Hall, Hastings, by noon of Monday, Feb. 12. An advertisement contains additional particulars.

The *Bath* Corporation invite tenders for high and low-tension cables, arc lamps, transformers, switchboards, &c. Tenders to 3, Wood-street, Bath, by Feb. 12.

The *Postmaster-General* invites tenders for the work of laying underground conduits and pipes for telephone purposes in several parts of the Metropolis. Forms of tender from the Controller of Stores (Mr. Chas. E. Stuart), G.P.O., London, E.C., and tenders must be in by noon of Feb. 15.

The *West Ham* Guardians invite tenders for the supply and erection of plant for the electric lighting of the workhouse and school premises at Union-road, Leytonstone, and for erecting an engine and battery house. Tenders to clerk (Mr. Fred. E. Hilleary) by 4 p.m. of Feb. 7.

The *Belfast* Electric committee invite tenders for the supply and erection of 400 kw. steam dynamos. Tenders must be lodged at office of town clerk (Sir Samuel Black) by noon of Thursday, Feb. 8.

The Corporation of *Great Yarmouth* invite tenders for the supply and erection of two water-tube boilers and three 200 kw. continuous-current steam dynamos. Tenders have to be delivered by 10 a.m. of Thursday, Feb. 15.

The *Glasgow* Corporation require tenders for supply and erection of two overhead electric travelling cranes for the tramways department. Specifications from the general manager (Mr. John Young), 83, Renfield street, and tenders to town clerk (Sir J. D. Marwick) by 6 p.m. on Feb. 5.

The *Tynemouth* Corporation invite tenders for the supply and delivery of electricity meters. Tenders to town clerk (Mr. Horatio Adamson), Town Hall, North Shields, by 31st inst.

The *Leyton* Electric Lighting committee invite tenders for the supply and erection of a switchboard. Tenders to engineer and manager (Mr. F. Harman Lewis) by Feb. 14.

The *Bradford* Tramways committee invite tenders for the electrical equipment of about eight miles of tramway on the overhead trolley system. Tenders to town clerk by Feb. 3.

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The *Stoke-upon-Trent* Guardians invite tenders for the electric lighting of a portion of the workhouse premises. Tenders to clerk the Guardians, (Mr. C. Daniel), Union offices, Stoke-upon-Trent, not later than 9 p.m. of Tuesday, Feb. 13.

The *Plymouth* Corporation invite tenders for the supply and erection of a 500 kw. high-speed steam dynamo, motor-generators, &c, 500 kw. high-speed steam alternator, 260 accumulator cells, four Lancashire boilers, high and low-pressure, paper-insulated and lead-covered mains, &c. Tenders to town clerk (Mr. J. H. Ellis) by 31st inst.

The *Glasgow* Corporation invite tenders for an electric or hydraulic lift for the new Art Galleries. Tenders to the town clerk (Sir J. D. Marwick), City Hall, Glasgow, by 29th inst.

The *Glasgow* Corporation also invite tenders for supplying and erecting electric motors and shafting for laundry machinery, mechanical stokers, elevator and conveyor at the Ruchill Fever Hospital. Tenders to the clerk, Police Department, by 31st inst.

The *Croydon* Corporation invite tenders for extending the electricity supply buildings. Tenders to town clerk by 29th inst.

The *Tunbridge Wells* Corporation invite tenders for two Lancashire boilers. Tenders to town clerk (Mr. W. C. Cripps) by Feb. 5.

The *French* Minister of Posts and Telegraphs invites tenders, until the 30th inst, for the supply of 10,000 metres of iron tubes (80mm. diam.) for pneumatic pipe lines. Particulars from and tenders to Le Sous Secretariat d'Etat des Postes et des Telegraphes, 103, Rue de Grenelle, Paris.

TENDERS RECEIVED AND ACCEPTED.

The following tenders have been received by the West Ham Corporation for the supply of electric lighting plant for the Chadwell Heath Asylum :—

Section A.—Three 84 kw. Steam Dynamos, Booster, Switchboard, &c.

Thames Iron Works, Engineering & Shipbuilding Co. (*accepted*)	£4,627 0 0	E. Scott and Mountain	£4,950
Veritys (Ltd)	4,144 10 9	Dutilh-Smith, McMillan & Co.	3,795
		Mather and Platt	6,055
		General Electric Co.	4,888

Section B.—Accumulators.

Hart Accumulator Co. (*accepted*)	£681 0	D. P. Battery Co.	£802 5
Pritchetts and Gold	858 0	Tudor Accumulator Co.	863 0
Chloride Electrical Storage Syndicate	1,117 0	Dutilh-Smith, McMillan and Co.	889 14
		Elec. Power Storage Co.	1,391 0

Section C.—Water Cooling and Condensing Plant.

Wheeler Condenser Engineering Co. (*accepted*)	£845 0	Worthington Pumping Engine Co.	£621 0
Ditto	963 0	Ditto	896 0
Dutilh-Smith, McMillan and Co.	531 15	T. Ledward and Co.	560 0
Klein Engineering Co.	638 0	Ditto	861 0
Ditto	1,222 0	Korting Bros.	782 0

Section D.—Motors.

D. Bruce Peebles and Co. (*accepted*)	£547 0	Dutilh-Smith, McMillan and Co.	£488 0
Witting Bros.	548 0	Mather and Platt	730 0
Thames Ironworks Shipbuilding & Eng. Co.	660 0	E. Scott and Mountain	690 0
C. and A. Musker	702 5	Veritys Ltd.	700 7
General Electric Co.	619 2	Phœnix Dynamo & Mfg. Co.	685 0

Section E.—Telephone.

Veritys Ltd. (*accepted*)	£135 3 0	General Electric Co.	£137 16 6
Dutilh-Smith, McMillan and Co.	116 0 0	Venner and Co.	153 11 6
Cox-Walkers	123 0 0	Western Electric Co.	150 0 0
Ditto (with combined battery box)	141 9 0	Consolidated Telephone Construction & Mfg. Co.	159 0 0
		Ditto	122 9 0

The following tenders have been received by the York Corporation for the wiring of the Mansion House, Guildhall and Municipal offices :—

Mansion House.

Cooke & Co. (*accepted*).....£117. 8s. 6d.
21 tenders received. Highest tender £282, lowest £79. 18s. 9d.

Guildhall and Municipal Buildings.

Ensor, Brentnall & Co. (*accepted*).....£154. 13s. 0d.
21 tenders received. Highest tender £730, lowest £87s. 3s. 0d.

The following tenders are recommended for acceptance by the Electric Lighting committee of the West Bromwich Corporation :—

E. Danks and Co., boilers.
C. A. Parsons and Co., steam dynamos, condenser, feed-water heater, and travelling crane.
Cowans (Ltd.), switchboard.
British Insulated Wire Co., cables.
Tudor Accumulator Co., storage battery and connections.

The following tenders are recommended for acceptance by the Tramways committee of the Glasgow Corporation for the new power station at Port Dundas :—

Morton and Anderson (tunnel under canal)	£1,400
Mechan and Sons (steel flues)	4,095
Hanna, Donald and Wilson (water storage tanks)	725
Mirrlees, Watson and Yaryan Co. (coal and ash conveying plant)	9,900
Babcock and Wilcox (eight pairs of mechanical stokers)	—
Vicars and Co. ditto	—

The following tenders have been received by the Hull Corporation for the supply of steam engines and dynamos :—

Engines.

W. H. Allen, Son and Co. (*accepted*)	£4,670
Chester and Co., Renfrew	4,625
Willans and Robinson	4,813
Bellis and Morcom	5,440
Ditto ditto	5,611

Dynamos.

Thos. Parker (Ltd.) (*accepted*)	£5,035
Earle's Engineering and Shipbuilding Co.	3,725
Electric Construction Co.	5,275
Crompton and Co.	6,313

Messrs. C. A. Parsons and Co's tender for combined engines and dynamos at £8,722 was declared not to specification.

The Morecambe District Council have accepted the following tenders for the supply of additional electric lighting plant :—

Babcock and Wilcox, boiler.
Thos. Parker (Ltd.), steam dynamo.
Callender Co., mains.

The Harrow Electric Light and Power Co. have accepted the tender of Messrs. Mather and Platt for the supply of a 150 kw. multipolar dynamo with Willans engine, and also for extension to switchboard.

The tender of Messrs. Read and Jenkins has been accepted for wiring the shire hall for the Herefordshire County Council at £172.

The Whitechapel District Board of Works have accepted the tender of Messrs. Crompton and Co. for the supply of 20 additional arc lamps at £764. 6s.

APPOINTMENTS VACANT AND FILLED.

The Southport Corporation Electricity committee invite applications for the position of electrician-in-charge. Applications to the borough electrical engineer (Mr. Chas. W. Taite), by Feb. 8. See advertisement.

A first-class electrical engineer is required for the Glasgow Corporation tramways. Particulars are set out in an advertisement elsewhere, and applications must be addressed to the manager of the tramways department (Mr. John Young), 88, Renfield street, Glasgow, or or before Feb. 24.

The Islington (London) Vestry require a draughtsman for temporary work for their electricity department. Applications to the vestry clerk (Mr. Wm. F. Dewey), Vestry Hall, Upper-street, London, N, by Feb. 7. See advertisement.

The directors of the London Electric Supply Corporation invite applications for superintendent engineer at their Deptford station, Applications to managing director, 25A, Cockspur-street, London, S.W.

The Bedford Corporation require an assistant electrical engineer. Applications to chief engineer (Mr. W. J. Hope-Johnstone) by 29th inst.

Mr. John Beaumont Mitchell, A.M.I.E.E., borough electrical and tramway engineer, at Southend-on-Sea, has been unanimously appointed electrical engineer to the Plumstead Vestry. Previous to his appointment to Southend Mr. Mitchell was borough electrical engineer at Dewsbury.

BUSINESS NOTICES.

With reference to the conversion of the business of Messrs. Felten and Guilleaume, of Mulheim-on-Rhine, into a limited liability company, we understand that the business at Carlswerk, Mulheim, as well as the Vienna and Budapest branches, are included in the arrangement, and that the title of the new company will be Felten and Guilleaume Carlswerk Actien-Gesellschaft. The managing directors will be Messrs. Th. and Max Guilleaume and Arthur Heiliger.

Messrs. F. L. L. Lindsay and E. F. Browning (trading as Lindsay and Browning and Co., Ltd.), electrical and mechanical engineers, have dissolved partnership. Debts by Mr. Lindsay, who continues.

BANKRUPTCIES, LIQUIDATIONS, &c.

Under the failure of John E. Liardet, Kensington and Cowley, Mr. Registrar Brougham, sitting at the London Bankruptcy Court, on the 19th inst., struck out the application for approval to a scheme of arrangement, which had recently been passed by the creditors. Mr. Ringwood, on behalf of the debtor, explained that since accepting the original scheme of arrangement which provided for a cash composition of at least 7s. 6d. in the £. The creditors had held an informal meeting and had decided to take shares to the full amount of their debts to a new company in which the debtor was interested. In allowing the application to be withdrawn, with a view to the amended offer being submitted to the creditors, the learned Registrar intimated that the Court preferred a cash scheme to one dealing solely with shares. The failure occurred in January, 1899; the assets were valued at £19,000, and proofs amounting to £13,254 have been admitted. The debtor attributes his failure to inability to realise his electrical and other patents.

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A sitting of the London Bankruptcy court was held on Tuesday, before Mr. Registrar Linklater, for the public examination of Claude Vautin, electro-metallurgist, who was made bankrupt in November, 1898. Accounts showed total liabilities £73,266, assets valued to yield a surplus of £16,534. Debtor stated that he came to this country from Melbourne in 1887 with a capital of about £4,000, and became managing director at a salary of £1,000 a year of the Newbery-Vautin Gold Extraction Co. (Ltd.). From 1888 to 1890 he was in South Africa, and in the latter year was made bankrupt in Johannesburg. After his return to England he practised as a metallurgist and made considerable sums also by the sale of processes invented by him, and by speculations on the Stock Exchange. At the end of 1895 he was worth at least £10,000. His failure was due to losses on the Stock Exchange, bad debts, lock-up of capital and depreciation in value of shares, but there was still a surplus. Examination was concluded.

In the High Court on the 11th inst. it was ordered that the voluntary winding-up of the Birmingham Carbide Co. (Ltd.), be continued, but subject to the supervision of the Court. A resolution for voluntary winding-up was passed by the company on the 10th inst., when Mr. E. M. Sharp, Colmore-row, Birmingham, was appointed liquidator.

It has been resolved to wind-up the London and Provincial Traction Co. (Ltd.) voluntarily, and to appoint Mr. T. A. Funnell, 2, Copthall-buildings, London, E.C., liquidator.

A meeting of John Dewhurst and Sons (Sheffield) Ltd., will be held at 20, Bank-street, Sheffield, on Feb. 27, to receive an account of the winding-up. Mr. J. W. Best is liquidator.

A receiving order has been made against F. King, electrical engineer, Stone Bridge, Bristol.

In the bankruptcy of F. Marson (trading as F. Marson and Co.), electrician, 1, Poplar-avenue, King Richard's-road, Leicester. The trustee (Mr. William M. Richards, 52, Belvoir-street, Leicester) has been released.

Mr. F. Gimblet, New Inn Chambers, London, W.C., has been appointed trustee in the bankruptcy of F. B. de Foe Paynter, electrical engineer, 2, Faversham-road, Catford, London, S.E.

Application for the discharge in bankruptcy of E. M. Winter, electrical engineer, Amberley House, Norfolk-street, London, W.C., will be heard at Bankruptcy-buildings, London, W.C., on Feb. 6.

A meeting of the creditors of Messrs. Mitchell and Schofield, electric lighting engineers, Brockholes, was held on Monday. The statement of affairs showed liabilities £696. 14s. 10d., assets about £440. It was resolved that the debtors should execute a deed of assignment to Mr. T. H. B. Tate, Huddersfield, as trustee for the benefit of creditors, three of whom were appointed a committee of inspection.

Plant for Sale.—The liquidator of the Birmingham Carbide Co. (Ltd.) is desirous of disposing of the whole of the steam and electrical plant for the manufacture of carbide of calcium, together with the lease of the premises of the company. Some particulars of the plant, &c., are given in an advertisement, and all further information may be obtained from Messrs. Pinsent and Co., solicitors, Bennett's-hill, Birmingham; or from the liquidator, Mr. E. M. Sharp (Messrs. Sharp, Parsons and Co.), 120, Colmore-row, Birmingham.

The Leeds electric lighting department have some second-hand transformers for sale. See advertisement.

Messrs. Allbright and Wilson (Ltd.), Oldbury, near Birmingham, have for sale three Babcock-Wilcox boilers and a Crompton steam dynamo. See advertisement.

Wire Rope.—A contemporary, in describing recently the Glasgow subway cables, credited Messrs. D. H. and G. Haggie, of Sunderland, with having manufactured the "record wire rope" for use on the Glasgow district cable tramways. This rope was described as the "largest in the world, its weight being about 55 tons." This promptly brought into the field Messrs. W. F. Dennis and Co. (agents for Messrs. Felten and Guilleaume, Carlswerk), who pointed out that their firm has for some years past manufactured and supplied steel wire towing ropes of 5½in. in circumference in one continuous length of 100,000ft. (nearly 19 miles) and weighing 210 tons. This statement was met by the suggestion that the Felten and Guilleaumme cables were made up in short lengths and spliced, and it was even hinted that there were no machines at Mülheim-on-Rhine, capable of turning out a rope of greater weight than 16 tons. This assertion was made on the authority of a firm who had supplied Messrs. Felten and Guilleaume with a rope making machine in 1872! Obviously it was a simple matter to point out that Messrs. Felten and Guilleaume have now one of the largest wire rope works on the Continent, and that they themselves manufacture and sell machinery for wire rope making of a magnitude altogether undreamt of 28 years ago. The firm claim that they can, with their present machinery, make a rope 5½in. in circumference more than 20 miles in length without a splice; and they further claim that they have not only made the longest but also the strongest rope. Such a rope has been supplied for the Kaiser Franz-Joseph bridge at Prague, with a breaking strain of 1,100 tons per rope, and that this could now be improved upon by the manufacture of ropes with a breaking strain of 1,500 tons if required.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Jan. 17 to Jan. 23, with the ports of destination:—

Africa—Alexandria, £70; Chinde, £864 (telegraph material); Durban, £1,222 (including £681 telegraph material). *Argentina*—Buenos Ayres, £215. *Australasia*—Auckland, £121; Launceston, £240; Melbourne, £201; Port Chalmers, £35; Sydney, £435 (including £282 telegraph material); Wellington, £145. *Belgium*—Ostend, £58. *Canada*—Halifax, £17; Montreal, £54. *Ceylon*—Colombo, £26. *Chili*—Valparaiso, £36. *China*—Shanghai, £461; Tientsin, £20. *Columbia*—Santos—£41. *Denmark*—Copenhagen, £293 (including £167 telegraph cable.) *France*—Boulogne, £133; Marseilles, £1,234 (telegraph cable). *Germany*—Bremen, £260 (telegraph instruments); Hamburg, £325 (including £300 telegraph material). *Gibraltar*—£192. *Holland*—Amsterdam, £125; Flushing, £81. *Hong Kong*—£624. *India*—Bombay, £7; Calcutta, £159 (including £95 telegraph wire); Karachi, £36; Madras, £67. *Norway*—Christiania, £179 (telegraph wire and cable). *Russia*—St. Petersburg, £1,000 (telegraph material). *Siam*—Bangkok, £32. *Sweden*—Stockholm, £171 telegraph material). *West Indies*—Trinidad, £24. Total £9,183, against £11,198 in the corresponding week last year (Jan. 18 to Jan. 24).

MUNICIPAL, FOREIGN, AND GENERAL NOTES.

Banbury.—The application of the Electric Power Distribution Co. for a provisional order has been sanctioned by the Town Council.

Brighton.—The estimated cost (£2,000) of overhauling and testing the electricity mains in certain streets and making new and improved house-service joints, as well as the cost of changing the voltage (estimated at about £1,500) are to be charged to reserve fund. At the Council meeting last week the chairman of the Lighting committee (Councillor Bryant) said that those were items of exceptional expenditure caused by the Council putting down wood paving, and it was only fair they should be charged to reserve and not to revenue. In addition to a reserve fund of £7,000, they had provided a sinking fund, and had maintained the machinery in efficiency out of revenue, while last year they wrote off £4,500 for special charges. The method of extending the amount over a number of years was suggested, but the committee were reluctant to do that, because out of the profits of the undertaking they had voted a sum in relief of the rates equivalent to 1 per cent. of the capital invested. The proposal excited some opposition, several councillors holding that the expenditure should be met out of revenue.

Canterbury.—The accounts of the Electricity department for the past quarter have been issued. The revenue amounted to £1,205. 19s. 1d., generation, &c., expenses to £350. 11s. 11d., and interest and sinking fund to £459. 5s., leaving a profit of £396. 2s. 1d. The net profit on the first three quarters amounted to £198. 12s. 3d., a satisfactory result, especially as the Council did not anticipate making a profit until the third year.

Carmarthen.—The British Insulated Wire Co. have been approached by the Council with a view to establishing electricity works for lighting and traction, and the company are making inquiries as to prospects of such an undertaking.

City of London. The Corporation have approved the recommendation of the Highways committee "That the sanction of the Council be given to that portion of the works of the Charing Cross and Strand Electricity Supply Corporation, under the City of London Order, 1899, which is within the Council's jurisdiction, such sanction being subject to the following conditions: That the Company give two days' notice to the Council's chief engineer before commencing the works; that the mains be laid under the footways wherever it is found practicable to do so, and be placed at least 12in. below the underside of the paving; that no street-boxes be constructed until full details shall have been submitted to and approved by him; that the concrete floor of the street-boxes be 9in. thick, and the York stone at the top 4in. thick; that the longitudinal girders (if used) in the boxes be laid on 3in. stone templets, the full thickness of the brickwork, which shall be 9in. thick; that adequate means be taken to prevent the accumulation of gas in the boxes and conduits; and that the work be carried out in all respects to the satisfaction of the proper officers of the Council."

Dumbarton.—The scheme of the Glasgow and District Tramways Co. for the construction of tramways in this district has been approved by the Council.

Dundee.—An important report on electric lighting extensions has been presented by the city electrical engineer (Mr. Walter H. Tittensor), who was recently requested to report upon the question of utilising the tramway standards for arc lamps for street lighting. The cost of extending the mains to a number of streets set out in the report is estimated at £16,000. To provide the requisite addi-

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tional generating plant at the station would necessitate an expenditure of £3,500 for condensing plant; £2,000 for feed and exhaust piping; £1,000 for feed pumps, &c.; and £175 for conduits for cables in Perth-road—total £22,675. The mains in the thoroughfares along which the electric tramways will run are proposed to be laid at the same time as the cables for traction are placed in position, and the standards will be so fitted as to serve the double purpose of conveying current for the tramways and for lighting. The Electricity committee have approved the report, and advise the Council to carry out its recommendations.

Durham.—The County Council have expressed approval of the scheme of the United Kingdom Tramway, Light Railway and Electrical Syndicate for the construction of an electric tramway between Sunderland, Houghton-le-Spring and Easington.

Electricity Supply Failure.—At the Marylebone (London) police-court, on Friday, the Metropolitan Electric Supply Co. (Ltd.) were summoned for making default in supplying electrical energy to houses to which they were required to supply it, contrary to a certain order and to the Electric Lighting Order Confirmation Act, 1889. Mr. Daldy, who appeared for the prosecutors (the London County Council), explained that he was there on behalf of a large number of consumers, chiefly residents in Marylebone, in the neighbourhood of Harley-street, Wimpole-street, and Weymouth-street. They had picked out three houses, and six summonses had been issued. The dates complained of ranged from October to December, the last being Dec. 15. For the defence Mr. Muir urged that there had been no failure since Dec. 15. As far as human foresight could provide, it was impossible that any such lapse of supply of current could happen again. Mr. Curtis Bennett, while giving the company every credit for what they had done, said they had failed in their obligations, and must be fined 10s., with 23s. the costs, on each summons, making altogether £9. 18s.

For the Front.—Messrs. Crompton & Co. have, it is stated, offered to the War Office six searchlights and fifty men. This means calling up the whole of the Chelmsford Electrical Engineer Corps, who are eager to go to South Africa.

Guildford.—The Council have asked the Guildford Electricity Supply Co. to state their terms for supplying and maintaining six or eight arc lamps at the most prominent junctions of the main streets, and also for supplying current for lighting the Council chamber.

Huddersfield.—On Dec. 31, there was an equivalent of 70,178 8-c.p. lamps, representing 1,082 customers connected. During the year 276 new customers were added, representing an equivalent of 16,024 lamps, and the increase in the number of units metered was 383,879, equal to nearly 60 per cent.

Ingleton.—The formal opening of the electricity supply works of the Ingleton Electric Lighting and Power Co. took place on Wednesday.

Islington (London).—On the recommendation of the Finance committee the following resolution has been passed by the Vestry:—

"The committee recommends that the Vestry should emphasise the principle which it has already laid down, that in every case where capital expenditure is involved, such expenditure should follow and not precede the sanction to the loan, and that it be an instruction to the Electric Lighting committee that no contract be entered into or liability incurred on capital account until it has received a report from this committee to the effect that the Vestry's standing orders have been complied with."

Lancashire Electric Power Scheme.—A meeting of representatives of local authorities affected by this scheme was held at Manchester on Tuesday. In a circular distributed by the opponents of the bill it is stated that the bill should not be allowed to pass the second reading on the following grounds of public policy:—

(1) That where Parliament has authorised a municipal corporation to borrow money for a municipal undertaking on the security of the rates, and the corporation has established their undertaking, special Parliamentary powers ought not, in the interest of the community, to be granted to a company trading for profit to execute works of a similar character within the borough, or to enter into competition with the corporation without the consent of the Council of the borough;

(2) That special Parliamentary powers to break up the streets ought not to be granted to a company trading for profit without the sanction of the community expressed through the Council;

(3) That the bill proposes to effect a practical repeal of the general law, on the faith of which millions of pounds throughout the kingdom have been borrowed by local authorities on credit of the rates. The Electric Lighting Acts make special provision with regard to the consent of the local authority for the express purpose of protecting local authorities, and such provisions ought not to be overridden to the extent proposed by the bill;

(4) Parliament has also expressed a decisive opinion upon enterprises of a similar character by the rejection of the General Power Distributing Co.'s bill on the second reading in the House of Commons on March 3, 1899. Powers similar to those sought by the present bill were also refused by Parliament in the case of the County of London and Brush Provincial Electric Lighting Bill in the session of 1899.

It is stated that the bill is at variance with the principles of existing statutes, as the consent of the local authorities affected has not been obtained, and it is submitted that a company trading for profit ought not, for its own benefit, to be allowed to override to such an extent general legislation enacted for the protection of local authorities. The authorities entirely dispute the claim of the promoters that the company can supply electricity at a lower price than the authorities. On the motion of Ald. Higginbottom, of Manchester, a resolution condemning the bill was unanimously adopted. An executive committee, consisting of representatives from Liverpool, Manchester, Salford, Oldham, Blackburn, Bolton, St. Helens, Stockport, Bury, Wigan, Southport, Warrington, Bootle, Rochdale, Burnley, and Ashton, was appointed to conduct the opposition to the bill, the expenses of which are to be apportioned amongst the authorities. The committee has also been authorised to consider the provisions of similar bills affecting other parts of the kingdom, and to co operate in reference thereto to such an extent as they may think desirable.

London County Council.—At Tuesday's meeting the Finance committee reported that the following loans had been completed for electric lighting:—Hackney, £50,000; Newington, £15,500; Poplar, £13,605; St. Pancras, £24,320; Whitechapel, £10,000; and £2,700 for Bermondsey. The committee further reported that, in view of the state of the money market and of the price at which the Council could probably raise money by the issue of stock, they had arrived at the conclusion that the rate should for the present be 3½ per cent. on all loans to local authorities. Further, the committee reported on the Council's form of sanction to loans. They had been informed that some difficulty had recently arisen from the method of repayment originally proposed by the borrower, and so stated in the sanction, not being acceptable to a particular lender, and they therefore proposed in future that the Council's form of sanction should enable the borrowing body to repay the loan either on the instalment or annuity system within the prescribed period, so that either method might be adopted as occasion might require. It was recommended that loans of £4,977 and £7,689 for electric and street lighting purposes respectively be granted to Islington subject to these amended conditions, and this was agreed to. It was agreed to sanction the erection at North Woolwich of a building exceeding in extent 250,000ft. for the Western Electric Co.

Light Railways.—The Board of Trade have confirmed the Basingstoke and Alton Light Railway (Amendment) Order, and the North Lancashire (Lincoln-Scawby) Light Railway Order, the former after modification.

Liverpool.—The Corporation have received sanction to borrow £300,000 for electric lighting extensions.

Newington (London).—At the Vestry meeting last week, it was decided to take over the public street lighting (both arc and incandescent) from March 25, and to pay the contractors the first instalment of 10 per cent. of the retention money (20 per cent.) under the contract, less the extra cost incurred from Michaelmas in lighting the main roads by gas.

Private Bill Legislation.—In the bill which has been deposited by the Charing Cross and Strand Electricity Supply Corporation, power is sought to establish a separate generating station for the purpose of supplying electric current in the City under the terms of their provisional order. The site of the new generating station will be situate in West Ham, and will be connected with the company's existing stations in the parishes of St. Giles and St Martin-in-the-Fields. The company is also endeavouring to obtain powers to supply electricity "in bulk" to local authorities.

The bill of the North Metropolitan Electric Power Supply Co. seeks power to supply electrical energy "in bulk" within the districts of Hendon, Barnet, Edmonton, Ware, Hertford, Hatfield, Welwyn and St. Albans, Chingford and Walthamstow. The capital of the company is to be £270,000, in £10 shares, and with powers to raise a further £90,000 in debenture stock. Two generating stations are to be erected, one at Edmonton and one at Hertford. The promoters are the same as for the County of Durham Electric Power Supply Bill, particulars of which were given in our last issue.

We have received from the Tyneside Electric Power Co. (Ltd.) a statement of the objects of the bill, which is being promoted by them. Statutory powers are sought for generating and supplying electrical energy throughout the whole Tyneside manufacturing district. The company will have a capital of £500,000, and the promoters are the Hon. C. A. Parsons, F.R.S., Messrs. A. A. Campbell Swinton, Saxton W. A. Noble, Norman C. Cookson, C. J. Leyland, H. C. Harvey, J. D. Milburn, J. B. Simpson, and E. Smith. The promoters point out that on the Continent and in America power stations, supplying in the aggregate nearly a million H.P., and transmitting electric power over distances in some cases as great as 40 miles, are already in successful operation. These stations are providing foreign competitors with facilities which English manufacturers do not at present possess. Some equivalent development in this country, if established on Tyneside, will, it is believed, have a beneficial influence on the trade and general prosperity of the locality. The leading Tyneside industries are of a character to be peculiarly benefited by cheap electric power, and several of the most important works in the district are desirous of obtaining such a supply. Further, electricity is now

becoming very largely used in chemical manufacture, and a cheap electrical supply is likely therefore to lead to important developments in the local chemical industry. The objects of the company are to co-operate with the local authorities, and with their assistance to establish throught the whole manufacturing district on both sides of the Tyne, from Blaydon and Newburn on the west, to Tynemouth and South Shields on the east, a system by means of which electric energy can be supplied to factories, shipyards, and works of all descriptions, and also for both public and private lighting, either by the local authorities themselves or by the company direct. Negotiations are in progress for acquiring suitable sites for generating stations by which electric power will be produced on a large scale with plants each of several thousand H.P. The power will be distributed at high pressure to all required points in the district, the pressure being reduced by suitable transformers to such voltages as consumers desire. The company propose to supply electric motors on hire, and will also be prepared, where desired, to arrange for the "free" wiring of shops, business premises, &c. Under the Bill the company will be authorised to charge for electric energy supplied in bulk at the following maximum rates, which will be automatically reduced when the company earns more than a certain percentage of profit:—For the first 200 hours of supply at the maximum power demanded per quarter, 4d. per unit; beyond 200 hours, and not exceeding 400 hours per quarter, 2d.; and for any further hours per quarter, 1d. per unit.

Redruth.—The application of the Urban Electric Supply Co. for a provisional order has been sanctioned by the District Council, who have also approved the proposal to construct an electric tramway from Redruth to Camborne.

Seaham.—The Council have appointed Mr. F. J. Warden-Stevens, consulting engineer, to report upon the desirability of establishing electricity supply, and particularly as to whether the application of the County of Durham Electric Power Distribution Co. for a provisional order should be approved.

Shannon Electric Power Scheme.—There is considerable opposition to the proposal of the Shannon Water and Electric Power Co.'s bill for authority to utilise the water of the river Shannon in the generation of electric current, and the inspectors of Irish Fisheries announce that they will shortly hold meetings to inquire into the probable effects of the scheme. The examiner of private bills has found non-compliance with standing orders by the promotors.

Sutton (Surrey).—The Council's provisional order is to be transferred to the County of Surrey Electrical Power Distribution Co.

Walker.—An inquiry was held here on Wednesday into the application of the Council to borrow £23,356 for the purpose of erecting electricity supply and refuse destructor works. The clerk (Mr. Sturgess) supported the application. The Council obtained its order in 1899.

Worcester.—Terms have been arranged between the Corporation and the local Tramways company in connection with the proposal to extend the tramways and to introduce electric traction. The terms include the payment by the company to the Corporation of £5,000, and the purchase by the company of electric current from the Corporation.

Workhouse Lighting.—The Finance committee of the Bournemouth Guardians is making inquiries as to the lighting the workhouse electrically.

York.—Although the Corporation have not yet commenced to supply electric current, they have applications in hand for the equivalent of over 6,000 8 c.p. lamps for lighting, and the question of extending the supply mains is already under consideration.

Electric-Harmonic Society.—This (Friday) evening a smoking concert of the Electro-Harmonic Society will be given at the Cafe Monico, Piccadilly, London, and is to be of a patriotic and stirring character. "The Absent-minded Beggar" is to be supplemented by "The Gallant English Tar" (by one of the musical directors of the concert). A string and wind orchestra will perform a nautical selection, entitled "A Life on the Ocean," for which no less than 18 songs have been "commandeered." Altogether a programme of more than usual interest is promised, and the gathering should prove one of the most successful of the season.

TAIPO ACCUMULATOR CO. (LTD).—Subscriptions have been invited to the capital of £25,000 of the Taipo Accumulator Co. (Ltd.) This capital is divided into 20,000 ordinary shares and 5,000 6 per cent. preference shares of £1 each. It appears from the prospectus that the company has been formed as a *parent* company to acquire and work patent No. 2,299/99 for Great Britain for improvements in the manufacture of electric accumulators, to acquire the option of purchase of the patents for Germany, France and Belgium, and to acquire the present plant at 101, Clifton-street, Finsbury, London, for the business of the company, and in conjunction therewith to supply electrical carriages. Various claims are made for the Taipo accumulator, amongst them being "that it is practically indestructible." The accumulator is the invention of Mr. John Garfield Hathaway, and the purchase price has been fixed by the inventor at £20,000, payable as to £2,000 in cash or cash and shares at

COMPANIES' MEETINGS AND REPORTS.

Eastern Telegraph Co. (Ltd.).

The fifty-fifth half-yearly ordinary general meeting of this Company was held yesterday (Thursday), under the presidency of the Marquis of TWEEDDALE, K.T.

The SECRETARY (Mr. George Draper) read the notice convening the meeting, and other formal business was afterwards disposed of.

The CHAIRMAN, whose remarks were frequently applauded, said: Gentlemen, I will now, as usual, refer to some of the more important events which have occurred during the half-year under notice. The gross revenue for the half-year under review amounted to £474,950, as against, in the corresponding period of 1898, £444,011, or an increase of £30,939, to which I will refer later. The total ordinary expenses for the half-year amounted to £121,630, as against, in the corresponding period, £121,376, or an increase of £254. This is apparently a small increase, but had it not been for some exceptionally heavy special expenses which appeared in the accounts for the period with which we are comparing the present half-year's figures, this increase would have been considerably greater. As I have repeatedly stated at former meetings, our expenses will have a tendency to rise. The important reductions in the tariff which we have lately made, and the further possible reductions in the future, will tend to increase the number of messages. This, in turn, necessitates an almost continual augmentation of our staff, in order to deal with the work in the same efficient manner as we have hitherto done. We are constantly endeavouring to improve our electrical instruments and apparatus, and owing to the rapidity with which improvements are being devised and introduced, expensive apparatus soon becomes obsolete, and has to be replaced by instruments of the latest design; but perhaps the most important feature is the necessity for additional cables to enable us to carry the extra work developed by tariff reductions, a feature which must always be taken into account in connection with all tariff reductions. Apart from the capital cost of these additional cables, heavy revenue and working charges are at once created. Expenses attending repairs and renewals of cables amounted to £33,096, as against £41,716, or a decrease of £8,620. This is to a large extent due to the extra credit received from the South African Co. for the hire of one of our ships to replace their ss. "Duplex" while laid up in harbour in London undergoing repair and general overhaul. Turning to our revenue, the principal increases have been derived from the traffic with the Philippines, Australia, and the Cape, but there is no very important development of any particular traffic. According to the state of the world's trade, fluctuations must necessarily occur in the volume of our commercial traffic; but there is generally some compensating influence at work in one part of the world to counteract any excessive fluctuation in another part. War has also an important effect upon our revenue resources, but we much prefer the traffic derived from commercial business. War invariably disorganises, at all events for the time being, the sound commercial prosperity of those nations directly or indirectly interested. It is our commercial traffic upon which we must depend for a satisfactory revenue account, and with which our organisation is principally designed to cope. The completeness of our submarine telegraph system, however, not only enables us to deal satisfactorily with all ordinary traffic, but provides a considerable margin of carrying capacity to enable us to handle any exceptional press of work, so long as the number of interruptions in our cables is of a normal character. During the present crisis in South Africa, some exceptional delay in the transmission of Press messages has occurred, but this delay has been caused by circumstances quite beyond our control. It is easy to understand the irritation to which these delays give rise, anxious as we all are to receive news of our gallant soldiers in South Africa, more especially when you consider the great expense incurred and the enterprise shown by our Press in supplying the country with the latest intelligence. In some cases, owing to the absence of a full knowledge of the surrounding circumstances, it has led—perhaps not unnaturally—to some undeserved complaints against this company. The delay has arisen from several causes, such as the action taken by the Press censors appointed by the Government, interruptions of one or other of our routes by the uncontrollable forces of Nature, and the excessive work thrown upon the Government land lines in South Africa. Notwithstanding the exceptional conditions under which we have been working, it is a great satisfaction to be able to say that Government messages have in no case been unduly delayed, and the rapidity in the exchange of messages between the actual field of battle and our War Office has, in several instances, been highly praiseworthy to all concerned. We were informed last night that instructions had been given that all Press telegrams are in future to be censored at Cape Town, and that such messages are to be transmitted by the West Coast cable. This will leave our best route *via* the East Coast practically idle, and all Press messages will consequently be heavily delayed. We have asked for a reconsideration of the routing of these messages, but meanwhile the Company must not be blamed for such delay. Our staff, who have at all times in the past cheerfully responded to any pressure of work, have during the present crisis exerted themselves to the utmost of their power. A brief history of the telegraph connection with South Africa will no doubt be interesting at the present time. In 1878 the warlike attitude of the natives of Zululand brought into greater prominence the necessity for submarine cable connection with South Africa. Negotiations which had been proceeding for some time previously were practically brought to a conclusion about May, 1879; and the work, which was immediately put in hand, was completed in December of the same year—just seven months afterwards. This was considered a record performance in cable work, and was much appreciated by our own Government and the Governments of Cape Colony and Natal.

only made possible by the close association and friendly assistance of the Eastern Extension Co., whose directors made arrangements to place at our disposal the cable which they had ordered for the duplication of one of their long sections in the Far East. At that time no prudent body of directors, having the interests of the shareholders in view, could have recommended them to provide the capital for this enterprise without some material assistance from the Government. Had they been rash enough to have done so, I am positive the money would never have been subscribed. The Government of the day appear to be entitled to no small credit for the wise discretion they displayed in granting the subsidy which enabled our Companies to improve telegraphic communication by submarine cables, the absence of which, in the present crisis, would have been attended with consequences terrible to contemplate. The Zanzibar-Mozambique section, owing to the action of the Rovuma river, gave us considerable trouble, and several interruptions took place. In order to guard against these interruptions, we decided to duplicate this section, five years after the original cable was laid, at a cost of £120,000. Extensive renewals have also been made in the Aden-Zanzibar section, involving a considerable expenditure of new cable. As the South African traffic developed, further duplications were considered advisable; but instead of making them by the East Coast route, it was found preferable to do so by an alternative route along the West Coast. Although by this route a larger outlay of capital was incurred, it brought other important places into telegraphic communication. These extensive duplications were undertaken by the South African Co. without any further assistance from the Government. These two routes, which are connected by a Government land line between Cape Town and Durban, are ample to carry all the ordinary South African traffic, with a considerable margin for any temporary press of work, so long as the lines are free from interruption. All cables are, however, subject to temporary disablement from various causes, such as corrosion, chafing on rocks, ships' anchors, submarine earthquakes, and the action of great rivers discharging immense volumes of soil-laden water into the ocean, causing submarine landslips, &c.; and quick repairs depend to a great extent on the state of the weather. In the ordinary course we have found it sufficient to have a repairing ship stationed on each coast, but realising the importance of maintaining telegraphic communication with South Africa during the war, the precaution was taken of moving forward additional ships, in order to effect with greater dispatch any repairs which might be necessary. By these means the telegraphic communication with South Africa has so far been secured during the present crisis, and the periods of interruption have been to a great extent minimised. Before leaving the subject of South Africa, I think it may be as well to correct any impression that we are deriving enormous receipts from the effect of the war. In the first place, let it not be forgotten that the tariff was reduced 20 per cent. from the 1st September last; and in the second place, it must be remembered that the lines have been very greatly occupied by the Government traffic at half rates and by Press traffic at quarter rates, although in several instances the Press have paid full rates in order to have their telegrams sent as ordinary messages. Again, I would call attention to the fact that the carrying capacity of all cables is limited, and it has been found necessary to restrict the number of words from each correspondent. When all these factors, together with the additional maintenance expenses and the extra cost of working the new line which is being laid to the Cape, are taken into account, we may find that the additional traffic carried during the war will be barely sufficient to recoup us for the loss which we may sustain in the future by the disturbance of commercial business. As will be seen from paragraph 6 of the report, your Directors, with the object of providing additional security to the submarine telegraphic communication with this country and South Africa, decided to lay down a third series of cables, connecting with our system at the same time the strategically important islands of Ascension and St. Helena. The Company laid a proposition before our Government, as long ago as March, 1897, for carrying out this undertaking by a route touching only on British territory, to be worked in conjunction with the Eastern Extension Co., who desired to continue this line from Durban across the Indian Ocean to Australia. The original proposal provided for certain subsidies and privileges, but, after protracted negotiations, the all-British scheme was, for good reasons, abandoned, and a scheme for making the connections by a commercial route, without any subsidies whatever, was substituted. For a project of such magnitude, involving as it does an expenditure of approaching three millions of capital, without tapping any fresh source of traffic, involving most important reductions of tariff, and complicated by the sympathy in certain quarters for a connection to Australia by a State-owned cable across the Pacific Ocean, it is not so difficult to realise why the negotiations have been of so protracted a nature. Notwithstanding the delay in the Australian negotiations, however, we still considered it advisable to expedite to the utmost of our power the South African connection; and we ultimately arrived at an understanding with the Postmaster-General at Cape Colony for landing rights at Cape Town, and with our own and the Portuguese Governments for similar rights at Ascension, St. Helena, and St. Vincent respectively; and the tariff was immediately reduced from 5s. to 4s. per word, with a proposed arrangement for a possible reduction to 2s. 6d. per word on the sliding-scale principle as the traffic responded to the reductions. Although these negotiations were only concluded in August last, we hope to have the connection completed with Cape Town to St. Vincent before the end of next month; and with the existing duplicate cables of our allies, the Western Telegraph Co., and the triplicate cables of this Company, a third route will then be available to South Africa. This triplicate route, however, could not have been so expeditiously carried out had it not been for the responsibility this Company took upon itself to order the manufacture of a certain portion of the cable some months before the negotiations were concluded.

In conjunction with the Eastern Extension Co., we are now proceeding with the remaining negotiations, which include an immediate reduction in the Australian tariff, and possible ultimate reductions to 2s. 6d. per word on a similar sliding-scale to that suggested for the South African tariff. This arrangement is, however, based upon the reasonable condition that the Eastern Extension Co. is granted the same freedom of dealing direct with their customers in Australia as we are at present enjoying in this country and elsewhere, and we look forward with confidence to a satisfactory solution before long. Perhaps I may be here allowed to point out that the notion that our Companies have all along maintained an attitude of uncompromising hostility to the establishment of cable communication in the Pacific is entirely unwarranted. Our Directors were willing to negotiate for the laying and maintaining of a Pacific cable, but could not accept the responsibility of laying and maintaining it by the particular route required by Her Majesty's Government. This was the view of my distinguished predecessor in the chair. You will observe from paragraph 8 of the report that it is proposed to alter the trust deeds of the staff pension and superannuation funds so as to admit of the retiring age being reduced from 60 to 55. This matter has already been submitted to the shareholders of the Eastern Extension Co., who are parties to the deeds, and agreed to by them. The change is strongly recommended by your Directors, inasmuch as we find the existing age limit too high to suit the peculiar conditions of our service. According to the present conditions set forth in the deeds, an employé cannot in any way participate in the benefits of the superannuation fund until he has actually reached the age of 60 years; and in the case of the pension fund he cannot receive the full benefits until that age is attained. We have already been reluctantly compelled to retire some of our older employés before they have reached the age of 60 years, and there being nothing available from the superannuation fund, the Company has been obliged to grant a gratuity from its other resources. The natural aversion we have to retire employés of long service without some adequate provision for their old age may tend to their retention after they are no longer able to perform efficient service. Unfortunately, they cannot all attain the higher positions in the service, and the special character of the ordinary work, which has frequently to be done in trying climates, prevents them remaining thoroughly efficient for so long a time as may be the case in other branches of work. It is, of course, not intended to retire our employés indiscriminately at the age of 55; but we consider it in the interest of the Company, as well as in that of the staff, that we should have the power to retire men at that age if advisable. It will, of course, be in the discretion of the Company to offer to retain their services after the age limit is reached. In the event of the Company desiring to retain the services of an employé after the age of 55, he will not, of course, have any claim on the funds while he remains in the service, but will continue to receive his salary in the usual way. To effect this alteration in the pension fund trust deed, the contribution will have to be increased from 2½ per cent. to 4 per cent. The staff will, I have no doubt, gladly agree to this proposal; and I feel confident the stockholders, who have always shown such a high appreciation of the work done by our staff, will also give their approval to the scheme. A formal resolution will be submitted to the meeting, after the adoption of the report, authorising the Directors to increase the Company's contribution from January 1st, 1900, to 4 per cent.; together with a sum sufficient to enable the trustees to pay the pensions which have already been purchased prior to Dec. 31, 1899, at the age of 55 instead of 60 years. The sum required from this Company to make up the back payments is roundly about £20,000, and if this amount be spread over 20 years, as proposed by the actuary, it will not be a very serious annual charge in addition to the proposed increased contributions to 4 per cent. instead of 2½ per cent. on the salaries. Authority will also be taken to make alteration in the superannuation trust deed, by which the age of limit will be reduced to 55 years, the Company guaranteeing to make up the loss (if any) that there might be in the fund on account of such reduction. I may say that the actuary informs us that there is little or no possibility of any loss arising under this head. There is only one other matter to which I should like to refer before sitting down, and that is the question of contributing to the various funds that have been established for the benefit of our soldiers in South Africa, and also those who have come from the colonies. We have already subscribed, but I may mention that we have intimated our intention to make further contributions, amounting in all to £3,000—that is, on the part of the associated Companies—namely, our Company, the Eastern Extension, and the Eastern and South African Co. We have received communications from more than one shareholder recommending that we should do this, and we thought that we should anticipate the wish of the shareholders if we made the contribution to which I have referred, and which, I am sure, will be approved by everyone present. He concluded by moving the adoption of the report and accounts.

Gentlemen, with these observations, I beg to move

"*That the report and accounts of the Directors to September 30, 1899, submitted to this meeting, be and the same are hereby received and adopted.*"

Mr. J. DENISON-PENDER (Vice-Chairman and Managing Director) formally seconded the resolution.

The CHAIRMAN invited discussion, but no shareholder rising to address the meeting, he put the motion in the usual way, and it was carried unanimously. Continuing, he proposed a resolution authorising the Directors to increase the Company's contribution to the staff pension fund from the 1st January, 1900, to 4 per cent., and provide a sum sufficient to enable the pensions which have already been purchased to the 31st December, 1899, to be paid at the age of 55 instead of 60 years; also to guarantee the loss (if any) to the staff superannuation fund which might occur by reason of the reduction of the age limit to 55 years, and to empower the Directors to make or consent to the making of such alterations in the trust deeds as they may deem expedient for the carrying of the above into effect.

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Mr. J. DENISON-PENDER seconded the motion, which was carried unanimously.

The CHAIRMAN afterwards proposed the re-election as a Director of Sir John Wolfe Barry, K.C.B., who, he stated, was absent at present on very important and special business in the East.

Mr. J. DENISON-PENDER seconded the resolution, which was carried unanimously.

On the motion of the CHAIRMAN, seconded by Sir A. J. LEPPOC CAPPEL, K.C.I.E., Mr. F. A. Johnston was also re-elected to his seat at the board.

The auditors were afterwards reappointed, on the motion of Mr. PARRETT, seconded by Mr. BAINES.

Mr. HENRY T. BURGESS afterwards proposed a cordial vote of thanks to the Chairman and the Directors.

The motion was seconded, and carried unanimously.

The CHAIRMAN, in returning thanks, said it was a great encouragement to the board to feel that they continued to receive the full confidence of the proprietors. The work of the Company was increasing every day, and making greater demands on those who gave their attention to it. The proprietors might be satisfied that the fullest and most constant attention was given to the work and administration of the Company.

The proceedings then terminated.

Automatic Telephone Co. (Ltd.).

The annual general meeting of this company was held yesterday, at Cannon-street Hotel, under the presidency of Mr. HENRY GEORGE SWORN, M.D., chairman of the company. The chairman said that as to the balance-sheet in the hands of the shareholders, the auditors of the company, Messrs. H. Pannell & Co., did not vouch for certain expenses in their certificate.

Mr. ALEXANDER (a director) asked if Mr. Pannell were present, or had he been asked to attend.

The SECRETARY: He has not been invited.

The CHAIRMAN: I told you to invite him.

Mr. PARKER: The secretary is instructed by the chairman, and does not obey orders.

The CHAIRMAN said he had asked that Mr. Pannell should be at the meeting.

Mr. WHITE said that the 1898 accounts were not passed at the last meeting, and the court declared the last meeting null and void. Mr. Justice North declared the proceedings illegal.

A SHAREHOLDER: Do these accounts include last year's accounts—those for the year 1898?

The CHAIRMAN: Yes. Besides the legal expenses, there was the question of the travelling expenses of Mr. Seligman-Lui. He moved that the accounts be adopted as set out in the balance-sheet presented to Sept. 30, 1899.

Mr. MAX MARGOWSKI seconded.

Mr. WHITE and Mr. COOPER opposed the resolution, and the latter asked if the Company was working?

The CHAIRMAN: No.

Mr. COOPER: How long has it been in existence?

THE CHAIRMAN: About five years. It is not now working: it is taking out and developing its patents.

Mr. COOPER said there were many curious things in the balance-sheet which called for most clear explanation. He wanted to know if the £3,541 13s. 6d. claimed by Mr. Seligman-Lui was to be paid. He asked what was happening. He would himself be glad to take 1s. a share and to get out of the concern.

Mr. GREY said that the Company ought to be wound up officially under order of the court.

Mr. MARGOWSKI said they were at loggerheads with their consulting engineer. As their managing director, he contended that they would not have had a penny left except for him. If the shareholders would trust him, he was prepared to guarantee the commercial success of the company. He would work without salary or fee. He had provided nearly 90 per cent. of the first working capital. He was ready to find all the money the company needed.

Mr. WHITE said that he could speak for Mr. Seligman-Lui, that if the shareholders possessed the company he could go along all right, but not while Mr. Max Margowski controlled matters.

Mr. COOPER said the position was serious: the directors were fighting across the table, and he could not recommend the re-election of half-a-dozen men to fight one another to the detriment of the shareholders.

The SOLICITOR (Mr. Spyer) said that the proper thing to do was to make an alteration of the board; and he had had a discussion with those opposed to the board, and he hoped that something could be done to smooth matters over. He felt sure that Mr. White (supporting Mr. Seligman-Lui) would be ready to meet them fairly.

Mr. COOPER said that with £144 in the bank something must be done.

A SHAREHOLDER asked if they could not get a man quite as good as Mr. Seligman-Lui to work the patents.

The CHAIRMAN said that they had another man quite as good.

Mr. BOYLEY (Chairman of the shareholders' committee) said that he would be glad of peace and to avoid performances like those of last year; but before the accounts were passed they ought to have the affairs of the company gone into from the commencement.

Mr. PARKER (speaking to a motion that he should join the board) said his desire was to make the company a success, and he had always had confidence in its patents. He had found that Mr. Margowski had always been antagonistic to the board and the shareholders. The fact was that Mr. Margowski could on a poll command the voting power of the company by reason of the shares he held. He had not been able to induce Mr. Margowski to reduce his voting power. He had been asked by Mr. Margowski to join the board, but he did not care to do it under the circumstances, and the negotiations he entered into came to an abrupt conclusion. He would now, however, under a new board willingly give his services free to the company as a director.

Mr. COOPER also agreed to join the board, which now consists of Messrs. Sworn, Margowski, Gibbs, Moore, Parker (chairman), and Cooper, Mr. Alexander retiring. The articles of association are to be amended to permit of this arrangement.

The meeting was then adjourned to within any time in two months, to enable the accounts to be duly audited. A vote of thanks to the chairman closed the proceedings.

Direct United States Cable Co. (Ltd.)

The report of the directors of this company for the six months to Dec. 31 states that the half-year's revenue, after deducting out-payments, amounted to £56,800. 2s. 5d., compared with £54,366. 4s. 10d. for the corresponding period of 1898, an increase of £2,433. 17s. 7d. The working and other expenses for the same period, including income tax, but exclusive of cost of cable repairs, amounted to £20,416. 10s. 5d., leaving £36,383. 12s. as net profit, making, with £3,176. 16s. 9d. brought forward, £39,560. 8s. 9d. For the corresponding period of 1898, the working expenses and other payments amouted to £21,620. 19s. 11d. Interim dividends of 3s. per share for the quarter ended Sept. 30, 1899 (paid Oct. 24), and of 3s. per share for the quarter ended Dec. 31 (payable 31st inst.), together amounting to £18,213, have been declared, and, after setting aside £15,000 to reserve the balance of £6,347. 8s. 9d. has been carried forward. Reserve has been debited with £1,989. 16s. for cost of cable repairs, and, after being credited with interest on investments, and amount set aside from revenue, the balance of the reserve fund account, taking investments at cost price, now amounts to £401,693. 16s. 2d.

The late traffic manager having resigned, the directors have appointed Mr. Tavenor Finnis general manager, and Messrs. Clark, Forde and Taylor consulting electricians of the company.

Anglo-American Telegraph Company, (Ltd.).

The report of the directors for the half-year to 31st December last states that the total receipts from July 1 to Dec. 31, 1899, including £24,701. 3s. 2d. brought forward, amounted to £232,776 8s. 5d. The traffic receipts show an increase of £6,798 compared with the half year to Dec. 31, 1898. The total expenses of the half-year, including the repair of cables, &c., amounted to £67,171 5s. 6d., an increase of £3,766 7s. over the corresponding period of 1898.

The directors, before declaring the net profits, have set apart £12,000 to the renewal fund, leaving a balance of £153,605 2s. 11d. Interim quarterly dividends of 15s. per cent. on the ordinary stock and £1 10s. per cent. on the ordinary preferred stock were paid on Nov. 1 last, absorbing £52,500, leaving £101,105 2s. 11d., out of which the directors recommend dividends of £1 8s. 6d. per cent. on the ordinary, £1 10s. per cent. on the preferred, and £1 7s. per cent. on on the deferred stock (amounting to £99,750), making a total distribution for the year of £3 13s. 6d. per cent. on the ordinary, £6 per cent. on the preferred, and £1 7s. per cent. on the deferred stock. The balance of £1,355 2s. 11d. is carried forward.

DOUGLAS SOUTHERN TRAMWAYS CO. (LTD.)—The directors' report for the year to Oct. 31 last states that the gross traffic receipts amounted to £4,444. The tolls payable to the Douglas Head Drive Co. amounted to £740, and, after allowing for other expenses, £1,706 was left for division, out of which a dividend of 6 per cent. is recommended on the 7 per cent. preference shares.

GREAT NORTHERN AND CITY RAILWAY CO.—The report of the directors states that the construction of the railway is actively proceeding, and, at the Regent's Canal, both the up and down line tunnels are making good progess. The shield chamber at Essex-road station is ready, and the shield is in course of erection. Excavation of the tunnel at this point will shortly be commenced, and work has begun at Drayton Park. An arrangement has been made with the City and South London Railway for a joint station at Old-street. The total capital expenditure to date is £136,944 9s. 8d.

NEW COMPANIES, STATUTORY RETURNS, &c.

BRITISH COMPRESSED AIR TRAMWAYS CO. (LTD.)—This company was registered on Jan. 8, with a capital of £75,000 in £1 shares, to adopt an agreement with the Electric and General Contract Corporation Ltd., to construct and equip tramways, railways, telephone and telegraph lines, &c., and to work any of the company's tramways by means of compressed air, electrical, or other mechanical or animal power.

LONGSTRETH'S (LTD.)—This company was registered on Jan. 19, with a capital of £3,000, in £1 shares, to carry on the business of electricians, electrical instrument makers, electrical, gas and general engineers.

TAIPO ACCUMUALTOR COMPANY (LTD.).—This company was registered on Jan. 20, with a capital of £25,000 in £1 shares, to acquire Mr. J. G. Hathaway's British Patent, No. 2,299 (1899), for improvements in the manufacture of electric accumulators and secondary batteries, and the option to purchase the patents for the said invention for Germany, France and Belgium; to take over the business carried on by the vendor, and to manufacture and deal in accumulators, batteries, rubber, gutta percha, motors, electric vehicles, &c. The subscribers are:—G. D. Freeman, J. G. Hathaway, engineer, A. Mackmurdo, G. E. Winthrop, A. P. Freeman, A. J. Howell and R. Lance. The first directors are:—G. D. Freeman, E. Mann, A. H. Mackmurdo, L. Major and J. G. Hathaway.

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CITY NOTES.

MEMORANDA.—Bank rate 4 per cent. (Jan. 25, 1900). Price of silver 27⅜d. per oz. (Jan. 25). Consols (2¾ per cent.) 101½—101⅝ for money, 101½—101⅝ for account; 2½ per cent. 99½—100 (Jan. 25). Stock Exchange Settling Days: Consols, Feb. 2; Stocks and Shares Continuation Day, Feb. 7; Ticket Day, Feb. 8; Pay Days, Jan. 26 and Feb. 9; Mining Share Carry-over Days, Feb. 6. and 20.

BRITISH ELECTRIC TRACTION CO. (LTD.)—A meeting will be held on Tuesday to consider and approve the electric traction bills which the company are promoting.

CITY AND SOUTH LONDON RAILWAY.—The accounts of this company for the year ended Dec. 31 show a balance, after providing for debenture interest, and the full dividend on the 5 per cent. preference stock (1891), sufficient to allow a dividend on the consolidated ordinary stock (increased to £855,000) at the rate of 1½ per cent. per annum, carrying forward £1,257. This compares with 2 per cent. for the corresponding period of 1898.

W. T. HENLEY'S TELEGRAPH WORKS CO. (LTD.)—Sir Henry M. Stanley, G.C.B., M.P., has accepted a seat on the board of this company.

LIVERPOOL OVERHEAD RAILWAY CO. (LTD.).—The accounts of this company for the past year show an available balance of £18,841, and the directors recommend a dividend at the rate of 5 per cent. per annum on the preference, and 5 per cent. per annum on the ordinary shares, against 4 per cent. on the ordinary shares for the corresponding period last year. The balance forward is £4,591, against £4,586. A special meeting will be held on Feb. 13 to authorise the creation of the whole of the share capital (created by the Company's Act of 1899) in 5,000 ordinary £10 shares.

LONDON ELECTRIC SUPPLY CORP. (LTD.)—Sir William H. Preece, K.C.B., F.R.S., has been elected a director of this company.

ST. JAMES'S AND PALL MALL ELECTRIC LIGHT CO. (LTD.).—The directors of this company recommend a dividend for the half-year ended Dec. 31 of 7s. 6d., together with a bonus of 2s. per share on the ordinary shares, making with the interim a dividend of 12½ per cent., and a bonus of 2 per cent. for 1899.

STOCK EXCHANGE NOTICES.—Application has been made to the Stock Exchange committee to appoint a special settling day in and to grant a quotation to the further issue of £50,000 four and a half per cent. debenture stock of the *Chelsea Electricity Supply Co. (Ltd.)*, and to appoint a special settling day in 125,000 vendor's ordinary £1 (fully-paid) shares (Nos. 1 to 125,000) of the *Aron Electricity Meter Ltd.* The committee has also been asked to allow the further issue of £54,415 Five per cent. debenture stock of the *Buenos Ayres and Belgrano Electric Tramways Co. (Ltd.)*, and the further issue of £670,529 Three-and-a-Half per cent. debenture stock of the *National Telephone Co. (Ltd.)*, to be quoted in the official list.

WATERLOO AND CITY RAILWAY CO.—The twelfth half-yearly general meeting will be he held at Waterloo Station on Thursday, Feb. 18.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	'99–1900	£	£		£	£
*Birmingham Tramways.	Jan. 20	4,029	+ 298	3	11,944	+ 592
Blackpool Corporation...	,, 18	129	+ 18	42	21,086	+ 4,393
Blackpool and Fleetwood	,, 20	140	+ 11	3	423	+ 13
Bradford Corporation ...	,, 21	338	+ 88	76	24,963	...
Brisbane Trams	Dec. 6	1,667	+ 455	10	22,991	+ 7,052
*Bristol Trams & Carriage	Jan. 19	2,715	+ 136	3	8,162	+ 520
*Buenos Ayres & Belgrano	Dec. 24	2,310	+ 488	51	111,506	+ 47,975
City & South London Ry.	Jan. 21	1,111	- 22	3	3,379	- 4
Dover Corporation	,, 20	149	+ 1	42	8,653	+ 1,000
Dublin United	,, 19	2,963	+ 341	3	7,941	+ 832
Dublin Southern Dist....	,, 19	609	- 22	3	1,624	
*Glasgow Corporation ...	,, 20	8,341	+ 527	...	...	...
*Liverpool Corporation...	,, 13	6,631	+ 799	2	13,405	+ 1,505
Liverpool Overhead Rly.	,, 21	1,471	+ 145	3	4,455	+ 453
*Sheffield Tramways	,, 21	1,785	+ 571	3	5,423	+ 1,721
*South Staffs. Trams...	,, 19	603	- 76	3	1,616	- 150

* Partly electrical.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	NAME.	Previous Week's Price, Jan. 17.		Price Wednesday, Jan 24.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Jan. 24. Highest	Lowest
			TELEGRAPHS.					£ s. d.			
£110,900	100	4%	*African Direct Telegraph 4% Mort. Deb. (red.)	99	103	99	103	3 17 8	January and July....	...	...
25,000	10	...	Amazon Telegraph.....	3	4	3	4	...	June and December ..	...	...
£125,000	100	5%	Do. 5 per Cent. Debentures	85	90	85	90	5 11 1	...	...	...
£875,520	Stock	15/0	Anglo-American	64	67	65	68	5 1 3	Feb., May, Aug., Nov	67	...
£3,062,240	Stock	30/0	Do. Preferred	114½	115½	115	116	5 3 4	,, ,,	116½	114½
£3,062,240	Stock	18/0	Do. Deferred.....	17¼	17½	17⅛	17⅜	5 1 5	...	17 1/16	17⅛
$10,000,000	$100	$2½	Commercial Cable Capital Stock	165	175	165	175	...	Jan., Apr., July, Oct.	...	...
£1,332,823	Stock	4%	* Do. 4 per Cent. Debenture Stock	102	104	102	104	3 16 11	,, ,,	103¾	102¾
16,000	10	8/0	Cuba Submarine Ordinary	8½	9½	8½	9½	8 8 5	February and August	9⅛	9 1/16
6,000	10	10/0	Do. Preference 10 per Cent.	19	20	19	20	5 0 0	,, ,,	13⅛	...
12,931	5	2/0	Direct Spanish Ordinary.....	4	5	4	5	4 0 0	April and October.....	...	...
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference	9	10	9	10	5 0 0	,, ,,	...	...
£30,000	50	4½%	Do. 4½ per Cent. Debentures	101⅞	105⅞	101⅞	105⅞	4 5 9	January and July.....	...	...
60,710	20	3 0	Direct United States Cable	11¾	12¼	11¾	12¼	5 14 3	Jan., Apr., July, Oct.	12⅛	12
£120,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red.)	99	102	99	102	4 8 3	June and December ..	...	...
£4,000,000	Stock	5%	Eastern Ordinary	151	156	153	158	4 8 7	Jan., Apr., July, Oct	176	152½
£1,795,000	Stock	3½%	Do. 3½ per Cent. Preference Stock	98	99	98	101	3 9 3	,, ,,	100	98¼
£1,432,268	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.)	114	119	115	120	3 7 3	May and November ..	...	...
250,000	10	2/6	Eastern Extension	14¾	15½	15¼	15¾	4 8 11	Jan., Apr., July, Oct	17⅝	14⅞
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	116	121	117	122	3 6 6	February and August	...	...
£16,200	100	5%	* Do. 5% (Austln. Gov. Sub.) Deb.,1900 (reg.) ...	99	103	99	103	4 17 1	January and July.....	...	...
£64,400	100	5%	Do. (Bearer)	100	103	100	103	4 17 1	,, ,,	...	...
£300,000	100	4%	*Eastern and S. African 4% Mort. Deb , 1909.....	101	104	101	104	3 16 11	February and August	...	...
£200,000	25	4%	Do. 4 per Cent. Mauritius Sub. Debs.(red.) ...	101⅞	104⅞	101⅞	104⅞	3 16 10	May and November ..	...	...
180,227	10	1/9	Globe Telegraph and Trust	10⅞	11⅛	11	11⅛	4 11 4	Jan., Apr., July, Oct.	11⅛	11
180,042	10	3/0	Do. 6 per Cent. Preference	14¾	15½	15	15½	3 17 5	,, ,,	15⅝	15 1/16
150,000	10	5/0	Great Northern of Copenhagen	30	32	30	32	3 18 2	January and July.....	31¾	31
£86,300	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb.(red.) ...	99	102	99	102	4 8 3	...	...	...
17,000	25	12/6	Indo-European.....	48	52	49	53	4 14 4	May and November ..	52½	50
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904 ...	106	109	106	109	5 10 1	March and September	...	...
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.)	101	104	101	104	3 16 11	June and December ..	...	...
11,839	8	4/0	Reuter's.....	7	8	7	8	5 0 0	April and October.....	...	...
3,381	£100 Cert.	6%	Submarine Cables Trust	125	130	125	130	4 13 0	,, ,,	...	...
15,609	10	...	West African Telegraph	2½	3½	2½	3½	4 9 3	December and July ...	...	...
£200,000	100	5%	* Do. 5 per Cent. Debentures (red.)	99	102	99	102	4 18 0	March and September	...	...
30,008	2½	...	West Coast of America	½	1	½	1	...	...	...	...
£150,000	100	4%	* Do. 4 per Cent. Debentures	100	103	100	103	3 17 8	January and July.....	...	...
88,321	10	6d.	West India and Panama	⅞	1⅛	⅞	1⅛	...	May and November ...	...	...
34,563	10	6/0	Do. 6 per Cent. 1st Preference	9¼	9½	9¼	9½	6 3 1	,, ,,	...	...
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	7	8	7	8	7 10 0	,, ,,	...	...
£80,000	100	5%	* Do. 5 per Cent. Debentures	104	107	104	107	4 13 6	January and July.....	...	...
£389,731	Stock	4%	Western & Brazilian 4 per Cent. Debenture Stock ...	100	104	100	104	3 16 11	June and December ...	...	...
207,930	10	3/0	Western Telegraph (late Brazilian Submarine)	14½	15	14¾	15¼	4 11 10	Mar., June, Oct., Dec.	15	14 3/4
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1900)	106	109	106	109	4 11 9	June and December ...	...	...
£158,100	100	6%	*Western Union 6 per Cent. Sterling Bonds (red.) ..	98	103	98	103	5 16 6	March and September	...	...
			TELEPHONES.								
44,000	£5	3/0	Chili Telephone (fully paid)	2	3	2	3	6 13 4	August	...	...
224,850	10s.	0/1½	Consolidated Telephone Const. & Manufacturing ...	⅛	¼	⅛	¼	4 15 3	July	...	...
72,680	1	0/6	Monte Video Telephone Ordinary	½	⅝	½	⅝	5 0 0	October.....	...	...
86,492	1	1 0	Do. 5 per Cent. Preference	¾	1	¾	1	5 0 0	...	...	...
490,000	5	3/0	National	5⅜	5⅝	5⅜	5¾	5 4 4	February and August	5⅝	5½
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Preference ...	14	15	14	15	4 0 0	,, ,,	...	...
15,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference ...	14	15	14	15	4 0 0	,, ,,	...	...
250,000	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref. ...	5¼	5½	5⅜	5⅝	4 8 11	,, ,,	5⅝	5 5/8
1,329,471	Stock	3½%	* Do. Debenture Stock 3½ per Cent. (red.)	98	100	98	100	3 10 0	June and December ...	99½	98⅛
171,504	1	0/4	Oriental	¾	1	¾	1	5 0 0	April and October.....	...	...
58,000	5	2/6	United River Plate	4⅜	5½	4⅝	5¼	7 2 10	July	...	...
16,639	5	1/4	Do. 5% Cumulative Preference	4½	5¼	4⅝	5¼	4 15 3	...	...	...
£179,947	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	103	106	103	106	4 14 4	June and December ...	...	...

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Jan. 17.		Price Wednesday, Jan. 24.		Rate per Cent. Yield. £ s. d.	Dividend Due.	Business Done During Week Ending Jan. 24. Highest	Lowest
			ELECTRICITY SUPPLY COMPANIES.								
100,000	1	...	Bl'ckb'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.)	⅝	¾	⅝	¾	...	...	...	...
6,000	10	7/9½	Bournemouth and Poole Elec. Supply Ord.	12	13	12	13	3 0 0	...	...	...
6,000	10	4/6	Do. 4½ per Cent. Cumulative Pref.	10	11	10	11	4 1 10	...	...	...
19,661	5	2/6	Brompton & Kensington Electricity Supply Ord.	7	8	7	8	3 15 0	...	...	...
12,000	5	3/6	Do. 7 per Cent. Preference	9	10	8½	9½	3 13 8	March and September	...	...
20,000	5	...	Calcutta Elec. Supply Ordinary (fully paid)	6½	6¾	6½	6¾	...	...	...	...
30,000	5	4/0	Charing Cross & Strand Electricity Supply Corp.	9¾	10¼	10	11	4 1 10	February and August	10⅛	10⅛
20,000	5	...	Do. (Nos. 3,001 to 50,000)	9½	10¼	9½	10½	...	...	10	9⅞
20,000	5	2/3	Do. 4½ per Cent. Preference	5¾	6	5¾	6¼	3 12 0	" "	...	...
34,000	5	2/6	Chelsea Electricity Supply Ordinary	7¾	8¼	7¾	8¼	3 10 7	March	8	7¾
£100,000	Stock	4½%	* Do. 4½ per Cent. Debenture Stock (red.)	109	111	109	111	4 1 1	June and December	...	...
$1,200,000	$1,000	5%	Chicago Edison 1st Mort. 5% 30 year Gold Bonds (red.)	100	110	100	110	4 10 11	April and October	...	...
60,000	10	7/0	City of London Electric Lighting Ordinary	10	11	10¾	11¼	5 4 4	February and August	11¼	10¾
40,000	10	6%	Do. 6 per Cent. Cumulative Preference	12½	13½	13	14	4 5 9	January and July	13½	13½
£400,000	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	122	127	122	127	3 13 9	June and December	...	...
40,000	10	...	County of London and Brush Prov. Ordinary	9½	10½	9½	10¾	...	...	...	...
20,000	10	6/0	Do. 6 per Cent. Cumulative Preference	13	14	13	14	4 5 9	March and September	...	...
£200,000	Stock	4½%	Do. 4½% Deb. Stock Certs. (all pd.) (red.)	106	109	108	111	4 1 3	...	...	...
15,000	5	10%	Kensington and Knightsbridge Ordinary	12	13	12	13	4 1 6	...	...	...
10,000	5	6%	Do. 6 per Cent. 1st Preference	7½	7¾	7½	7¾	3 17 5	January and July	...	...
110,000	3	...	London Electric Supply Ordinary	2¼	2¾	2	2½	...	...	...	...
48,050	5	3/0	Do. 6 per Cent. Preference	5¼	5¾	5	5¾	...	...	5½	...
£100,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures	102	104	101	103	3 18 1	Mar., June, Sept., Dec.	103	...
62,500	10	5/0	Metropolitan Elec. Supply Ord. (Nos. 1 to 62,500)	14	15	14½	15½	3 4 6	April and October	11⅛	11½
22,500	10	3/7½	Do. (Nos. 62,501 to 85,000)	13½	14½	14	15	2 5 8	...	...	...
£220,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage	115	117	115	117	3 16 11	June and December	...	...
£125,000	Stock	24/8	Do. 3½ per Cent. Mort. Deb. Stock (red.)	96	97	96	97	3 12 3	...	96	...
6,452	10	6/0	Notting Hill Electric Ordinary	15½	16½	15½	16½	3 15 0	March	...	...
10,000	5	5/0	Oxford Electric Ordinary	6¾	7½	6¾	7½	3 9 0	"	...	...
300,000	1	8%	Rand Electric	⅜	½	⅜	½	10 13 4	...	...	...
£130,070	Stock	5%	River Plate El. Lt. & Tr'ct'n, Ltd., 6% 1st Mor. Deb.	80	90	80	90	5 11 1	...	...	...
150,000	$100	$2	Royal Electric Company of Montreal Shares	150	170	150	170	4 14 2	...	...	...
£123,200	100	4½%	* Do. 4½ per Cent. 1st Mortgage Debentures	104	106	104	106	4 5 6	April and October	...	...
31,980	5	5/0	St. James's and Pall Mall Electric Ordinary	15	16	15½	16½	4 8 1	February and August	16⅜	15¾
20,000	5	3/6	Do. 7 per Cent. Preference	9	9½	9	9¾	3 13 8	" "	...	...
65,000	5	...	South London Electric Supply Ordinary (fully paid)	4	4½	4	4½	...	...	...	...
79,900	5	5/0	Westminster Electric Supply Ordinary	14	15	14½	15½	3 17 5	March and September	15½	14½
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
125,000	1	7½d.	Aron Electricity Meter 6 per Cent. Cum. Pref.	⅜	½	⅜	½	6 17 2	...	...	...
45,000	1	...	British Electric Works Co. Ordinary	⅛	¼	⅛	¼	...	...	...	...
50,000	1	...	Do. 5 per Cent. Cumulative Preference	⅛	¼	⅛	¼	...	...	...	...
£50,000	100	...	Do. First Mortgage Debentures xd	99	101	97	99	4 5 8	...	...	...
40,000	5	5/0	British Insulated Wire Ordinary	11½	12½	11⅝	12⅜	4 0 0	...	...	...
27,500	5	3/0	Do. Preference	6	6½	6	6⅜	4 12 4	...	...	...
90,000	2	2/0	Brush Electrical Engineering	1⅞	2	1⅞	2	5 0 0	September	1⅛	...
90,000	2	1/2½	Do. 6 per Cent. Pref. Non-Cumulative	2¼	2⅜	2¼	2⅜	5 1 1	"	...	...
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Deb. Stock	110	115	110	115	3 18 5	February and August	...	...
£50,000	Stock	4½%	* Do. 2nd Debenture Stock (red.)	103	105	102	105	4 5 9	June and December	...	...
20,000	5	5/0	Callender's Cable Construction Ordinary	13	14	13½	14½	5 3 5	" "	13⅞	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5½	6	5½	6	4 3 4	...	...	...
£90,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb. (red.)	110	115	110	115	3 18 3	November and May	...	...
300,000	1	0/9½	Castner-Kellner Alkali Co. (fully paid)	1⅛	1⅜	1⅛	1⅜	5 16 5	...	...	...
60,000	1	0/7½	Chadburn's Ship Telegraph Ordinary	⅞	1⅛	⅞	1⅛	5 6 8	...	...	...
60,000	1	0/7½	Do. 6 per Cent. Cumulative Preference	⅞	1⅛	⅞	1⅛	5 6 8	...	...	...
32,098	3	1 9½	Crompton and Co. (Nos. 1 to 32,098)	3¾	4	3¾	4	4 10 9	January and July	...	...
£100,000	100	5%	* Do. 5 per Cent. First Mortgage Deb. (red.)	99	101	99	101	4 19 0	" "	...	...
60,000	1	0/3	Davis and Timmins 6 per Cent. Cum. Pref.	¾	1	¾	1	...	...	...	...
99,261	5	1/9½	Edison and Swan United ("A" Shares) (£3 paid)	1⅞	2⅛	2	2⅛	7 3 9	February and August	2⅛	...
17,139	5	2/9½	Do. (£5 paid)	3¾	4⅛	3¾	4⅛	6 13 4	" "	...	...
£314,023	Stock	4%	Do. 4 per Cent. Mortgage Deb. Stock (red.)	91	93	92	94	4 5 4	June and December	...	...
26,100	5	5/11½	Edmundson's Electric Corporation Ord. (fully pd.)	4⅜	5⅛	4⅜	5⅛	5 14 3	Half-yearly	...	...
112,100	2	1/2½	Electric Construction Co. (Limited)	1⅞	2⅛	2	2⅛	5 2 3	January and July	2⅛	...
25,000	2	2/9½	Do. 7 per Cent. Cumulative Preference	2⅝	3⅛	2⅝	3⅛	4 6 2	July	...	...
182,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	103	109	103	108	3 15 6	January and July	103	...
30,000	5	...	Henley's Telegraph Works Ordinary	12	13	13	14	...	February and August	13⅜	...
15,000	5	...	Do. 4½ per Cent. Preference	5½	5⅞	5¼	6	3 15 0	" "	5⅞	5⅞
£50,000	Stock	4½%	Do. 4½ per Cent. Mortgage Deb. Stock (red.)	111	114	111	114	4 0 0	" "	...	...
50,000	10	10/0	India Rubber, Gutta Percha, &c., Works	20½	21½	21	22	4 11 10	" "	21½	21
£300,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	100	104	103	104	3 16 11	March and September	...	...
37,350	12	12/0	Telegraph Construction and Maintenance	35	39	36	40	4 11 1	March and July	39½	36½
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909	102	103	102	105	3 16 2	...	...	...
20,000	5	3/0	Do. Manufacturing Ordinary	9	10	9	10	3 10 0	...	...	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5½	6	5½	6	4 3 4	...	...	...
30,000	5	5/0	Willans and Robinson Ordinary	9½	10¼	9½	10½	4 5 9	April and October	10½	...
30,000	5	3/0	Do. 6 per Cent. Cumulative Preference	7	7½	7	7½	4 0 0	" "	...	...
£100,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Debentures	104	106	104	106	4 0 2	May and November	...	...
			ELECTRIC RAILWAYS, TRAMWAYS, &c.								
12,000	10	6/0	Blackpool and Fleetwood Tramways	17	19	17	19	3 13 8	...	...	...
£167,900	100	5%	Brisbane Tramway 5 per Cent. Debentures	104	106	104	106	4 14 4	...	...	...
50,000	10	7%	Bristol Tramways and Carriage Ordinary	23	24	23	24	2 17 2	February and August	...	...
25,000	10	...	Do. Cumulative Preference (£6 paid)	6½	6¾	6½	6¾	...	...	...	...
£100,000	Stock	4%	Do. 4 per Cent. Debentures	117	118	117	118	3 7 3	...	...	...
30,000	10	9/0	British Electric Traction Ordinary (Nos. 1 to 30,000)	12½	16½	16	17	3 10 7	...	16½	15¾
£15,000	10	...	Do. (Nos. 60,001 to 75,000)	...	...	15½	16½	...	...	...	...
30,000	10	6/0	Do. 6% Cum. Pref. (Nos. 30,001 to 60,000)	13	13½	13½	13⅝	4 7 3	...	13⅜	13⅛
£200,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures	125	128	125	128	3 18 6	...	...	...
40,000	5	1/9	Buenos Ayres & Belgrano 6% "A" Cum. Pref.	4¼	5⅛	4¼	5⅛	5 17 1	...	...	...
27,500	5		Do. "B"	4¼	5	4¼	5	...	...	...	...
265,585	Stock	5%	Do. 5 per Cent. Debentures	103	108	103	108	4 12 7	...	...	...
213,553	10	3/0	Central London Ordinary	9½	10	9½	10	3 0 0	June and December	9⅝	9⅜
£955,000	Stock	2½%	City and South London Railway Con. Ordinary	59	62	59	62	3 8 6	January and July	60	59
37,100	10	...	Do. (Nos. 22,501 to 60,000) (£5. 10s. paid)	4⅝	5⅛	4⅝	5⅛	...	...	...	...
£150,000	Stock	5%	Do. 5 per Cent. Perpetual Preference (1891)	142	148	142	148	3 8 0	January and July	...	...
£200,000	Stock	5%	Do. (1896)	135	140	135	140	3 11 11	...	137½	...
£87,701	Stock	4%	Do. 4 per Cent. Perpetual Debenture	125	130	125	130	3 1 11	May and November	...	...
20,000	10	7½%	†Imperial Tramways Ordinary	23	24	23	24	...	March and September	...	...
10,000	10	6%	† Do. 6 per Cent. Preference	15⅛	15⅝	15⅛	15⅝	3 13 10	" "	...	...
£200,000	Stock	4½%	† Do. 4½ per Cent. Debenture	113	115½	113	115	3 18 6	January and July	...	...
30,000	10	1/3	Kidd'rm'nst'r & Dist. E.L & Tr'ct'n 5% Pref. (£8 pd.)	8	8½	8	8½	...	May and November	...	...
37,500	10	2½%	Liverpool Overhead Railway Ordinary	8⅞	9	1⅛	9⅛	3 8 5	February and August	...	...
10,000	10	5%	Do. 5 per Cent. Preference	13	13½	13	13⅜	3 15 6	" "	...	...
125,000	Stock	4%	Do. 4 per Cent. Debenture	102	104	105	107	3 14 9	January and July	...	...
24,000	5	...	New General Traction Ordinary	3½	4	3½	4	...	...	...	...
30,000	5	6/0	Do. 6 per Cent. Cumulative Preference	5	5½	5	5½	5 9 1	May	...	...
4,000	10	...	Oldham, Ashton and Hyde Elec. Tramway Ord.	18	19	18	19	...	February and August	...	...
4,000	10	5/0	Do. 5 per Cent. Preference	10½	10¾	10⅜	10⅞	4 11 11	" "	...	...
13,334	10	...	Potteries Electric Traction Ordinary	11⅛	12½	11⅛	12⅛	...	...	...	...
20,000	10	5/10	Do. 5 per Cent. Cumulative Preference	10	11	10	11	4 10 11	...	10⅜	10½
£540,000	Stock	3%	Waterloo and City Ordinary	101	104	101	104	2 18 4	June and December	101⅛	...

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption.
† The London Stock Exchange Committee refuses to quote these.

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THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,133. [No. 15. Vol. XLIV.] FRIDAY, FEBRUARY 2, 1900. PRICE SIXPENCE (by post, 6½d.), Abroad, 8d., or 16 cents. or 80fr.. or 70pf.

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NOTES.

THE inauguration of a Chair of Education at Owens College, Manchester, gave the newly appointed Prof. H. L. WITHERS an opportunity to criticise the systems of education approved by the Government of the United Kingdom. In the course of his inaugural address he drew attention, in trenchant language, to the many glaring defects in these systems, and more especially to the science teaching under the control of the Science and Art Department. We have often had occasion to criticise the methods of that Department, under which the bulk of the science teaching throughout the country has long been held in bondage beneath a stunting and narrowing influence. We have repeatedly expressed views with which Prof. WITHERS is in practical accord when he describes the antiquated and musty curriculum of this Department as being "neither educationally nor technically a wise one."

IT is high time that the entire system of secondary and scientific education under the Government of this country was cast into the melting-pot, refined, and consolidated in a very different mould. A far more liberal and modern spirit should inspire its character and define its form. When, on April 1st next, the machinery of the new Board of Education is set in motion at Whitehall, it is to be hoped that then a loftier ideal and a more efficient administration than heretofore will be revealed. Prof. WITHERS appears to be in doubt as to whether this will be the case.

"AT present there is no sign," he said, "that the secondary department of the Board is going to be adequately manned and equipped. The constitution of the three departments has been left in the hands of six high officials, only one of whom, and he a Charity Commissioner, possessed any special knowledge of secondary schools. It is a grievous anomaly that the only national grant now given to secondary schools is administered by the Science and Art Department, which under the new *régime* will become the technical department of the Board of Education. . . . A questionable course of study has been imposed throughout the country, and protected by a preferential bounty of between £5 and £6 per head of the scholars per annum. The constitution of this committee of six officials gives only too much reason to fear that the administration of the national grant for secondary schools will be left in the hands of the Science and Art Department. In that case the reorganisation of secondary education, the supposed object of these new measures, will be a sham. It behoves all who care for the future of education to spare no effort to impress upon members of Parliament and others the absolute necessity of making the new secondary department in the Board of Education a fully manned and thoroughly efficient body, to give to it the duty of making a full survey, not being committed to any particular point of view, of the whole field of secondary education, and to so alter the conditions of the grant that it shall encourage every type of effective and properly equipped school."

THE chief feature of the discussion on Swiss electrical engineering at the Institution was the comparisons between continuous and three-phase currents for traction work. From the various opinions expressed, it may generally be taken that a three-phase trolley line is eminently suited for traction lines on which the stopping places are few and far between, and in localities where crossings and junctions are not numerous. For urban work generally, therefore, continuous currents with series motors appear best, and if three-phase transmission is desirable rotatory converters or motor-generators must be employed. Another point of interest in the discussion was the difference of opinion between Mr. CROMPTON and Mr. FERRANTI about three-phase switchboards. Mr. CROMPTON admired their simplicity, while Mr. FERRANTI said that the complication made him quite ill. The profusion of bare metal at high pressure in the Kanderwerk and elsewhere is somewhat surprising, no doubt, and not perhaps as well protected as it would have to be in this country; but the arrangements, which were explained to us by the engineer-in-charge, are by no means complicated. Mr. FERRANTI himself could hardly

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devise anything simpler, and at the same time as effective as the high-pressure three-phase connections in the sub-stations at Rheinfelden, and one of these, at any rate, could not be appropriately described as a "chamber of horrors."

According to the American technical journals, Prof. H. Rowland has been engaged, during the past twelve months, in making experiments intended to explain the phenomenon of the earth's magnetism. So far as can be ascertained from the newspaper reports (for Prof. Rowland's experiments have not yet been officially communicated to any scientific society), the apparatus employed consists of a brass wheel, on which is wound several miles of wire, which, by some unexplained process, develops a definite, though very small, magnetic field when it is set in rotation. A brass casing surrounds the wheel at a distance of about 1cm. from it, the annular air space being supposed to represent the atmospheric layer surrounding the earth. We are not at all certain of the manner in which the coil is rotated, whether as an earth-inductor or a spinning-wheel, though we imagine it is the latter method which is employed. Prof. Rowland is said to be quite satisfied with the results of his experiments so far as they have gone, and hopes to show that the strength of the magnetic field developed increases with the speed of rotation of his coil.

Comment is of course impossible until we have accurate and authorised particulars of these experiments, but the idea apparently is that a body moving through the ether generates an electric current within itself, which current circulates through the body and develops a magnetic field. In this connection we recall that Prof. Schuster, in his presidential address to Section A of the 1892 meeting of the British Association, appeared to attach very great importance to an affirmative answer to the question, "Is every large rotating mass a magnet?" as a satisfactory basis for a reliable theory of the earth's magnetism. Prof. Schuster had indeed, in a Paper previously communicated to the Royal Society, worked out a sound theory on this very assumption. We await, therefore, with considerable interest further particulars of Prof. Rowland's experiments, which, so far as they have gone, appear to support Prof. Schuster's theory.

An architect's views on the design of electric power stations, whether for electric supply or traction, should possess unusual interest for electrical engineers, especially for those who are entrusted with the task of superintending the design of such buildings for housing machinery comprised in their own scheme of electric supply. Mr. A. Roberts' Paper on this subject, recently read before the Society of Architects will therefore be welcomed by a large section of our readers. We reprint the Paper in another part of this issue.

There are some few central station engineers in this country who consider themselves capable of dispensing with a professional architect, and who consider that the desired end has been attained when they have schemed out four walls and a roof to cover their plant, with usually—but not always—a wall to separate the boilers from the machinery. For temporary or small country installations, as well as for rough colonial uses, such practice may be justified on the score of economy. But it would be sadly ill-advised to follow this course in the case of large and costly installations, designed to run for a number of years. The expert architect is therefore a person whose advice should always be esteemed, and whose services ought to be retained in the vast majority of cases.

But the mutual relation between architect and electrical engineer calls for intimate and thorough interchange of ideas during the planning of electricity works. It is as necessary for the electrical engineer to assert the claims of his plant to due consideration, as it is for the architect to insist upon good structural and other qualities in the plans of the various departments. Mr. Roberts' Paper should therefore serve the double purpose of enlightening engineers as to what a responsible architect will demand, and of eliciting the criticisms of engineers where the architectural claims appear to press hard on engineering requirements. Indeed, a Paper on this subject would probably lead to a very instructive discussion, if read before the Institution of Electrical Engineers.

To turn to the details of Mr. Roberts' Paper, we may first notice that he rightly attaches great importance to the choice of a site, both in the interests of the architect and of the engineer. In our opinion, the engineer should have the chief voice in this matter, for a site that is badly chosen from his point of view might easily lead to financial disaster. Nevertheless, it behoves the engineer to pay due heed to the architect's warnings concerning vibration, smoke nuisance, ancient lights, rotten substrata, &c. With regard to the author's recommendations as to the various departments, Mr. Roberts' ideas are generally sound engineering, though occasionally they exhibit too great a tendency to hard-and-fast rules and crystallised practice. Such is the multiplicity of types of electrical and other engineering plant to be dealt with, and the great variety of electrical systems in vogue, that there ought to be considerable elasticity in the attitude of architects towards them. To insist on machinery foundations being "constructed of a continuous block of concrete (not separate beds for each engine)," or switchboards being "raised one step above the engine house floor-level," would be much too rigid; and, again, it is scarcely within the province of the architect to require switchboards to be of "slate slabs in timber framing." Moreover, the engineer would probably object to the latter, if not to all three of these dicta. On the whole, however, the Paper is excellent.

Erratum.—On page 453 of our issue last week, column 2, line 32, for "required only 27lb. per horse-power hour" read "was guaranteed to require only 27lb. per kilowatt hour."

Handsome Donation to an American University. — The University of Pennsylvania has received a gift of £50,000, to be used for the building and equipment of a physics laboratory.

Cable Interruptions and Repairs:—

	Date of Interruption.	Date of Repair.
Latakia—Cyprus	June 21, 1899	...
Cayenne—Pinhieros	Oct. 11, 1899	...
Mozambique—Lourenco-Marquez	Dec. 17, 1899	Jan. 12, 1900
Tangier—Tarifa	Jan. 3, 1900	...
Serena—Valparaiso	Jan. 9, 1900	Jan. 26, 1900
St. Thomé—Loanda	Jan. 25, 1900	Jan. 31, 1900

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Electro Harmonic Society.—At the smoking concert held on Friday, January 26, after the singing by Mr. Ivor Foster of "The Absent Minded Beggar," the sum of ten guineas was collected for, and has since been forwarded to, the *Daily Mail* war fund.

The Royal Society.—Among the Papers down for reading yesterday were: "Thermal Radiation in Absolute Measure," by Dr. Bottomley, F.R.S., and Dr. Beattie; and "Electrical Conductivity in Gases Traversed by Cathode Rays," by Dr. McLennan.

Association of Technical Institutions.—The following officers were elected at the annual meeting of this Association, held in the Mercers' Hall, London, on Wednesday last: President, Sir Swire Smith; vice-presidents, Lord Spencer, Sir Bernard Samuelson, Bart., Mr. H. Hobhouse, M.P., and Mr. W. Mather; treasurer, Mr. R. F. Martineau; honorary secretary, Prof. J. Wertheimer.

Electrically-Driven Shell Factory Destroyed at Johannesburg. — The principal shell factory of the Boers, at Johannesburg, is reported to have been completely destroyed through an accidental explosion. This factory was entirely driven by electric power. Originally it was an engineering works, the largest of the kind in South Africa, the machinery alone having cost some £80,000.

French Cable Schemes.—The Submarine Telegraphs Bill introduced by the French Government proposes one cable from Oran, Algeria, to St. Louis, Senegal, *viâ* Tangier and Teneriffe; a second from Hué to the north of Hong-Kong; a third from Tamatave, in Madagascar, to Réunion; and a fourth from the Gulf of Benin to the French Congo. The total expenditure will be about 150,000,000f.

The London Electric Supply Corporation.—A change has been made in the board, and also in the engineering staff, of this company. As announced in our City Notes last week, Sir William Preece has joined the board. Mr. P. W. d'Alton has resigned his position as engineer-in-chief. Mr. G. W. Partridge is retained as chief electrician, and an engineer is to be engaged to take charge of the station at Deptford. Mr. Burstall, of the firm of Burstall and Monkhouse, has been appointed consulting engineer.

Communication with South Africa.—The St. Thomé-Loanda cable was repaired on January 30th, and communication with South Africa by the West Coast route is therefore restored. The Telegraph Construction and Maintenance Co.'s cable steamer "Anglia" left London on Monday with the Ascension-St. Vincent section of the new cable to the Cape, which it is anticipated will be open for traffic about February 20th. The laying of this cable will complete the third submarine telegraph route between South Africa and Great Britain.

McGill University, Montreal.—According to the *Canadian Engineer*, the McGill University has been the recipient of a number of very generous gifts from Sir William C. McDonald during the academic year 1898-9. He has made up the deficiency of $7,650 in the Faculty of Applied Science, and, among many other generous contributions, has given $30,000 to supplement the equipment of the electrical engineering laboratories, and $10,000 additional endowment for the Chair of Electrical Engineering. His other contributions during the same period considerably exceed $250,000.

Local Sections of the Institution of Electrical Engineers.—An announcement was made, at the meeting of the Institution of Electrical Engineers on January 25th, that committees for the local centres at Dublin and Glasgow had been elected, and that they had been approved by the Council. We gave in our last issue a list of the Glasgow committee. The following are the officers elected at Dublin: Prof. G. F. Fitzgerald has been elected chairman, Col. C. F. C. Beresford, R.E., vice-chairman. Members of the committee: Prof. W. F. Barrett and Messrs. C. P. C. Cummins, R. Humphries, M. C. Olssen, G. F. Pilditch, A. E. Porte, M. Ruddle, P. S. Sheardown, and F. Gill (hon. sec.).

Obituary.—Our New York correspondent writes that on January 8th a sad catastrophe occurred at Schenectady, N.Y., which threw the electrical fraternity into deep gloom and sorrow. Mr. S. Dana Greene, general sales manager of the General Electric Co., and widely known throughout the electrical fraternity as one of its most brilliant and active members, together with his wife, was skating on the Mohawk River about five o'clock in the evening, and in some unknown manner both fell into the water and were drowned. Mr. Greene was 35 years of age, and the son of the late Commander S. Dana Greene, who succeeded to the command of the "Monitor" after Admiral Worden was disabled in the famous fight with the "Merrimac" during the Civil War, and was a nephew of Major-General Francis Vinton Greene. He graduated from the Naval Academy in 1883 at the head of his class. After a short term of service at sea, he became actively connected with the old Sprague motor interests, followed them into the Edison General Electric Co., and then, on the consolidation of that with the Thomson-Houston Co., became prominently identified with their successor, the General Electric Co. In this corporation he again came to the front, rising rapidly, until at the time of his death he was in full charge of all the sales as general sales manager. He took a deep interest in naval affairs, and presented Papers on electrical-naval topics before various bodies connected with the navy. He was also a valuable contributor to the *Proceedings* of the American Institute of Electrical Engineers and to those of the New York Electrical Society. An important work to which he had of late devoted attention and energy is the standardisation of electrical apparatus and its testing, &c. Mrs. Greene was the daughter of Rear-Admiral Ralph Chandler.

We also learn with deep regret, from our New York correspondent, that Mr. James Hamblet, well known in telegraphic circles through his connection with the Western Union Telegraph Co. as manager of its time service, died on January 2nd, at his home in Brooklyn, at the age of 75 years. Mr. Hamblet was born in Boston, Mass., June 16, 1824, and was identified with the electrical business from 1862 until 1870, during which time he was engaged in the manufacture of general electrical apparatus and telegraph instruments. In 1878 he established the time service for the Western Union Telegraph Co., and at the time of his death had charge of the system. He introduced many improvements and refinements previously unknown. He was at one time one of the managers and vice-president of the American Institute of Electrical Engineers, and took an active part in the work of the New York Electrical Society. He also presided over the electrical section of the Brooklyn Institute.

MEETINGS OF SCIENTIFIC AND ENGINEERING SOCIETIES, &c.

(TO-DAY) FRIDAY, February 2nd.

INSTITUTION OF CIVIL ENGINEERS.

2.30 p.m. Students' visit to the electrical works of the London United Tramways (Limited), 88, High-road, Chiswick.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.

7.30 p.m. General Meeting in the Lecture Hall of the Literary and Philosophical Society, Westgate-road, Newcastle-on-Tyne. Among the business of the evening is the discussion on Prof. R. L. Weighton's Paper, "Receiver Drop in Multiple Expansion Engines."

ROYAL INSTITUTION.

9 p.m. Evening Discourse, "Wireless Telegraphy," by Signor G. Marconi.

MONDAY, February 5th.

SOCIETY OF ENGINEERS.

7.30 p.m. Ordinary Meeting at the Royal United Service Institution, when the President for the year, Mr. Henry O'Connor, will deliver his inaugural address.

SOCIETY OF CHEMICAL INDUSTRY.

8 p.m. Meeting of the London Section in the Chemical Society's Rooms, Burlington House, W. The following Paper will be read and discussed: "Some Recent Objections Urged Against the Adoption of the Metric System," by Dr. W. S. Squire.

THURSDAY, February 8th.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary General Meeting. Paper to be read: "The Standardisation of Electrical Engineering Plant," by R. P. Sellon.

FRIDAY, February 9th.

PHYSICAL SOCIETY.

5 p.m. Annual General Meeting in the Rooms of the Chemical Society, Burlington House, W. Address by the President, Prof. O. J. Lodge, F.R.S.

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A NEW TELEPHONE SYSTEM FOR PARTY LINES.

BY JUL. H. WEST.

Telephone party lines have the purpose of cheapening the use of the telephone for that class of subscribers whose number of daily conversations is limited. The duration of an average conversation is about 2·5 minutes, and the average number of daily conversations per subscriber is, in England, about eight; that is to say, an ordinary subscriber in England uses his telephone 16 times per day, and each time for 2·5 minutes—*i.e.*, 40 minutes per day. The duration of the daily service being generally 15 hours, the line and apparatus of an ordinary telephone subscriber is in use only 5 per cent. of the allowed time. The best way to cheapen the use of the telephone is to have the telephone system more intensely used. the new system of common party lines, and as compensation for this the subscribers on the new system enjoy a reduction of 30 to 60 per cent. on the ordinary telephone rates.

The system invented by me and described in the following paragraphs allows the telephones of two, three, four, or five subscribers to be connected to the exchange by one common party line. A small alteration in the construction of one of the apparatus used would allow a still greater number of telephones on one circuit. A diagram of the system is shown in Fig. 1. The system contains a small central apparatus, 0, 0, 0, 0, and the telephone apparatus of the different subscribers, of which only three—I., III., V.—are shown in the diagram. The central apparatus is connected to the exchange by means of the common line, which can be either a double wire, L_1 L_2, or a single wire, L_1; in the latter case the other wire, L_2, must be

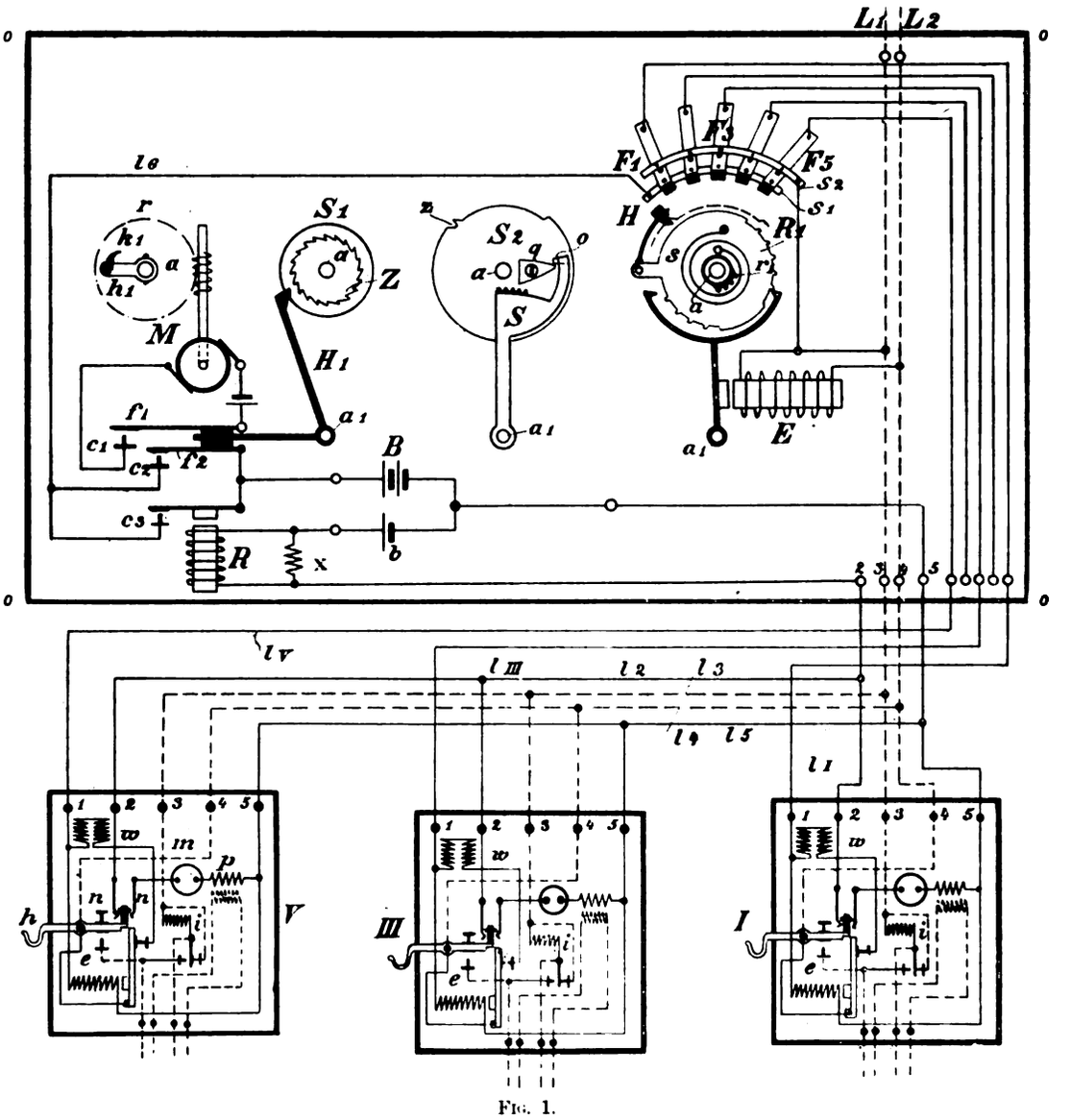

Fig. 1.

If three subscribers, A, B, and C, use their lines only 5 per cent. of the daily time, if we connect them to the exchange by means of one common party line, this line will be in use 15 per cent. of the daily time of service. It is clearly understood that the telephone company can give a telephone service to the subscribers on such lines cheaper than if every subscriber has his own line.

As in the instance chosen the daily speaking time on the common line is only one-seventh of the daily time of service, it will seldom occur that the telephone will be engaged by one subscriber when one of the other subscribers wishes to use it. Of course this will happen sometimes, and then the second subscriber must wait until the first subscriber has finished his conversation. This is the only inconvenience of

earthed. These two wires L_1 L_2 and two other wires l_2 l_5 branch out to all the subscribers' telephones; besides that, each of these is connected to the central apparatus by means of a special wire l_1, $l_{III.}$, or l_V. These wires being rather numerous, the system is mainly designed for such cases where the subscribers of one party line are in the same building. The central apparatus may be located in any suitable place in the building, preferably beside the telephone of any one of the subscribers. The batteries of the whole system, containing seven accumulators, are placed together at the side of the central apparatus.

As soon as one of the subscribers takes his telephone from the hook, all the other subscribers' stations on the same line are immediately "locked," so that none of the other sub-

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scribers can hear the conversation or disturb it; and similarly, when the exchange rings up one of the subscribers, all the stations on the line are locked at once, and immediately afterwards—by means of the central apparatus—the one station which is to be rung up is "unlocked" and its bell inserted in the circuit, so that the subscriber may be called without any of the other subscribers being disturbed.

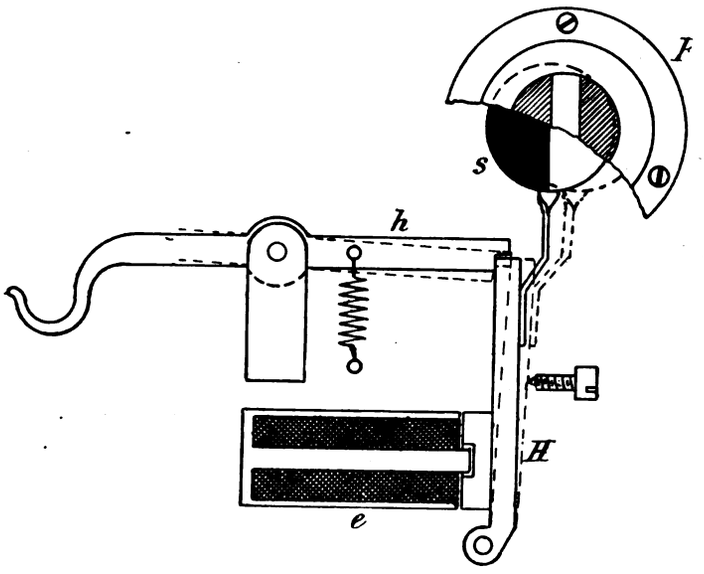

FIG. 2.

The locking and unlocking device is shown in Fig. 2. At the end of the telephone switch-hook h is the armature lever H of an electromagnet, e. When e attracts its armature, then H prevents h from moving downwards. In Fig. 1, in the subscriber's station, h is the switch-hook, c is the electromagnet just spoken of, m is the microphone, p is the primary of the induction coil, i is the magneto-generator, and w is the bell. When subscriber V. takes his telephone from the hook, he at once inserts his two telephones (not shown in the diagram) and the secondary of his induction coil in the circuit of L_1 L_2, and at the same time he closes the microphone circuit by way of the two springs n n; in this circuit is the battery b and the relay R. To prevent the self-induction of R having any influence on the microphone current, R is shunted by means of an inductionless resistance, x. When R attracts its armature the circuit of the locking battery B is closed at c_3; therefore it sends a current by way of c_3 l_6 into the contact plate s_1, and from this into the five springs F_1-F_5 bearing against it and over the wires l_I-l_V to the binding posts 1 of the subscribers' stations, through electromagnet e, to the binding posts 5, and then by way of the wires l_5 back again to the battery. In consequence the electromagnets e attract their armatures, thus locking all the stations except station V, where the hook h had already turned down before e could attract its armature.

Subscriber V. can now in the ordinary way ring up the exchange, while the other stations are locked. In connection with the locking lever H (Fig. 2) is a signal disc, s, which appears behind a small window, F, in the box of the stations, and indicates whether the line is busy or not. In the first instance the white and in the second case the black part of s is visible behind the window.

When the exchange calls one of the subscribers, it sends, according to his number on the line, one, two, three, four, or five short impulses of current which pass through the electromagnet E of the central apparatus. The construction of the central apparatus is shown in Fig. 3 in longitudinal and cross sections and in plan, while in Fig. 1, within the lines 0, 0, 0, 0, the different parts are shown in detail, together with their connecting wires. The apparatus contains two spindles, a, a_1. On a is fixed a small arm, h_1, with a movable ratchet, k_1; the latter works in a toothed wheel, Z; this wheel and the two discs S_1 S_2 are fixed together and turn freely on the axis a. This is also the case with the toothed wheel R_1, in the teeth of which works a pinion pivoted on the spindle a_1, and carrying the armature of the electromagnet E. Fixed together with

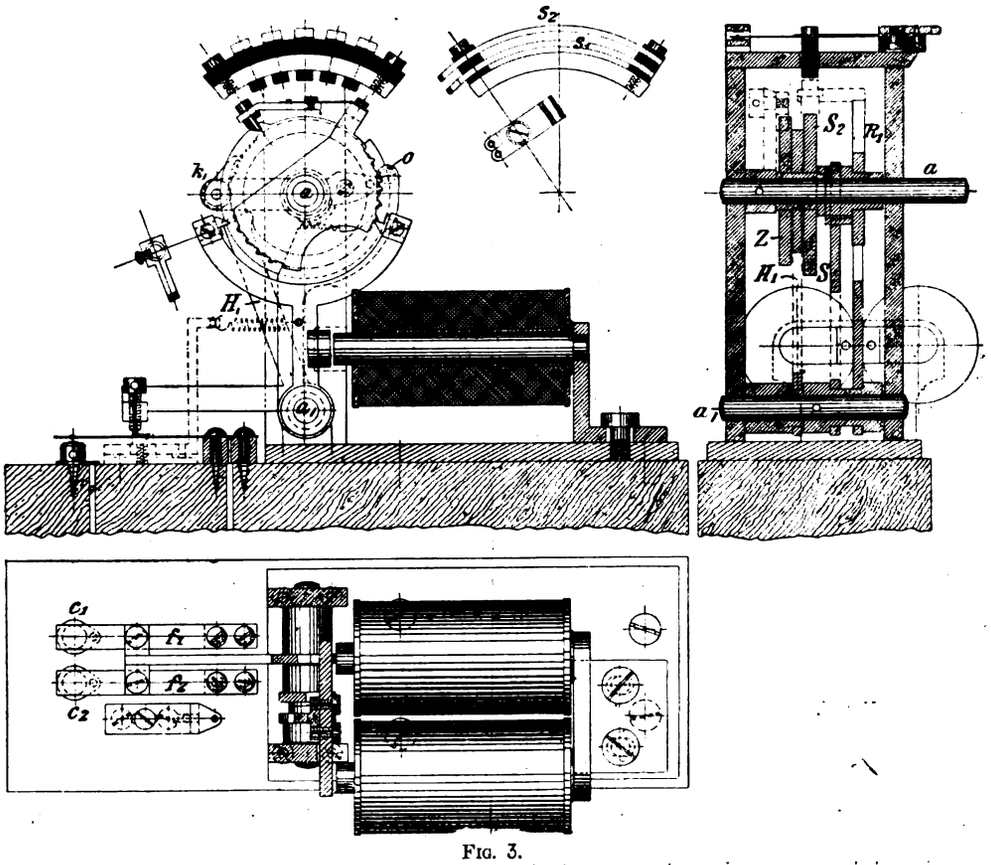

FIG. 3.

R_1 is a partly toothed wheel r_1 which works in the partly toothed segment S pivoted on the spindle a_1. The spiral spring s is fixed with its inner end to R_1, while its outer end is fixed to the bearing plate above the spindle a, so that it tends to turn R_1 and r_1 in the direction of the hands of a watch.

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When the central office sends say one impulse of current, the pinion carrying the armature of E releases the toothed wheel R_1 by one cog, so that the hammer H, pivoted on an arm of R_1, will be opposite to the contact spring F_1. In moving forward the hammer resting in the slot z of the disc S_2 turns with it S_2, S_1, Z; in the normal position the upper end of the two-armed lever H_1 rests in a slot of the disc S_1. Therefore, when S_1 turns, it turns the lever H_1, the lower arm of which carries two contact springs $f_1 f_2$, which close the circuit of the small electromotor M and the locking circuit of the battery B referred to above. Thus all the subscribers'

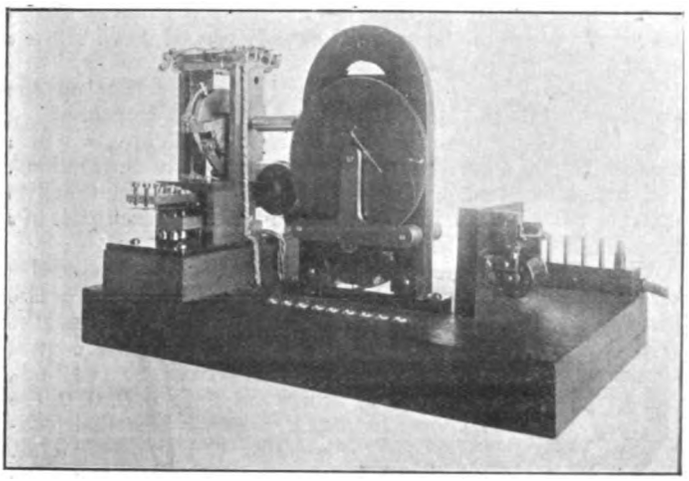

FIG. 4.

apparatus are locked at once. The electromotor M turns the spindle a slowly (one revolution in about two minutes) by means of an endless screw and a toothed wheel r. The arm h_1 and ratchet k_1 force Z, S_1 and S_2 to follow the revolution of a; thereby S_2 presses the hammer H outwards, and this, touching an ivory piece fixed to the spring F_1, lifts the spring from the lower contact rod s_1 and presses it against the upper contact rod s_2. By this movement of F_1 the locking circuit of the subscribers' apparatus I. is interrupted, and the bell w is at the same time inserted in the circuit of L_1 L_2

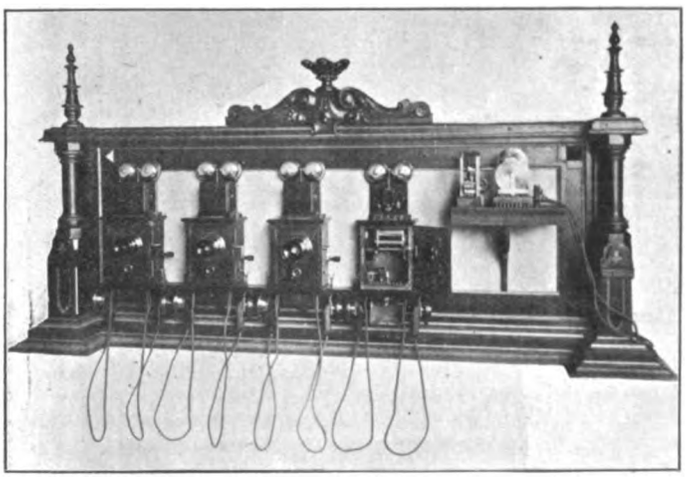

FIG. 5.

leading to the central office. The apparatus I. is thus unlocked, and the subscriber may be rung up by the office in the ordinary way, while all the other subscribers' apparatus are locked.

This state lasts until disc S_2 has turned about $\frac{3}{4}$ of a revolution when the hammer H_1 falling into the larger slot of disc S_2, the spring F_1 returns into its normal position, thus disconnecting the bell w again and locking the station I. The subscriber must therefore answer the ring within $1\frac{1}{2}$ minute, a time which is perfectly sufficient under any ordinary circumstances.

A short time after the hammer H has fallen into the larger slot of S_2, the small triangular-shaped piece of metal q fixed on disc S_2 reaches the projection o of the segment S, which by the movement of R_1 r_1 has been moved to the left, and presses it back again to the position shown in the diagram. Thereby S turns r_1 R_1 in the contrary direction to the hands of a watch until H reaches the small slot z of the disc S_2. Immediately afterwards q releases the projection o, thus allowing r_1 R_1 to move again a small distance in the direction of the hands of a watch until R_1 is stopped by the pinion. During the last part of R_1's travel H has turned with it S_1 S_2 until H_1 has fallen into the slot of S_1, whereby the circuit of the motor M and the locking circuit have been interrupted. Now the normal position of the apparatus is reached, all the subscribers' stations being unlocked. This unlocking will not take place if the subscriber I. answers the ring in due time; in this case the other stations will remain locked by means of the relay R until the subscriber I. has finished his conversation. Instead of having one induction coil in each of the subscribers' stations one common induction coil for all stations may be used; then X will be the primary of this coil, while the secondary will be inserted in the wire L_1 between the connection with the electromagnet E and the binding post 3.

Fig. 4 shows a photograph of the central apparatus: to the right is the relay and in the middle the small electromotor. The apparatus is connected to the batteries and to the wires leading to the stations by means of plug contacts, so that if out of order the apparatus can be changed at once. Fig. 5 shows the central apparatus and four subscribers' stations fixed together on a panel.

The diagram, Fig. 1, shows clearly that, otherwise than the ordinary contacts of the telephone hook, there are no movable contacts in the speaking circuits, and the function of one apparatus does not depend upon such contacts in the other apparatus. This is one of the advantages of the new system, as movable contacts are the most frequent cause of disturbances in telephone apparatus. The central apparatus alone contains a limited number of movable contacts, which are, however, all in the local circuits of the system. If any disturbance occurs through these contacts—or through any other cause—the result will never prevent the calling up of the central office. From the description the central apparatus may seem to be complicated; nevertheless its construction is most simple and not likely to get out of order. Another advantage of the system (one which renders it extremely easy of adoption) is that no alteration whatever of the boards at the central office is necessary.

The new system has been thoroughly tested by the Post Office of the German Empire, and is to be introduced very shortly into the German public telephone service.

GOVAN ELECTRICITY SUPPLY WORKS.

The Corporation works for the supply of electricity in the small burgh of Govan have now been completed, and, as announced in *The Electrician*, the official opening took place on Saturday, the 20th inst., when power was first put into use for lighting the main streets. The electrical supply in Govan is in a somewhat unique position, from the fact that Govan is the first of the three small burghs which, although forming an integral part of "Greater Glasgow," yet are not officially embraced in the larger municipality, but still have their own Corporations and powers to lay down electricity works of their own. When the bill was going through Parliament a strenuous effort was made by Glasgow for the authority which supplied the gas to be made the authority for the supply of electricity; but the effort failed, and the Burgh Commissioners became the local authority within the meaning of the Act. Little was done in Govan for some years to exercise the authority, although the Board were approached by several companies with the object of securing the right to supply power. These applications were, however, uniformly refused, and in 1891 the Commissioners applied for a provisional order to enable them to manufacture and supply electricity. This order was confirmed by Act of Parliament in the follow-

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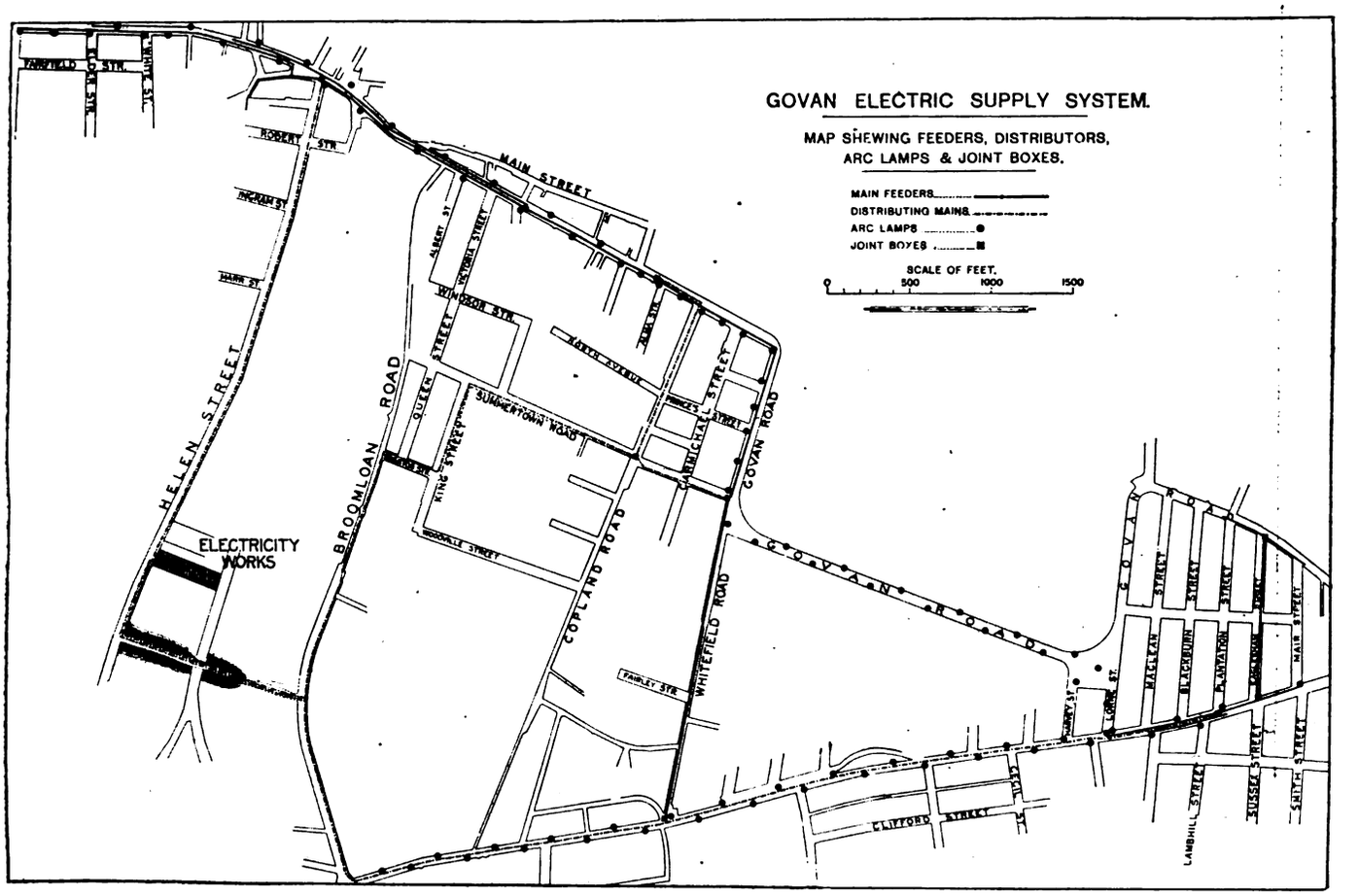
ing year, but it was not till 1897 that any definite steps were taken. A committee was then appointed, with Bailie Wightman as convener, to inquire into the question and report; and after consideration, and having consulted Mr. William Arnot, M.Inst.C.E., M.I.E.E., their report took the form of a recommendation to embark on the experiment. Mr. Arnot was then formally appointed consulting engineer to the burgh, and proceeded to draw up plans for the required works.

The installation, like that of Glasgow, where Mr. Arnot was also Corporation engineer, is on the three-wire continuous-current system, with 250 volts on each side of the middle wire. Naturally the present works are on a modest scale, for although the field seems a promising one, the Commissioners have deemed it wise to proceed cautiously. In designing the buildings, however, they have left abundant room for any reasonable extensions, as with very slight structural alterations the production of the works, which is equivalent to 10,000 8 c.p. lamps, may be greatly increased to meet applications for more power.

The supply station, which is situated in Helen-street, although a little to one side of the centre of supply, is very convenient in view of the facilities for expansion, and also in view of the fact that it has a railway siding available. The design and erection of the station buildings were carried out by Mr. Arnot, and they consist of a brick building containing boiler room, engine room, accumulator room, and offices. The frontage, however, is of red dressed stone, and this front portion of the buildings containing the engineers' and various other offices arranged on two floors. From the front portion of the buildings three lofty and one low bay run back. Two of the lofty bays, which are 24ft. to the spring of the roof, are taken up by the boiler house, which measures 48ft. broad by 60ft. deep. The engine room, which is next, is of the same height, and measures 30ft. by 60ft. deep. The roofs of both houses are of tied steel joists, with glass filling on either side, surmounted with ventilating louvres. The accumulator room is a low building, 10ft. high to the spring of the roof, running along the side of the engine room, and is 15ft. wide by 60ft. long.



The boiler room plant at present consists of two water-tube boilers of Messrs. Babcock and Wilcox's make. Each boiler is capable of evaporating 4,000lb. of water per hour under natural draught when burning Scotch bituminous coal. A superheater is provided with each boiler, and these are placed so that the hot gases pass through them before going up into the flue. Each superheater is fitted with all the necessary valves and mountings, and arrangements are made so that the heater can be flooded when there is no steam in the boiler, and either saturated or superheated steam can be used, or a mixture of both. The working pressure of the boilers is 160lb. The fittings on each boiler consist of two safety valves to blow off at 160lb. also arranged for a low water blow-off, 12in. steam gauge, two water gauges, and the usual valves and other fittings. There is a Shaffter and Brudenburg injector, and also one of Babcock and Wilcox's vertical feed-water heaters.

The feed pump was supplied by the British Thomson-Houston Co., and is motor driven. The pump is manufactured by the Blake and Knowles Co., and the motor by the General Electric Co., of Schenectady, N.Y. The pump is capable of delivering 1,500 gallons of water per hour against a steam pressure of 160lb. per sq. in. The pump and motor are combined on one bedplate, and the driving is by Hollick's friction gear. The motor is shunt-wound, and is able to give its full output at any voltage between 500 and 600 volts. Carbon brushes are used, and the necessary starting switches and resistances are provided. In view of a live steam injector being provided which is capable of the full requirements of the two boilers, the same as the pump, only one of the latter is provided, there being no necessity for duplicating it.

All the pipe work has been carried out by Messrs. John McNeil and Co., and the pipes have all been covered with magnesia covering by Messrs. Reid, McFarlane and Co. The main steam pipes form a ring, with suitable valves for cutting it up into sections if necessary. Each engine branch is taken separately off the ring again, the pipe being drained and trapped with one of Geipel's traps on either side of each engine. The exhaust pipes are carried under the floor

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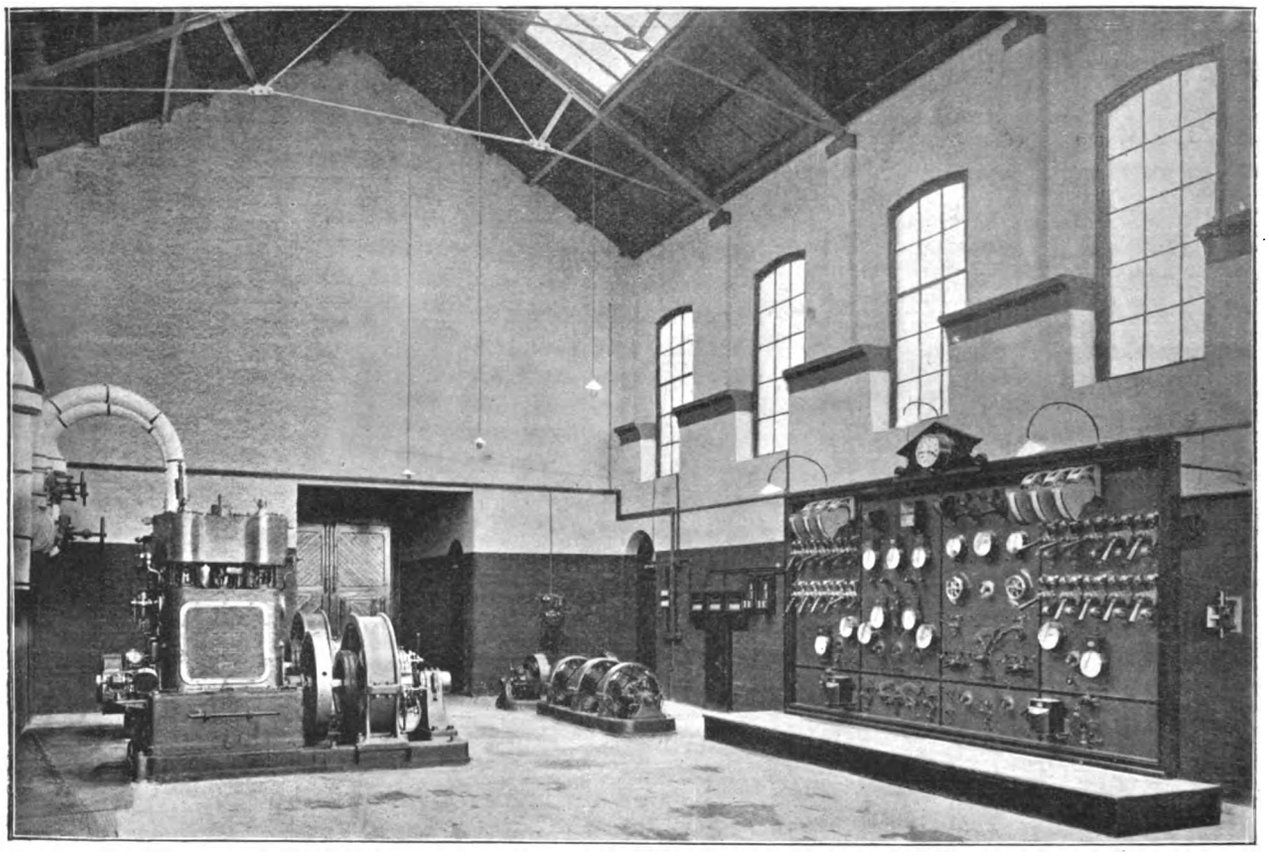
plates to the feed-heater, and thence up the centre of the chimney. The chimney, it should be mentioned, is 110ft. high, built of red brick, with red stone embellishments. The first 50ft. is lined with fire-brick and has an internal diameter of 5½ft., the diameter of the concrete block upon which it stands being 22ft.

The engine room plant consists of two combined sets of steam engines and dynamos, the contractors for which, together with the balancer and booster, were the British Thomson-Houston Company. The two engines were built by Messrs. Belliss and Morcom, and are of this firm's well-known make of enclosed quick-speed self-lubricating engine. They are each capable of indicating 150 H.P. at 440 revolutions, with superheated steam at a pressure of 150lb. per square inch at the stop valve. The engines are fitted with Messrs. Belliss's recent improvements, such as external glands, &c., and consist of the usual high and low-pressure cylinders, with the single valve places centrally between them, mounted side by side, and actuating a double crank: on the eccentric there is the usual pump for the forced lubrication. The series coils opposes the current in the shunt windings, and so weakens the field, and on the generating side the current in the series coils assists the current in the shunt windings and strengthens the field. The result of these windings is that the dynamo end is 15 volts higher than the motor end when the motor is taking 50 amperes and the dynamo generating its full output.. Either armature may be motor or dynamo, this being covered by the difference of load on either side of the system.

The motor driven booster consists of three machines coupled together on one bedplate, the centre machine being the motor and the two outer ones being each dynamos or boosters. The combination runs at a speed of 1,000 revs. per min. Each booster gives a current of 40 amperes at 169 volts. The fields are shunt-wound, and a variable resistance and switch is provided for the shunt of each machine, so that they can work with any pressure from 230 to 300 volts, and also be able to reduce the voltage to 20 when running at full speed with no load at the time of switching into circuit.



MACHINERY ROOM AT GOVAN MUNICIPAL ELECTRIC SUPPLY STATION.

governing is effected by direct action on the throttle, the governor itself being placed at the end of the crank shaft away from the dynamo. On the same bedplate and coupled direct to each engine is a four-pole dynamo. The dynamos are shunt wound, and give a continuous current at from 500 to 600 volts. The armature is drum wound and is insulated with mica, and carbon brushes are used. The regulation of the voltage is effected by adjustable resistances in the shunt circuits of the dynamo fields.

For balancing purposes an equaliser or motor-generator is provided. It consists of two complete machines coupled together end to end on one bedplate, and so constructed that one spare armature shall fit either machine; and it runs at a speed of 1,000 revs. per min. Each armature is capable of carrying 50 amperes, and the two are connected across the 'bus bars of the three-wire system where the voltage varies from 250 at light load to 300 at full load. Each machine is compounded by means of series windings, which are so connected that on the motor side the current in the

The Edison and Swan United Electric Light Co. secured the contract for the switchboard, including the fitting on the board of the switches provided by the machinery contractors, and also all the various connections for connecting up the dynamos, boosters, battery, &c., to the switchboard. The switchboard consists of four panels mounted in an iron frame, neatly covered with polished teak. Of the four slabs, one is for the positive side of the system, one for the negative side of the system, one slab is for the batteries and boosters, and one for the equalisers and regulating voltmeters. The slabs on the positive and on the negative sides both contain 10 two-way switches, three feeder edgewise ammeters to 350 amperes, one Kelvin dynamo ammeter to 250 amperes, one Kelvin dynamo voltmeter and six-way switch, one single-pole maximum and minimum automatic cut-out set to break at 300 amperes, one field circuit switch and spark coil, and one dynamo shunt regulating switch and resistance. The 20 two-way switches are all of one pattern, and are made to carry 400 amperes

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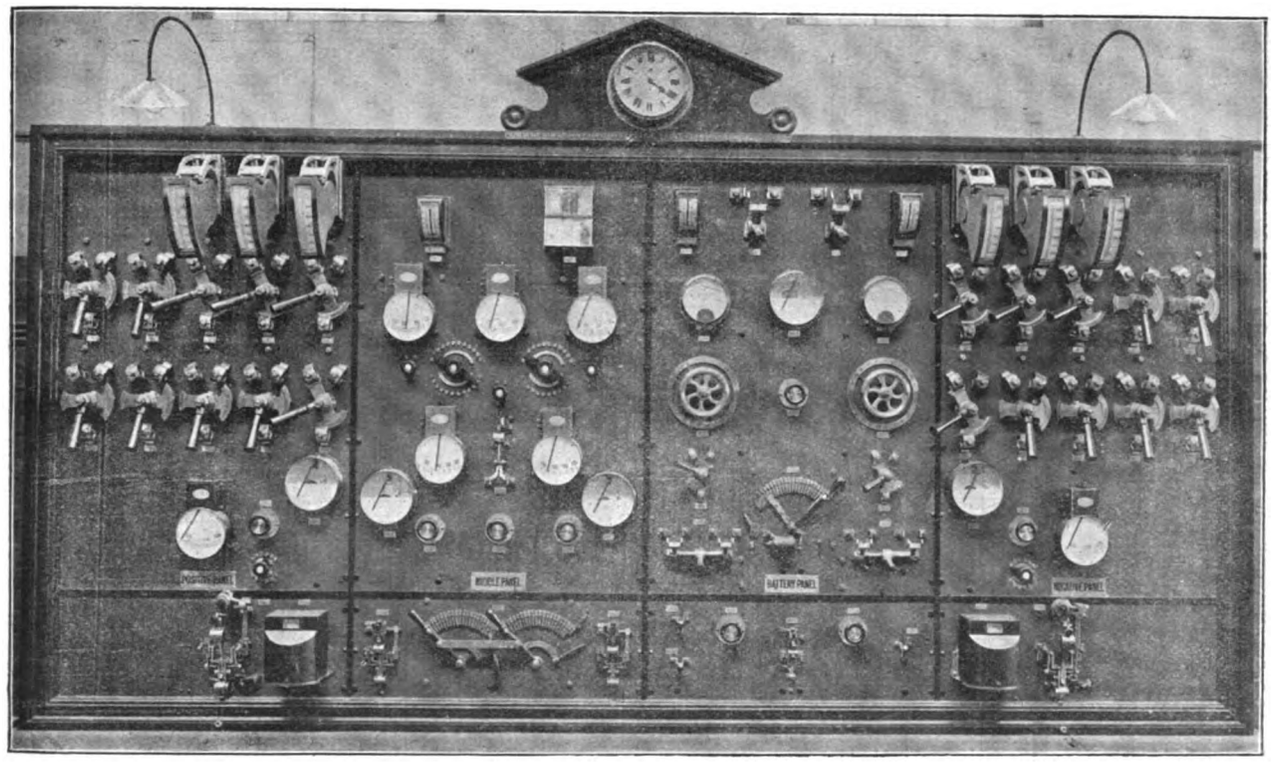
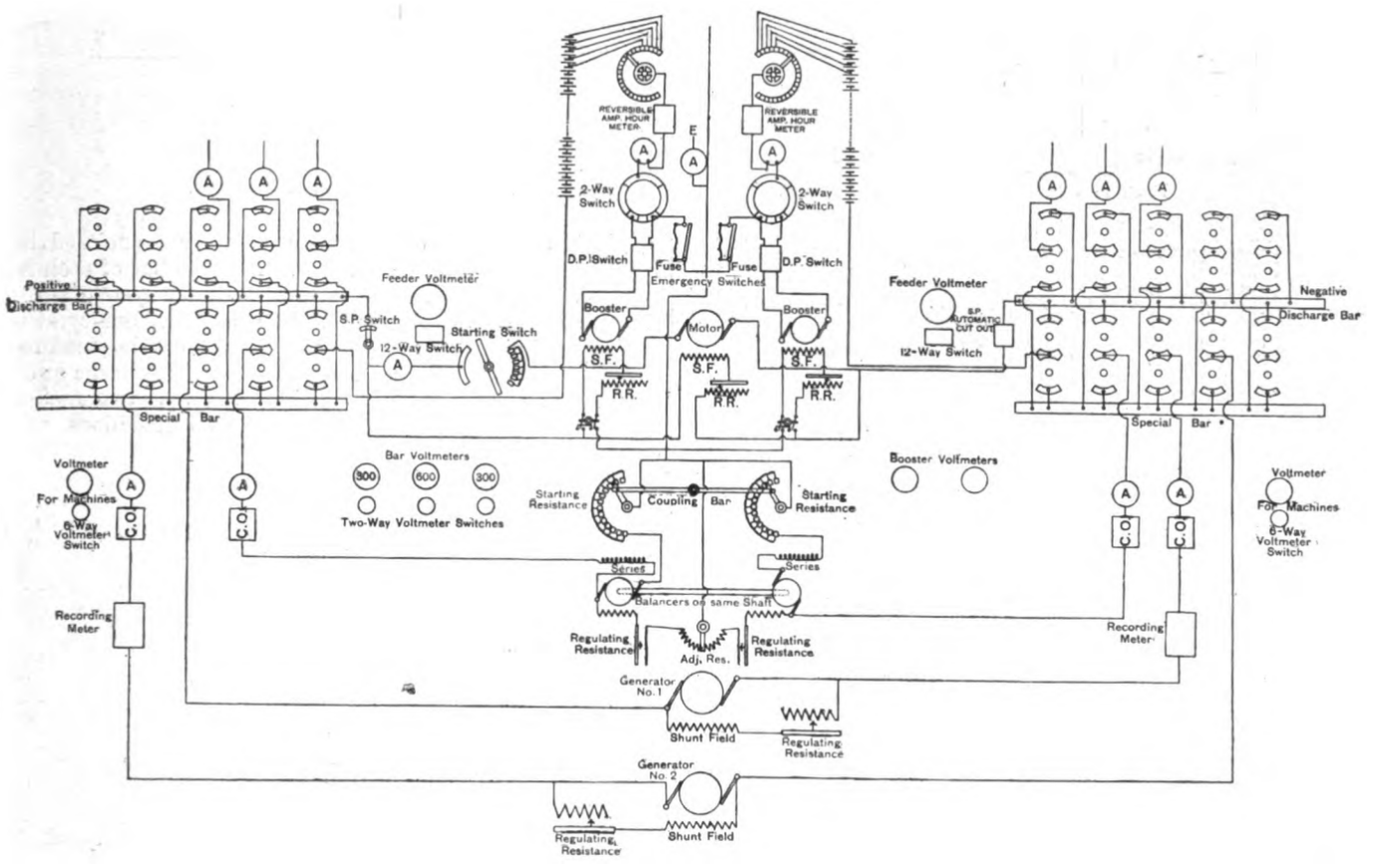
each. These switches are placed between two 'bus bars of high conductivity copper, and carry in rotation the positive of No. 1 equaliser and the negative of No. 2 equaliser, the positive of No. 1 battery and the negative of voltmeter on the negative slab through the first contact of the six-way double pole switch under the voltmeter, the connection being taken from the dynamo side of the automatic cut-out. In the same manner dynamo No. 2 is connected to the



VIEW OF FRONT OF SWITCHBOARD AT GOVAN ELECTRIC SUPPLY STATION.



SWITCHBOARD CONNECTIONS AT GOVAN MUNICIPAL ELECTRIC SUPPLY STATION.

No. 2 battery, the positive and negative of three feeders, and the positive and negative of three dynamos, three switches on each slab being spare. Dynamo No. 1 is connected to the voltmeter on the positive slab. For each dynamo a switch is placed on the switchboard to make and break the field-circuit, and each of these switches has a spark coil to take the dis-

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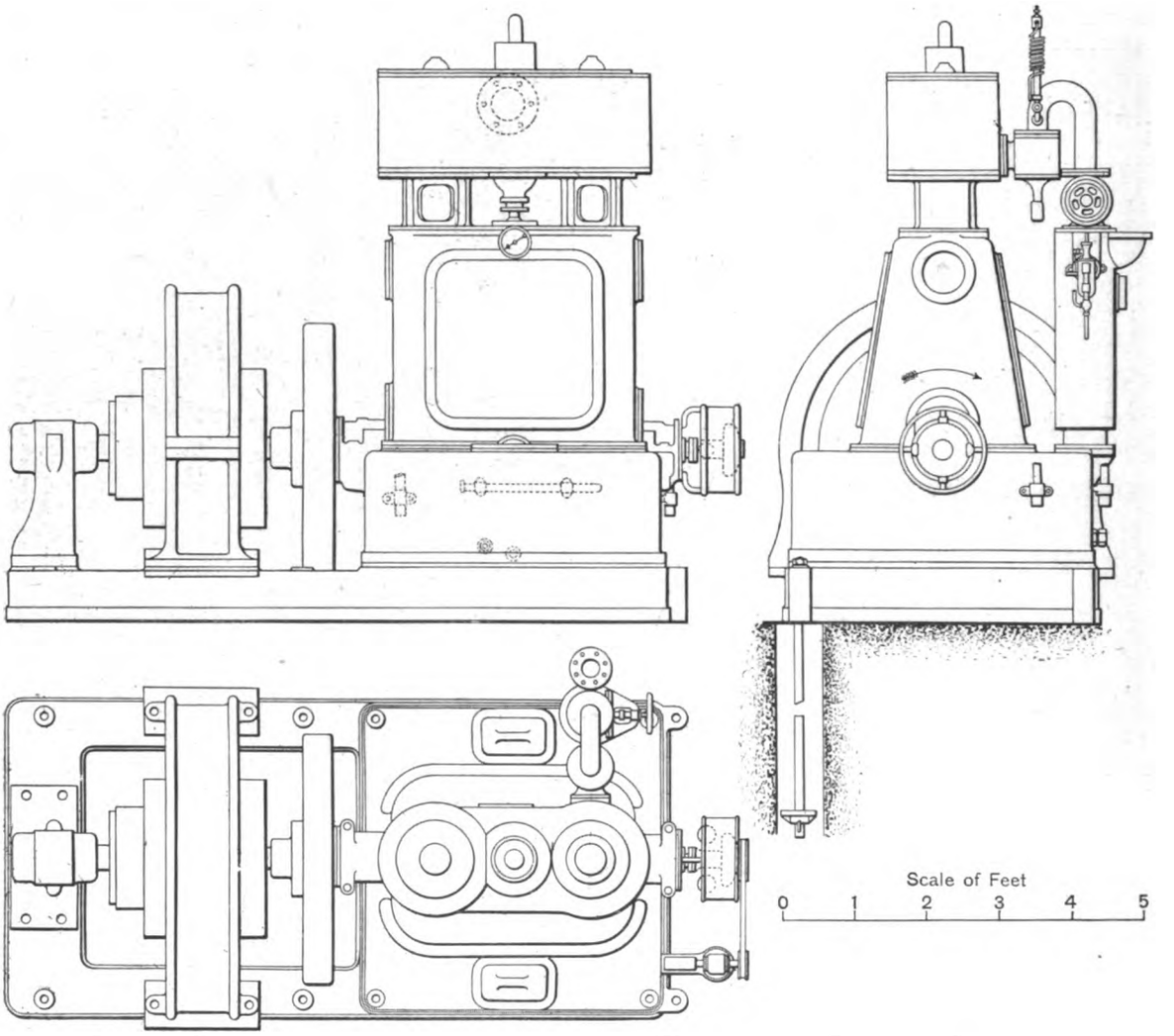
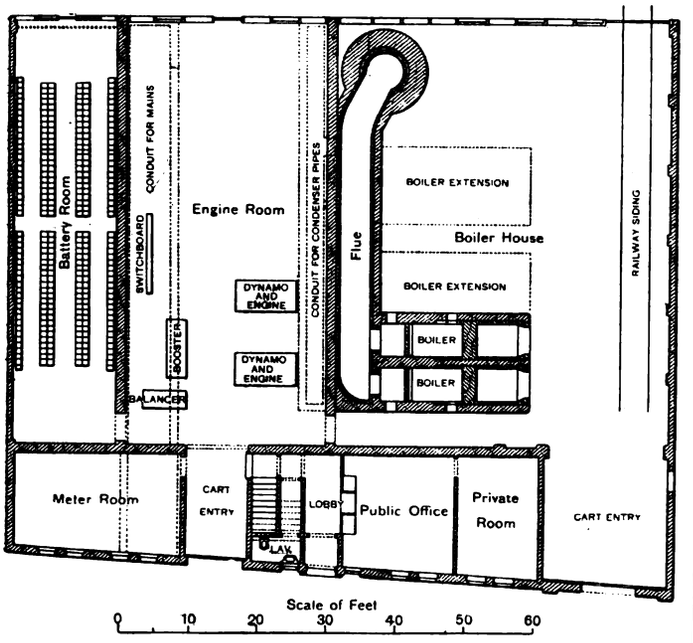
charge of the field when breaking. These switches are interlocked with the automatic switch in the armature circuits of their respective dynamos, so that the automatic switch cannot be closed until the field circuit is complete, and the field-circuit can not be broken until the armature circuit is open.

The battery regulators are placed in the battery room, which is directly behind the switchboard, the spindle only of the regulator coming through to the front of the board, with a wheel and a pointer indicating the number of the cell with which the switch of the regulator is making contact. The regulating switches in the battery room are enclosed in an acid-proof case with a glass front. The 'bus bar of each regulator is connected to the middle wire of the system through the meter, ammeter, two-way switch, and emergency switch. Two reversible ampere-hour meters for 60 amperes, reading up to 1,000 ampere-hours, are fitted to record the charge and discharge of the two batteries. There are also two recording voltmeters for 250 volts, with suitable connections to the potential leads for indicating the pressure at any feeding point. All the connections between the battery regulators and the cells are made with bare copper rod supported upon insulators attached to the walls. The connections with the switchboard and the various machines are made with india-rubber-covered cable.



PLAN AND ELEVATIONS SHOWING GENERAL ARRANGEMENT OF 150 I.H.P. BELLISS ENGINE AND GENERATOR.



GOVAN MUNICIPAL ELECTRIC SUPPLY STATION (PLAN).

The battery was supplied and erected by the Tudor Accumulator Co., and consists of L.A. type cells of the latest pattern. The cells are carried on four long stands, and are all on one tier only, with a clear passage between each row. They are contained in glass boxes, and the plates are burnt on to the connecting bars.

The cables, of which there are about 28 miles, were manufactured by the Callender Co., and consist of single-fibre, insulated, lead-covered, lock-coil, armoured cables, laid direct in the ground; and it is interesting to note that the whole of them were laid by the burgh's own employés, under the supervision of Mr. Arnot.

The street lighting in the two important thoroughfares—viz., Govan-road and Paisley-road West—has been undertaken by the electricity department: 85 arc lamps replace 296 gas lamps formerly in use. The arc lamps were supplied by Messrs. Crompton and Co., and are of their double carbon long

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type. The arc lamp pillars are of neat design and were supplied by Messrs. James Allen (Senr.) and Son.

The original intention was to spend about £18,000 on the station and plant, but the total cost of the installation will come out at about £26,000, something like £8,000 more than was originally estimated.

We give below a list of the contractors and manufacturers who have supplied plant, &c., for these works :—

Boilers	Babcock and Wilcox.
Injector	Shaffter and Brudenburg.
Feed pump	Blake & Knowles Steam Pump Works
Pump motor	British Thomson-Houston Co.
Steam pipes	John McNeil and Co.
Steam pipe covering	Reid, McFarlane, and Co.
Engines	Belliss and Morcom.
Dynamos, balancer, boosters, &c.	British Thomson-Houston Co.
Switchboard	Edison and Swan Company.
Battery	Tudor Accumulator Co.
Cables	Callender's Cable & Construction Co.
Arc lamps	Crompton and Co.
Arc lamp pillars	James Allen (Senr.) and Son.

VENTNOR ELECTRICITY SUPPLY WORKS.

The station which Messrs. Edmundsons' Electricity Corporation have built at Ventnor, Isle of Wight, follows the same lines as those they have erected in other small towns. A provisional order was granted to the Urban District Council in 1897, and transferred to the Ventnor Electric Light and Power Co. in the following year, Messrs. Edmundsons finding all the capital required for the erection of the station. The works have been in operation since last March. At present the company's operations are confined to a comparatively small area, but provisional orders have been acquired for the lighting of Sandown, Shanklin, and Newport, and, in addition, negotiations are in progress for the transfer of the order held by the Cowes District Council. The Ventnor Co. are also applying this session for an order for the parish of Bonchurch, which adjoins Ventnor.

The system employed is that invariably adopted by Messrs. Edmundsons—viz., a 2 × 210 volts three-wire system—and the equipment of the station is almost identical with the others they have built. Some difficulty was found in obtaining an appropriate site for the works, and eventually they had to be built in the position shown in Fig. 1, it being necessary to blast away portions of the rock behind to make room for them. Even then, as seen by the plan, Fig. 2, the various rooms had to be placed in a somewhat unusual position relatively to each other, and at peculiar angles, in order to fit the site obtained.

In the boiler house are two Babcock and Wilcox boilers, each with a heating surface of 1,265 sq. ft., and a feed heater and purifying drum built by the same firm capable of dealing with 6,000lb. of water per hour. The feed water is obtained from the town mains, and is very hard. There are two Worthington feed pumps, capable of supplying 10,000lb. of water per hour. No economiser is employed. Ring steam mains are used, of wrought steel, with welded seams and heavy forged flanges screwed on hot and brazed. The feed pipes are in duplicate and allow either pump to supply either boiler, and in addition, there is a bye-pass for the feed heater. The boilers and pipes are covered with "Magnesia" lagging.

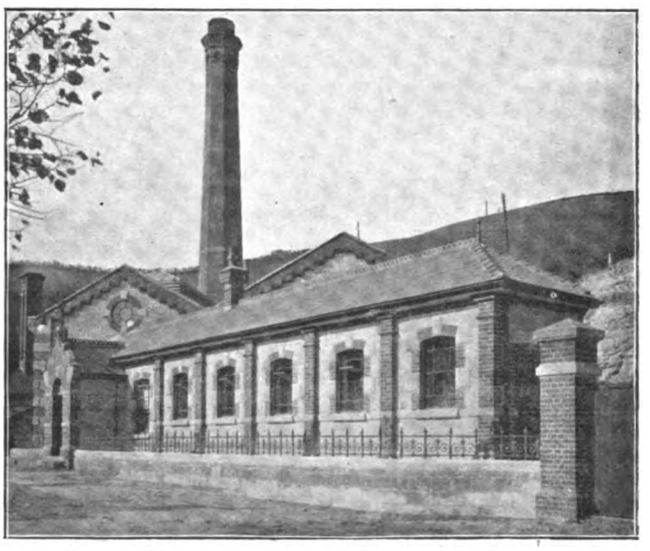

FIG. 1.—VIEW OF THE VENTNOR ELECTRICITY WORKS.

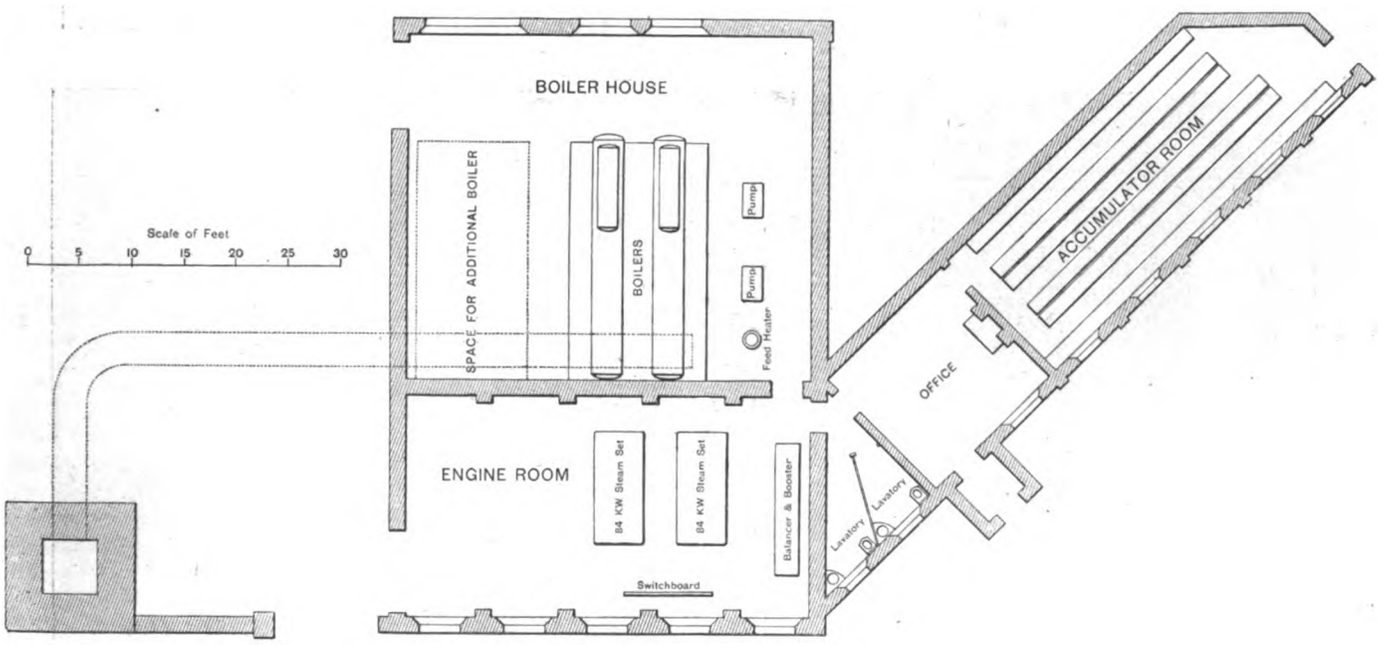

FIG. 2.—PLAN OF VENTNOR ELECTRICITY WORKS.

A view of the engine room is seen in Fig. 3. It contains two E.C.6 Belliss engines, each of 120 B.H.P., running at 420 revs. per min., and coupled to 84 kw. Parker dynamos, each designed for 180 amperes at 410 to 440 volts. A combined booster and balancer set in the engine room is not seen in the illustration. It is of Messrs. Parker's make, the balancer being capable of supplying a make-up current of 50 amperes, and the boosters of raising the pressure by 70 volts for a current of 70 amperes.

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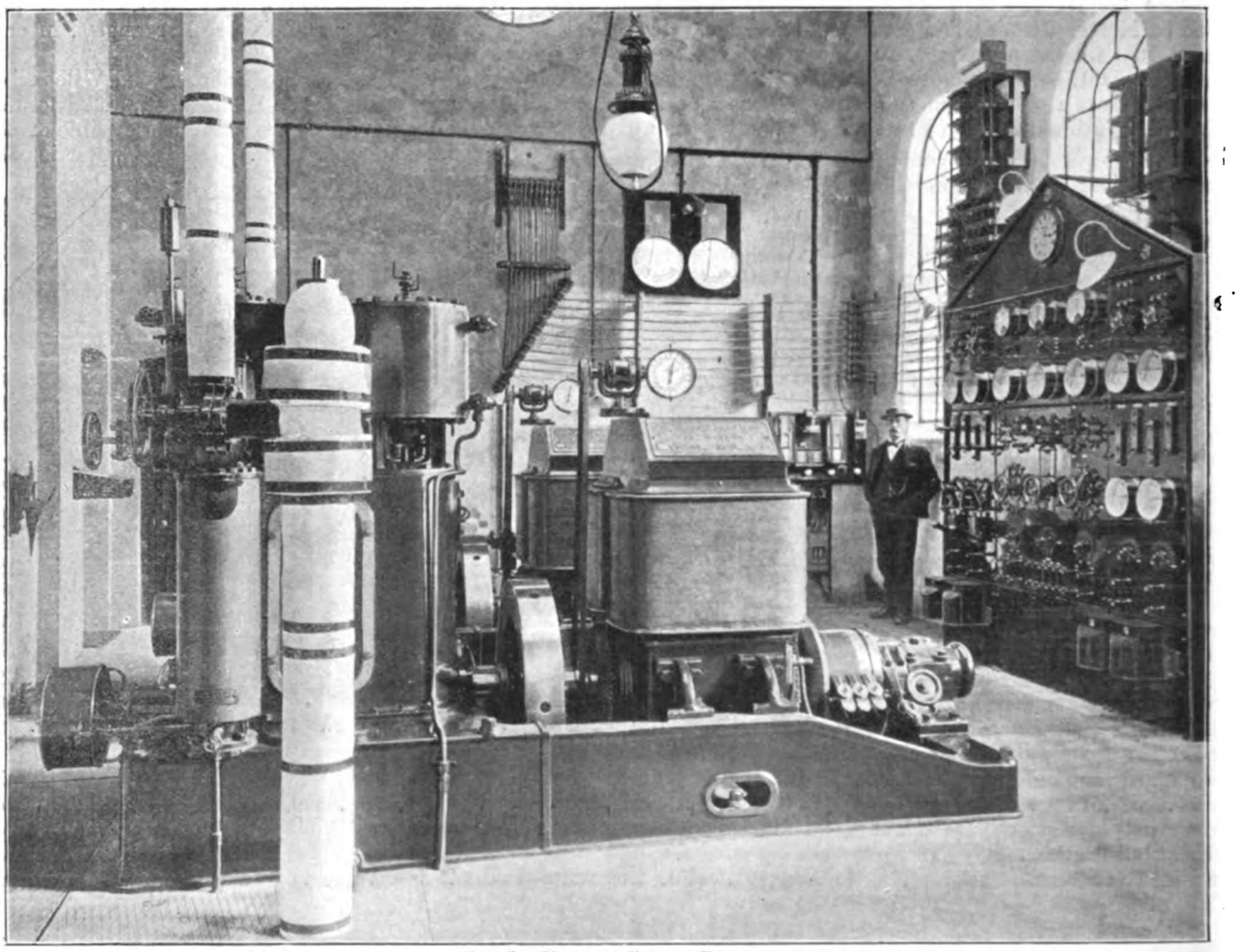

FIG. 3.—VIEW OF ENGINE ROOM.

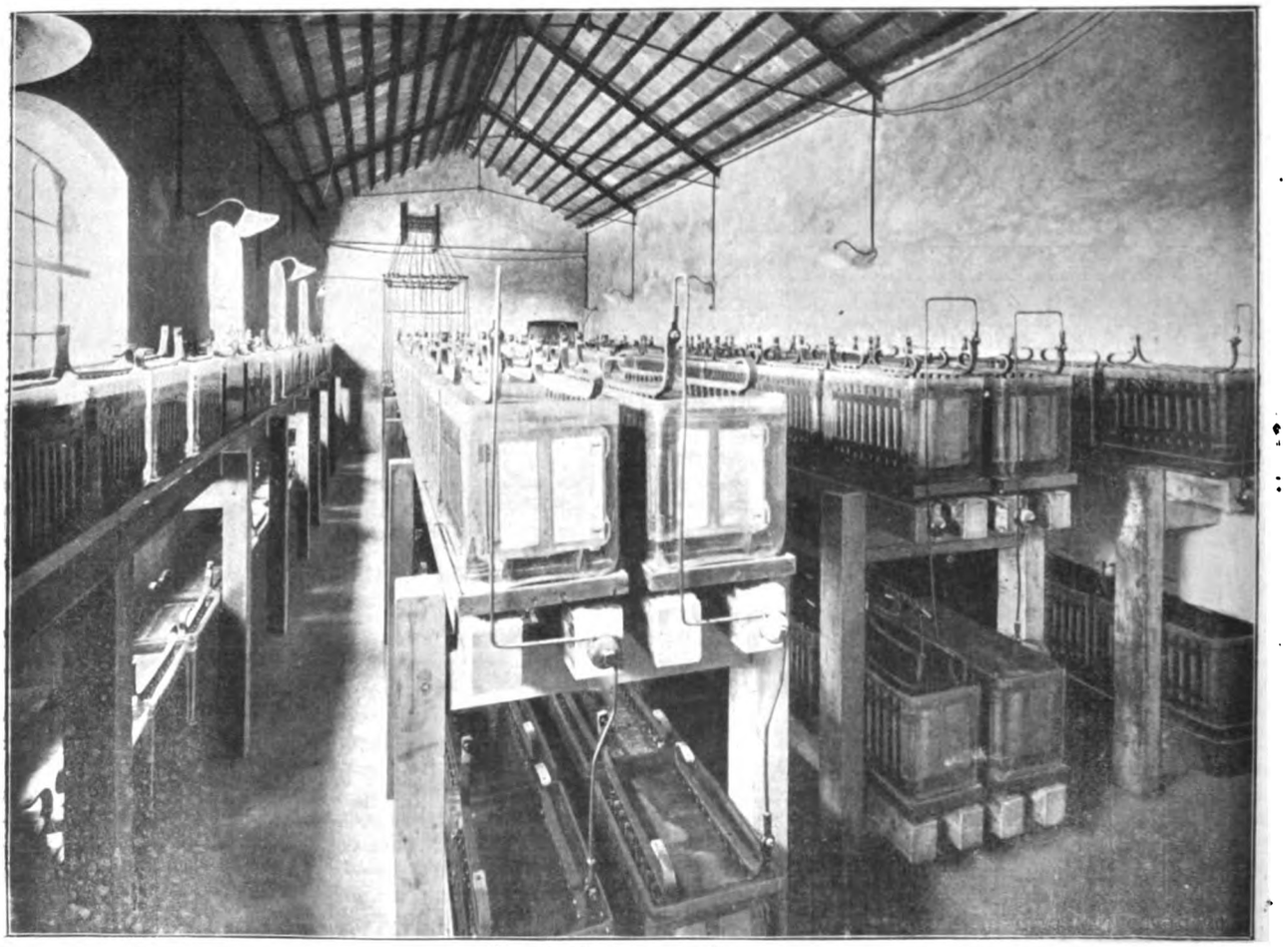

FIG. 4.—ACCUMULATOR ROOM.

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The switchboard is of Messrs. Edmundsons' standard type, so frequently illustrated in our columns, and is arranged for two dynamos and feeders. The instruments are of the Kelvin type.

Fig. 4 shows the accumulator room, in which are 220 19-plate D.P. cells, with a capacity of 480 hours at 55 amperes discharge, and capable of discharging at 80 amperes without injury. The wires connecting the cells to the switchboard are bare and run on insulators.

As already mentioned, the area of supply is not a very extended one at present. The works adjoin the railway station, and are at the edge of the district. Nevertheless, they are within half a mile or less of all their consumers, with the exception of the National Hospital for Consumption (by far the largest consumer), which is a mile distant. In Ventnor itself are two feeding points, and there is a special feeder running to the hospital. The latter is triple concentric, and as it runs through chalky ground, a lead-covered and braided cable was chosen, laid in a wooden trough run in "solid" with bitumen. All the other mains are laid directly in the ground, the feeders being concentric and the distributors three-core, and all are of Messrs. Callender's manufacture. At the end of the year 1899 there were 3,730 8 c.p. lamps or equivalent connected to the mains, exclusive of 16 10 ampere open arc lamps and 65 25 c.p. incandescent lamps now being erected for the entire lighting of the area. The first contract for street lighting consisted of eight 10 ampere open arc lamps and about 86 incandescents of 25 c.p. each. The station is already to be enlarged, and the following plant is on order: A Babcock and Wilcox boiler, with 2,437 sq. ft. heating surface; an E.C.10 Belliss engine of 250 B H.P., at 380 revs. per min.; and a Parker dynamo, 380 amperes at 420 to 460 volts. The switchboard is to be extended to suit.

The charge for lighting is on the Wright system, at 7d. for the first hour and 4d. afterwards, and for power an all-round rate of 4d. Ferranti meters are in use. The company has done most of the wiring in the town, and has employed the "Simplex" conduit to a considerable extent. Gas is supplied to the district by the Ventnor Gas and Water Co. at 4s. 6d. per 1,000 cubic feet.

Our thanks are due to Messrs. Edmundsons, who have put information at our disposal and supplied us with the photographs from which our illustrations are made, and to Mr. A. E. Mayes, the resident engineer, for his courtesy to us when we visited the station while it was in process of erection last spring.

PHYSICAL SOCIETY.

At an ordinary meeting, held Jan. 26, Prof. Lodge, F.R.S., President, in the chair,

A Paper by Prof. AYRTON and Mr. MATHER, on

"Some Developments in the Use of Price's Guard Wire in Insulation Tests,"

was read by Prof. AYRTON.

For insulation tests made by the direct deflection method the guard wire properly applied affords complete protection against surface leakage when the ends of the cable tested are near the galvanometer, so that it is possible to have the wire connecting the conductor of the cable with the galvanometer terminal "air insulated." A difficulty, however, arises when the ends of the cable are at a considerable distance from the testing instrument; this may render air insulation impossible. The authors have overcome this difficulty by applying a guard wire along the entire length of the lead. This is done by using a concentric wire to connect the cable and galvanometer, the inner of the concentric being used as the lead and the outer as the guard wire. The principle can also be applied to determine whether a defective piece of cable is bad throughout or bad owing to one or more isolated faults. In this case the cable is placed in two water tanks, one of which is earthed and the other fairly well insulated. By a suitable arrangement of the guard wire it is then easy to determine the resistance of the wire in the earthed tank, so that by altering the length of this wire the character of the insulation can be determined throughout the whole length of the cable. In referring to some of the earliest experiments with the guard wire made by Mr. Appleyard in 1895, Prof. Ayrton pointed out that the principle had not been applied completely, and that at one point there was a chance of leakage.

Mr. CAMPBELL said that the necessity of having a concentric could be obviated by simply hanging the lead from the guard wire by short lengths of material of fair insulation.

Mr. APPLEYARD said that he quite agreed with Prof. Ayrton that the guard wire ought in general to be applied at both ends of all leads, provided that both ends could be got at. The reason it was used at one end only in the experiments on dielectrics made in 1895 was that the far end of the lead was carried into the condenser box, which was submerged in water in the temperature tank. Special precautions were taken to ensure good insulation of the submerged end of the lead, and tests showed that the leakage there was nil. As the end of the wire could not be got at, no guard wire could be applied. He congratulated the authors upon the use of a concentric cable for a lead, and pointed out that such a lead was sufficient for all the routine tests on core; the inner and outer conductors could be used for the purpose of taking the "copper" resistance

Mr. PRICE expressed his interest in the developments of his principle which had been made by the authors.

Mr. APPLEYARD then read a Paper on

"A Fault-Test for Braided and other Cable-Core."

This method enables the fault to be found without the removal of braiding or tape. The core is wound on two insulated drums or tanks, the intermediate piece of cable being about 10ft. long. One end of the core is left free, the other is connected to earth through a galvanometer and a battery. A guard wire is connected from some point between the galvanometer and the battery to some point of the braiding on the wire between the drums. A wet cloth connected to an earth wire is laid on one or other of the drums, over the braiding. The galvanometer deflection is noted. The earth wire is then changed over to the second drum, and the corresponding deflection is observed. A comparison of these deflections at once indicates upon which drum the fault lies. With the galvanometer still deflected, the core may be run through a suitable contact brush or sponge attached to the guard wire. The instant the fault passes under the guard wire contact, the deflection falls and the fault is located. The Paper gives the theory of the method and indicates how to apply it (1) to localising "distributed" faults, (2) to several faults in a single cable, and (3) to the case of a single fault. One advantage of the method is that at the critical moment when the fault passes under the guard wire the galvanometer is short-circuited through the fault and thus completely protected.

A Paper on

"Reflection and Transmission of Electric Waves along Wires,"

by Dr. E. BARTON and Mr. L. LOWNDS, was read by Dr. BARTON.

The waves used were produced by means of an induction coil and an oscillator, and travelled along wires 0·15cm. diameter, 8cm. apart, and 166 metres long. The ends of the wires were connected by graphite markings on ground glass, so that any wave trains which reached the ends were at once absorbed. Three circular parallel-plate condensers were used, of 15cm., 9cm., and 5cm. radius respectively. The plates were in all cases separated by air, and were placed 1cm. apart. The needle of the electrometer connecting the wires was uncharged, so that it was always attracted by the charged plates. The positions of the condenser and electrometer could be varied so as to study either the reflected or the transmitted waves. The electrometer produced a negligible disturbance, as it reflected only 0·04 per cent. of the energy incident upon it. The authors have attacked the problem mathematically, using the relations of Heaviside, and have obtained expressions for the reflected and transmitted systems. These expressions consist of two terms, one of which is comparatively unimportant. From the other term certain values have been calculated. A superior limit has then been given to the other term, and the values already obtained have been subjected to a correction on this account. By a suitable arrangement of the condenser and electrometer these calculated values have been experimentally determined, and are in close agreement with the theoretical numbers, falling in many cases between the results derived from the approximate and the corrected theories. The authors have also investigated the stationary wave system produced by interference when the electrometer is placed close to the condenser and between the condenser and the oscillator.

The CHAIRMAN said that the experiments afforded a satisfactory verification of Heaviside's theory.

A Paper on

"The Frequency of Transverse Vibrations of a Stretched Indiarubber Cord,"

by Mr. T. J. BAKER, was taken as read.

In this Paper Mr. Baker has investigated the frequency of the note given out by an indiarubber cord of square section when subjected to different tensions. The relation between length and tension is linear over a considerable range. The curve connecting length with frequency shows that while the cord was doubling its length the pitch was rising rapidly, but that further extension was practically without effect. Since the relation between length and tension is linear, while the sectional area is decreasing it follows that the value

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of Young's modulus must be changing. The author has shown that the value of Young's modulus is proportional to the square of the stretched length of the cord. Using this fact the frequency of the note given out by a stretched indiarubber cord is shown to be proportional to a quantity which varies very slightly with increase in length of the cord, and hence the variation in elasticity is given as the cause of the constancy of the note.

Mr. APPLEYARD exhibited some mirrors produced inside incandescent electric lamps by the application of voltages much above those for which the lamps were designed, and the consequent deflagration of the filaments. The meeting then adjourned until Feb 9.

BOOKS RECEIVED.

(Copies of any of the undermentioned works can be had from *The Electrician* office post free, on receipt of published price.)

"Stained and Leaded Glass." By W. T. Whitehead. (London: Dawbarn and Ward.) 6d.

"*Proceedings* of the Royal Society." No. 422, Vol. LXV. (London: Harrison and Sons.) 2s. 6d.

"Generatoren, Motoren und Steuerapparate für Elektrisch Betriebene Hebe-und Transportmaschinen." By Dr. F. Niethammer, assisted by E. Veesenmeyer. (Berlin: Julius Springer.) 20m.

"American Telephone Practice." By Kempster B. Miller. (New York: American Electrician Co.)

"Laboratory Note Book for Chemical Students." By Vivian B. Lewes and J. S. S. Brame. (Westminster: Archibald Constable and Co.) 4s.

"Transmission de l'Electricité sans Fil." By Emile Guarini Foresio. 2nd edition. (Liège: Henri Poncelet.) 2fr.

"Artificial Wood and Shavings in Decoration." By C. G. Leland and the Rev. F. C. Lambert. (London: Dawbarn and Ward. 6d.

"The Official Gazette of the United States Patent Office." Nos. 2 and 3, Vol. XC. Published by authority of Congress. (Washington: Government Printing Office.)

ELECTRICITY WORKS ACCOUNTS.

Hastings and St. Leonards-on-Sea Electric Light Co. (Ltd.).

Although the public lighting at Hastings and St. Leonards was acquired by the Corporation at an earlier date than that on which the private lighting undertaking was taken over—viz., July 1, 1898—yet, in order to present an intelligible and comparable statement of the accounts, the public and private lighting figures have been conbined in the analysis which we give in our first table.

The purchase price paid on sale of the undertaking was £58,000, while £3,200 was the sum already paid by the Corporation for the "Front" lighting installation.

As may be gathered from the following table showing some of the past results, the amount by which the output of 1898 exceeded that of 1897 indicates an unfortunate falling off in the rate of progress which had previously characterised the concern. Thus, the output in units sold of 1897 was over 15 per cent. higher than that of 1896; but in 1898 the business done, as measured by the output of 363,678 units sold, showed an increase of only 7·4 per cent. Unfortunately, in other respects there has been a retrogression, which, however, is very likely largely due to conditions brought about by the piecemeal transfer of the undertaking:—

Year.	Output.	Equivalent lamp connections.	Load factor.	Revenue per unit sold.	Total costs per unit sold.	Working profit.	Dividend.
1895	265,846	9,667	...	5·76d.	4·64d.	£1,246	nil
1896	283,100	10,061	12·6	5·92d.	4·37d.	1,894	nil
1897	338,705	13,418	12·5	6·30d.	3·86d.	3,426	6 %
1898	363,678	14,817	12·7	6·76d.	4·28d.	3,302	7½%

Looking down the column of costs, the various items of generating costs all present values which are above the average, especially the items of "fuel" and "oil, waste, water, stores."

The result is, of course, that not only are the aggregate generating costs abnormal, but so also are the total works costs—the latter standing at about 1·55d. in excess of the average. It is satisfactory to find that, although the management and property charges have increased, they have not yet risen above what they should be.

A slight increase in the total revenue has helped to keep the working profit from showing a very excessive fall, so that with the balance of £58 brought forward from 1897, and after satisfying the interest charges of £1,309, there remained a balance available for distribution of £2,051. This net profit, sufficient for a dividend of 7½ per cent. on the ordinary share capital of £27,220, was disposed of by being added to the profit on the sale of the undertaking, thus realising to the ordinary shareholders a total dividend of £2. 3s. per £10 share.

Eastbourne Electric Light Co. (Ltd.).

It is satisfactory to be able to record figures for the Eastbourne undertaking showing that in all salient points the concern is making excellent headway. The output of 1898 exceeded that of 1897 by 67,231 units, marking an advance of about 28 per cent., while the addition of 117 new consumers with the equivalent of 3,740 8 c.p. lamps promises well for the future. The items of generating costs have either remained practically constant or have fallen, but all except "repairs and maintenance at station" still show figures above the average under similar conditions as regards output and load factor—the value of the latter being in 1897 10·7, and in 1898 11·38 per cent. We should like to see the works and total costs about 0·4d. per unit below their present values, though doubtless the situation of Eastbourne precludes the possibility of much lower fuel costs. The management and property charges stand at a very reasonable figure.

As the result of the year's operations, the working profit was £1,574, representing 8·24 per cent. of the mean capital expended. Of this gross profit £400 was again placed aside to the depreciation fund, while £1,370 was paid as interest. Nothing, however, was allocated to the sinking fund, so that, with the balance of £451 brought forward from 1897 and £421 premiums on preference shares, there remained a balance of £3,676 for division, out of which a dividend of 12½ per cent. for the year was paid.

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

Aberdeen (Municipal)	Jan.	12, 1900	Lancaster (Municipal)	Jan.	19, 1900
Ayr (Municipal)	Sept.	22, 1899	Leeds (Municipal)	Dec.	1, 1899
Bedford (Municipal)	May	19, ,,	Leicester (Municipal)	Jan.	26, 19 0
Belfast (Municipal)	Sept.	15, ,,	Leyton (Municipal)	Sept.	8, 1899
Birmingham (Company)	Sept.	15, ,,	Liverpool (Municipal)	June	9, ,,
Blackburn (Municipal)	Jan.	19, 1900	Manchester (Municipal)	Aug.	11, ,,
Blackpool (Municipal)	Sept.	29, 1899	Newcastle and District (Co.)	Oct.	6, ,,
Bournemouth (Company)	April	28, ,,	Newcastle-upon-Tyne (Co.)	April	14, ,,
Bolton (Municipal)	Nov.	24, ,,	Newport (Mon.) (Municipal)	Dec.	15, ,,
Bradford (Municipal)	April	14, ,,	Northampton (Company)	Oct.	20, ,,
Brighton (Municipal)	May	12, ,,	Norwich (Company)	Nov.	17, ,,
Bristol (Municipal)	July	14, ,,	Notting Hill (Company)	Mar.	17, ,,
Burnley (Municipal)	Aug.	25, ,,	Nottingham (Municipal)	July	21, ,,
Burton-upon-Trent (Mun.)	April	21, ,,	Oldham (Municipal)	Dec.	1, ,,
Bury (Municipal)	Sept.	22, ,,	Oxford (Company)	May	19, ,,
Cambridge (Company)	Mar.	10, ,,	Pontypool (Company)	May	5, ,,
Cardiff (Municipal)	Dec.	15, ,,	Portsmouth (Municipal)	July	14, ,,
Charing Cross (Company)	Mar.	17, ,,	Prescot (Company)	Dec.	8, ,,
Chelsea (Company)	Mar.	31, ,,	Preston (Company)	Sept.	29, ,,
Cheltenham (Municipal)	Nov.	10, ,,	Reading (Company)	Oct.	13, ,,
Chester (Municipal)	June	23, ,,	Richmond (Company)	Oct.	13, ,,
City of London (Company)	May	12, ,,	Scarborough (Company)	Nov.	3, ,,
Clerkenwell (Company)	Aug.	18, ,,	St. Helens (Municipal)	Dec.	8, ,,
Derby (Municipal)	Jan.	26, 1900	St. James' & Pall Mall (Co.)	Feb.	24, ,,
Dewsbury (Municipal)	Nov.	24, 1899	St. Pancras (Vestry)	May	26, ,,
Dover (Company)	June	2, ,,	Sheffield (Municipal)	Dec.	29, ,,
Dundee (Municipal)	Jan.	12, 1900	Shoreditch (Vestry)	Oct.	27, ,,
Eastbourne (Company)	July	22, 1898	Southampton (Municipal)	Nov.	10, ,,
Edinburgh (Municipal)	Nov.	17, 1899	Southport (Municipal)	July	7, ,,
Exeter (Municipal)	Aug.	5, 1898	South Shields (Municipal)	July	7, ,,
Glasgow (Municipal)	Sept.	1, 1899	Stafford (Municipal)	Dec.	29, ,,
Guildford (Company)	May	5, ,,	Sunderland (Municipal)	July	28, ,,
Halifax (Municipal)	July	21, ,,	Taunton (Municipal)	June	16, ,,
Hammersmith (Vestry)	May	26, ,,	Tunbridge Wells (Mun.)	Sept.	1, ,,
Hampstead (Vestry)	Aug.	25, ,,	Wakefield (Municipal)	Dec.	1, ,,
Hanley (Municipal)	April	28, ,,	Walsall (Municipal)	June	23, ,,
Harrogate (Municipal)	Oct.	20, ,,	Wandsworth (Company)	Aug.	19, ,,
Harrow (Company)	June	16, ,,	Westminster (Company)	Feb.	24, ,,
Hast'gs & St. Leonards (Co.)	April	29, 1898	Whitehaven (Municipal)	July	28, ,,
H'use-to-H'useCo. (K'ns'gt'n)	Mar.	31, 1899	Windsor (Company)	Dec.	22, ,,
Hove (Company)	Mar.	10, ,,	Woking (Company)	Dec.	22, ,,
Huddersfield (Municipal)	Oct.	6, ,,	Wolverhampton (Municipal)	June	30, ,,
Islington (Vestry)	Oct.	27, ,,	Woolwich (Company)	Jan.	13, ,,
Kensington & Knightsbr'(Co.)	Mar.	8, ,,	Worcester (Municipal)	April	7, ,,
Kingston-upon-Hull (Mun.)	June	9, ,,	Yarmouth (Municipal)	Nov.	8, ,,
Kingston-on-Thames (Mun.)	April	21, ,,			

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	HASTINGS & ST. LEONARDS.		EASTBOURNE.	
Undertaking Worked by	Hastings and St. Leonards-on-Sea Electric [Light Co. (Ltd.)		The Eastbourne Electric Light Co. (Ltd.) [street boxes.	
Date of Commencement of Supply	1893.		1882.	
System of Supply	Alternate-current transformers.		H.T. alternate-current with trans. in houses and	
Chief Engineer	L. Andrews.		Henry Wall Wilkinson.*	
YEAR ENDED	DEC. 31, **1897.**	DEC. 31, **1898.**	DEC. 31, **1897.**	DEC. 31, **1898.**
QUANTITIES—				
Units generated	466,362	521,000	402,068	466,688
„ SOLD (TOTAL)	338,705	363,678	240,806	308,037
„ sold to consumers	213,873	239,580	218,404	284,924
„ sold for public lighting, &c.	124,832	124,098	22,402	23,113
„ used on works	5,000	—	10,876	10,530
UNITS SOLD PER 8 C.P. LAMP CAPACITY	28·9	31·0	16·8	19·4
Maximum supply demanded	310 kilowatts	326 kilowatts	257 kilowatts	310 kilowatts
Number of public lamps	52 arc	53 arc	25 arc	25 arc
Number of consumers	—	294	283	400
Connections to mains in 8-c.p. lamps	13,418	14,817[f]	19,288	23,028
CAPACITY OF PLANT IN 8-C.P. LAMPS	11,700	11,700	14,360	15,900
CAPACITY OF PLANT IN KILOWATTS	375	375	460	510
CAPITAL—	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.
AUTHORISED (TOTAL)	£50,000 / £133	— / —	£50,000 / £109	£50,000 / £98
Share	50,000 / 133	— / —	50,000 / 109	50,000 / 98
Loan (including Debenture charges)	— / —	— / —	— / —	— / —
RECEIVED (TOTAL)	50,470 / 135	— / —	47,990 / 104	53,605 / 105
Share	27,220 / 72·6	— / —	19,490 / 42·3	25,105 / 49·2
Loan (including Debenture charges)	23,250 / 62	— / —	28,500 / 62·0	28,500 / 55·9
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	22,780 / 60·8	— / —	2,010 / 4·37	— / —
Share (unissued)	22,780 / 60·8	— / —	— / —	— / —
Share (uncalled)	nil / —	— / —	— / —	— / —
Loan (including Debentures)	— / —	— / —	— / —	— / —
REPAID (TOTAL)	— / —	— / —	— / —	— / —
RESERVE OR SINKING FUND	76 / 0·203	— / —	2,838 / 6·17	3,250 / 6·38
DEPRECIATION FUND	503 / 1·34	— / —	3,025 / 7·06	3,391 / 6·65
EXPENDED (TOTAL)	54,735* / 146	—[a] / —	53,543 / 116·4	57,538 / 113
Lands and buildings	— / —	— / —	7,683 / 16·7	7,726 / 15·1
Plant	— / —	— / —	26,736 / 58·2	29,019 / 56·9
Mains	— / —	— / —	12,485 / 27·2	14,020 / 27·5
Miscellaneous	— / —	— / —	6,630 / 14·4	6,773 / 13·3
BALANCE OF CAPITAL ACCOUNT	−4,265[b] / −2·84	— / —	−5,553[a] / −12·1	−3,933[a] / −7·72
REVENUE—	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.
TOTAL	£8,881 / 6·30d.	£10,247 / 6·764d.	£8,003 / 7·980d.	£9,449 / 7·354d.
Revenue from supply	8,735 / 6·19d.	7,643 / 5·040d.	6,734 / 6·710d.	8,140 / 6·340d.
„ meters, &c.		— / —	297 / 0·296d.	307 / 0·239d.
„ public lighting		2,476[h] / 1·633d.	736 / 0·734d.	752 / 0·585d.
„ sale of lamps, &c.		— / —	1 / 0·001d.	42 / 0·033d.
„ miscellaneous sources	146 / 0·101d.	128 / 0·085d.	235 / 0·235d.	207 / 0·161d.
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	£5,455 / 3·86d.	£6,946 / 4·580d.	£4,385 / 4·370d.	£4,874 / 3·793d.
WORKS COSTS	4,486 / 3·18d.	5,539 / 3·653d.	3,421 / 3·410d.	3,809 / 2·964d.
Generation of electricity	*3,908 / 2·77d.*	*4,905 / 3·235d.*	*2,883 / 2·870d.*	*3,192 / 2·484d.*
Fuel (including cartage, &c.)	2,213 / 1·57d.	2,899 / 1·912d.	1,334 / 1·330d.	1,717 / 1·336d.
Oil, waste, water, stores	201 / 0·142d.	402 / 0·265d.	279 / 0·278d.	274 / 0·213d.
Wages at station	791 / 0·560d.	967 / 0·638d.	972 / 0·969d.	950 / 0·740d.
Repairs and maintenance at station	703 / 0·498d.	637 / 0·420d.	298 / 0·297d.	251 / 0·195d.
Distribution of electricity	*229 / 0·162d.*	*188 / 0·124d.*	*446 / 0·445d.*	*498 / 0·388d.*
Wages, &c.	89 / 0·063d.	105 / 0·070d.	197 / 0·196d.	225 / 0·175d.
Repairs, renewals of mains, &c.	139 / 0·099d.	82 / 0·054d.	249 / 0·248d.	274 / 0·213d.
Public lighting	*349[c] / 0·248d.*	*446 / 0·294d.*	*82 / 0·082d.*	*119 / 0·093d.*
Attendance	346 / 0·245d.	446 / 0·294d.	82 / 0·082d.	119 / 0·093d.
Renewals	3 / 0·002d.			
MANAGEMENT AND PROPERTY CHARGES	969 / 0·687d.	1,407 / 0·929d.	974 / 0·971d.	1,065 / 0·830d.
Royalties	*nil* / —	— / —	— / —	— / —
Rent, rates, taxes	*295 / 0·209d.*	*491 / 0·324d.*	*292 / 0·291d.*	*301 / 0·234d.*
Management	*674 / 0·478d.*	*916 / 0·604d.*	*682 / 0·680d.*	*764 / 0·595d.*
Salaries	456 / 0·323d.	598 / 0·394d.	437 / 0·436d.	513[e] / 0·399d.
Stationery, &c.	39 / 0·028d.	69 / 0·046d.	49 / 0·049d.	44 / 0·034d.
Establishment charges	47 / 0·035d.	77 / 0·051d.	66 / 0·066d.	78 / 0·061d.
Law charges, &c.	131[d] / 0·093d.	172[g] / 0·113d.	130[b] / 0·130d.	129[f] / 0·100d.
FINANCIAL RESULTS—	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded
WORKING PROFIT FOR YEAR	£3,426 / 6·62%	£3,302 / 6·03%	£3,619 / 7·00%	£4,574 / 8·24%
Sum carried to Depreciation Fund	nil / —	— / —	400 / 0·774%	400 / 0·720%
Sum carried to Reserve or Sinking Fund	nil / —	— / —	412 / 0·798%	nil / —
Net interest on loans (incl. Debenture charges)	1,318 / 2·59%	1,309 / 2·39%	1,373 / 2·66%	1,370 / 2·47%
BALANCE FROM LAST ACCOUNT	−116 / 0·224%	58 / 0·106%	479 / 0·927%	451 / 0·812%
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	1,991 / 3·84	2,051[i] / 3·75%	1,913 / 3·70%	3,676[g] / 6·62%
Deficit	— / —	— / —	— / —	— / —
ORDINARY DIVIDEND PAID	6% / —	—[i] / —	7½% / —	12½% / —
PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE	61·4%	67·8%	54·8%	51·6%
Expenditure per kilowatt capacity	£14. 10s. 0d.	£18. 10s. 0d.	£9. 10s. 10d.	£9. 11s. 2d.
REVENUE PER KILOWATT CAPACITY	£23. 13s. 2d.	£27. 6s. 0d.	£17. 8s. 0d.	£18. 10s. 0d.
Expenditure per 8-c. lamp capacity	9s. 3½d.	11s. 10½d.	6s. 1½d.	6s. 1½d.
REVENUE PER 8-C.P. LAMP CAPACITY	15s. 2d.	17s. 5½d.	11s. 1½d.	11s. 10½d.
REVENUE PER 8-C.P. LAMP CONNECTED	13s. 2½d.	13s. 9½d.	8s. 3½d.	8s. 2½d.
Price charged for lighting, per unit	6d.	6d.[e]	8d.	7½d.
Price charged for power, per unit			—	—
Price charged for public lighting	—	—	£29. 8s. per lamp	By contract

HASTINGS AND ST. LEONARDS.—REMARKS—* Including £3,200 received from Corporation for purchase of "Front" lighting installation. *a* The total purchase price of the undertaking, including £3,200 paid for the "Front" lighting installation, was £61,200. *b* Over-expended. *c* Includes also some private arc lamps. *d* Includes £38 for auditing, £75 for insurance, and £15 bad debts. *e* *Plus* a charge of 1s. per quarter per 8 c.p. lamp. *f* Including 830 as the assumed equivalent in 8 c.p. lamps of the 53 arc lamps. *g* Includes £28 for auditing and £184 for insurance. *h* Includes £1,743 in respect of current consumed, and £733 actual [illegible]

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THE ELECTRIC WIRING OF BUILDINGS.

The Paper by Mr. W. A. Chamen, which we print in this issue in a slightly abridged form, although containing nothing of absolute novelty, yet furnishes an able review of the present status of house wiring, and a practical consideration of the advantages and defects of the several systems now in vogue. Omitting the history of the early stages of this industry, when cotton-covered wire fixed up with bell staples and connected to wooden switches and lamp-holders was deemed sufficient for the purpose, Mr. Chamen starts his critical review with a consideration of the much-abused "wood-casing" system. He rightly draws attention to the fact that it has done remarkably good service for many years, although it is now realised that it may be improved upon. Mr. Chamen considers the chief disadvantage of such casing to be that it affords too easy a means of hiding bad work; but in enumerating this and other disadvantages he hardly lays enough stress on the point that when bad work is executed on indiarubber-covered wires in wooden casing, not only is the risk of fire greater than, for instance, in iron barrel, but when once a fire is started in such a wiring system the danger of its spreading is considerable. This is important, for a workman whose habit it is to execute bad work and then to hide it will find a means of doing the latter almost whatever system is employed. As Mr. Chamen points out, proper supervision is essential; and here again the foreman who winks at bad work on one system would do the same on another system. It is in such a case the workman's and foreman's system that is at fault, not the wiring system. While agreeing that there are methods of wiring far preferable, the fact remains that excellent wiring can be done with wooden casing, and that in some instances this practice still offers advantages over others—*e.g.*, for "disguised" surface-work in ordinary dry rooms. For this purpose twin lead-covered wire also frequently lends itself admirably, and surface-work is certainly to be encouraged wherever permissible. We are of opinion that even the flexible wire run out of reach on small insulators, so much employed on the Continent, is as safe if not safer than much of the hidden casing and iron-barrel work carried out even at the present day, and it is undoubtedly cheaper. It is to be regretted that the fire offices, who do not prevent flexible wire being run from wall plugs on 200-volt circuits, with switches

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only on the consumer's end of the wire, should oppose the introduction of this simple and effective method of wiring.

For hidden wiring, whether in old buildings or in buildings in course of construction, the iron-barrel system is the one *par excellence*. The work of standardising a proper system of bends and joint-boxes has been done to some extent, we believe, but as regards the latter especially leaves much to be desired. With regular standard joints, bends, outlets, and boxes, and proper tools for cutting and ryming, the iron tube system should be able to compete in price with a properly-finished wood-casing system, especially in view of the fact, pointed out by Mr. CHAMEN, that in these days of trades unionism it is frequently necessary to employ for the latter two different classes of tradesmen. Cost is, in fact, a most important element in comparing systems of wiring, and therefore the various lead-covered systems require careful consideration. Their claims and drawbacks are clearly enunciated in Mr. CHAMEN's Paper; but, again, it must not be forgotten that the chance of electrically-caused fires is so small in any case that an increase or decrease of it by a small percentage may not be of very great import. It is possible to build and furnish a house entirely with non-inflammable material, but such is not the general practice.

Mr. CHAMEN, it appears, has a distinct leaning towards concentric systems. He is not quite accurate, however, when he states that no one has yet proposed a system of house wiring in which both of the two concentric wires are insulated. Such a system, designed by Mr. G. WILKINSON, has been employed in Harrogate, but we believe that its popularity has not extended far outside the sphere of influence of the electrical engineer to that Corporation. The modification proposed by Mr. CHAMEN, of employing a wrought-iron tube as the armouring, he admits himself introduces difficulties by increasing the number of joints necessary; and it is hard to see that it has any advantage over a lead-covered and armoured system laid without further protection. It is evident, however, that the necessity of uniting practically three concentric conductors at each joint materially increases the labour of erection, and consequently the cost of the system as a whole. No doubt insulated concentric systems are much simpler, but whether they can eventually be employed on public supply mains opens a large question. So long as the present rule is in force, that the middle wire of a three-wire system is to be earthed at the station, and at the station only, house-wiring with one pole bare cannot be employed on such systems. To prevent electrolysis and other troublesome effects through leakage of the return current from its proper path, it would at least be necessary to earth the middle wire at the feeding points; but it is not yet known whether even that would be sufficient. The "common-sense compromise between the distribution-board system and the tree system," mentioned by Mr. CHAMEN, is a more or less obvious one, and must, we think, have been employed frequently on fairly large buildings. We fail to see, however, why it should be necessary to retain the full section of what may be called the trunk mains, for this might well be reduced as each branch is taken off.

In spite of the multiplicity of wiring systems and the keen competition in the trade of "installing the electric light," we are of opinion that the ruling prices for really good work are higher than they need be. A reduction in cost can, as Mr. CHAMEN suggests, be effected by more thorough standardisation. Such a reduction is eminently desirable, however, not only for the reason that good electric wiring should be able to compete in price with gas fitting, but also that it may compete on better terms with bad quality electric wiring, and win the day.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

NOTE.—Wiedemann's *Annalen der Physik und Chemie* are now simply called *Annalen der Physik*, and are edited by Paul Drude. The current number is the first of a new series, the last being closed by the resignation of Dr. Eilhard Wiedemann.

Deflection of Becquerel Rays.—H. Becquerel has discovered some further interesting qualities of the rays named after him. It appears that their magnetic deflection is a property varying from one radiant preparation to another. Polonium preparations show no traces of deflected rays in the most powerful magnetic field, whereas radium preparations show very distinct magnetic deflection. This would point to the conclusion that the difference between Röntgen and Becquerel rays is, after all, a quantitative rather than a qualitative one, and absorption and magnetic deflection appear to go hand in hand. Another striking experiment described by the author is the following: A piece of radium preparation is placed in a uniform magnetic field, and a photographic plate near it with its plane normal to the lines of force. The result is "an intense impression, limited by a spiral whose sense is that of the current which produces the field." This spiral is the trace, deformed by the field, of the line of intersection of the vertical plate and the plate on which the radium rests. If it could be proved that the radiation transports charged particles which are deflected by an electrostatic field, it would be possible to form an estimate of the velocity of the rays. But the experiments undertaken hitherto in this direction have not given any indication of electric deflection or electric charges. The curves obtained in the photographs show that the speed of propagation of radium radiation is of the order of the speed of rotation communicated by a magnetic field of about 4,000 units. If it is admitted that in a field in air of unit strength the speed of rotation of the magnetic whirls is $2\pi \times 6{\cdot}6 \times 10^5$ per second, the velocity of the radium rays comes out very near the velocity found for cathode rays.

[H. BECQUEREL, *Comptes Rendus*, Dec. 26, 1899.]

Röntgen and Becquerel Rays.—It has been somewhat hastily assumed by a number of physicists that the radiation of the Röntgen tube and the radiation of uranium, thorium, and "polonium" compounds are identical in nature and differ only in intensity. The magnetic deflection of Becquerel rays may now be said to be definitely proved. Further points of difference will probably appear as our acquaintance with the two forms of radiation becomes closer. B. Walter brings out in a striking manner the fact that there are considerable differences in the absorption and diffusion of the two types of rays. One of the most striking of the author's experiments is that of cutting two holes in a plate of lead and covering them with a layer of graphite 4mm. thick and a 0·07mm. platinum sheet respectively. To the Röntgen rays the graphite is quite transparent, while the platinum intercepts them to a great extent. On exposing the same combination to Becquerel rays from one of Giesel's preparations, the platinum appears more transparent than the graphite. In fact, to obtain equal absorption the graphite would have to be 50 times as thick in the case of the Röntgen rays. The strong diffusion of Becquerel rays by air and by bodies of small atomic weight renders them unfit for surgical use.

[B. WALTER, *Fortschr. d. Röntgenstrahlen* III.]

Three-Phase Currents for Röntgen Tubes—The employment of three-phase currents for radiography, by means of tubes with three poles, was theoretically indicated two or three years ago. Radiguet showed last year that when an induction coil is connected with two of the three terminals of a three-phase circuit, a Tesla flame appears between the terminals of the secondary. A tube does not light up unless the exhaustion is diminished, and then it lights up throughout for an instant only and breaks. M. Delézinier solves the problem by interposing an electromagnet with laminated core, and consisting of two

straight branches mounted at an angle of 120deg. and provided with two coils wound in opposite senses, in the primary circuit. The Wehnelt interrupter then works well for hours, and the light of the tube is so uniform and perfect that its intermittence can only be detected by stroboscopic methods. Of variable-rate interrupters, that consisting of a vertical coil with its lower end in mercury works best, especially if it be so regulated that the phase utilised is between $\frac{1}{2}\pi$ and $\frac{3}{2}\pi$. When the terminals of the indicator are reversed, the illuminated zone is not displaced. It is just as active photographically, and only a little less effective on the screen.

[DELÉZINIER, *Comptes Rendus*, Dec. 26, 1899.]

Properties of Iron.—To explain the peculiar phenomena of the tempering of steel, Osmond and Werth put forward the hypothesis of the existence of two allotropic forms of iron; α iron, stable at ordinary temperatures, and β-iron, stable at high temperatures. M. Galy-Aché describes some experiments which go to confirm this view. Some of them recall the familiar facts of recalescence, while others show that recalescence is accompanied by a certain retardation in the breaking by compression, which depends greatly upon the manner in which the iron is cooled down from temperatures above 850deg.

[GALY-ACHÉ, *Comptes Rendus*, Dec. 26, 1899.]

Half-Ring Electromagnet.—The ring electromagnet described by H. du Bois yields a field of some 40,000 units over a space of several millimetres. By using micromagnetic appliances with dimensions of the order of 0·1mm., the values 51,600 for H and 74,200 for B were obtained. But the whole apparatus weighs 5 cwt. and uses 5 kw. The author has therefore constructed a lighter type, by reducing the linear dimensions 20 per cent. and cutting off the lower third of the ring, which is replaced by a bedplate. Excitation is made by eight magnetising coils, with an interval between the highest and the second on each side, which allows the observer to remove two plugs running along the magnetic axis, and thus expose the axis for polarisation and other experiments. The power consumed in this type is 1·44 kw., or about 2 H.P. In another type, which is still smaller, the power consumed is 256 volts, the weight is 25 kgm., the height of the axis above the table is 25 cm., the number of turns 2,000, the resistance 4 ohms, and the inductance 60 henries. The efficiency of these half-ring electromagnets is, if anything, greater than that of the whole-ring instrument, the field furnished by the heavier type being 86,000 units, and by the lighter type 20,000 units.

[H. DU BOIS, *Zschr. f. Instrumk*, December, 1899.]

An Electric Cyclical Process.—An interesting application of thermodynamic methods to electric theory has been made by O. Dörge. He takes a soap bubble, assumed to be free from surface tension, and performs four distinct operations upon it. It is first extended infinitely slowly while in contact with a conductor of very great capacity at potential V_1. It is then disconnected and further extended until the potential falls to another potential V_2. It is then connected with another conductor of great capacity at potential V_2, and contracted, and finally disconnected and further contracted until it reaches its initial stage. Stages 1 and 3 correspond to Carnot's isothermals, and stage 2 and 4 to his adiabatics. The author shows that the work performed during the cycle is

$$\frac{V_1}{8\pi}(V_1 - V_2)(r_2 - r_1).$$

A counterpart of the second law of thermodynamics is obtained in the proposition that "no process is possible consisting only of the transfer of electric energy from a higher to a lower potential without the absorption or the giving out of work." The author also attempted to prove his conclusions experimentally, but with only partial success. Quantitatively the conclusions were corroborated, at all events.

[O. DÖRGE, *Ann. d. Physik*, No. 1, 1900.]

THE DESIGNING OF ELECTRICAL GENERATING STATIONS.*

BY MR. A. ROBERTS, M.S.A.

In complying with the council's request to read a Paper on the above subject, I did so with some diffidence, fearing it was hardly of sufficient general interest, electrical generating stations being comparatively few and far between, and their design being often entrusted to electrical consulting engineers, who make a speciality of this class of work. However, I hope to be able to give a description of a typical station, together with some particulars and data.

The first matter to be considered, which naturally largely affects the design, is the selection of site. In doing this, many matters of vital importance to the ultimate economical working have to be considered. It should, if practicable, be near a river, canal, or railway, so that coal may be unloaded direct from the barges or trucks into the coal bunkers, preventing the necessity of cartage, which involves a large extra outlay each year. It should not, if possible, be in the centre of a residential neighbourhood, as this involves many difficulties, such as complaints as to alleged vibration, noise, smoke, condensed steam, &c., in most cases unfounded, but at the same time involving cost to refute. One instance in this respect came under my notice, where adjoining owners brought an action for damages in respect of vibration. They stated they had kept careful note of the times when the vibration complained of was extremely bad, and the worst period was when the company in question were able to prove that no engines were running. Another instance was a chimney shaft in the centre of a residential neighbourhood in connection with a generating station, which had been disused for this purpose on account of the company requiring much larger works, the chimney shaft therefore being entirely out of use, and having no flues or boilers connected therewith: notwithstanding this, complaints were made by adjoining owners of the smoke, &c; but in this case, happily, it was not difficult to refute the alleged nuisance.

Another consideration in selecting a site is possible actions for damage to ancient lights. Care, of course, is necessary in all cases, but more particularly so in the case of an electric light company, most people thinking that a company of this description with a large capital behind them are "fair game to shoot at," and therefore endeavour to obtain injunctions and other pleasant legal hindrances, which are annoying to the architect, who is generally pressed to rush the building up as quickly as possible.

One other, and although last by no means least important thing to be considered in selecting a site, is space for future extension. In starting, a company usually does not wish to overburden itself with a large capital, and therefore the ground taken is often only sufficient for the building immediately required: in the course of a few years, as the company grows and has to meet a larger demand for supply of current, more generating plant is required and further building becomes necessary, and this then means either having two or more stations, with a larger staff required than is concentrated in one station only, or in obtaining statutory powers (in itself an expensive luxury) and the compulsory purchasing of the various interests of adjoining owners and occupiers, when enormous claims have to be met and compensations paid. It is therefore false economy in the first place not to acquire a large enough site for all contingencies of extension and growth which may be anticipated for many years to come. Other matters in selecting a site have to be considered, such as the nature of the subsoil, facilities for drainage into parish sewers, &c., but as these are common to all building operations and not special to electric light buildings, I will make no particular reference to them.

Having considered the questions relating to acquisition of site, the next matter for consideration is the design and construction of the buildings. In the first place, it is usual for an electrical engineer to decide upon the system of supply to be adopted, and to formulate a scheme and prepare sketch plans showing disposition and space required for machinery, plant, &c. The architect then has to design his buildings to meet the requirements of the engineer, and practically as a shell to cover and protect the engineering plant. The ideas and wishes of the electrical engineer should therefore always be studied and adopted, as the primary function of a building of this description is the supply of current and not as a testimony of the architect's artistic taste (if he has any). Engineers' architectural ideas, however, as a rule do not run on parallel lines with those of an architect (for instance, Vauxhall Bridge), but the *suaviter in modo* system is far more preferable than endeavouring to force one's own taste and inclinations. The plan of necessity depends to a large extent upon the shape of site, but simplicity and economy of working should be the key-note. It is needless to say that in the London district the buildings must be planned in accordance with the Factory Act and also the London Building Act, the latter, however, having special clauses relating to electrical generating stations, whereby the Council have power to authorise buildings to be erected of greater cubical dimensions than

* Paper read before the Society of Architects, Jan. 25.

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250.000 cubic ft., and in other respects to exempt such buildings from any of the provisions of the Act if they think fit

The following are the principal departments for which provision must be made in the plan: (1) Coal stores, (2) boiler house, (3) engine house, (4) workshops, (5) stores, (6) meter and testing rooms, (7) engineers' apartments, (8) offices; and also battery rooms, if any batteries are proposed to be erected at the generating station.

1. *Coal Stores.*—These should be situated adjoining and readily accessible from the boiler house. They should be divided into a number of bunkers, to obviate danger of fire and for other reasons: one to each pair of boilers is a convenient arrangement, so that a check may be kept upon the consumption per boiler. Generally, however, from contingencies of site, the coal bunkers cannot all be placed near the boilers, in which case it is necessary to have a system of iron tip-up trucks running on narrow-gauge rails from the vaults, with turntables at any point where the trucks have to turn at right angles. The doors to bunkers should be of iron, hung to lift with counterbalance weights: the flooring is usually of concrete or blue Staffordshire bricks. Where the coal is shot into bunkers out of carts, it is well to have several removable coal plates and shoots to each bunker rather than one central one, as in the latter case it is difficult to fill the coal bunker to its utmost capacity without trimming the coal, which entails much labour. As to capacity of coal vaults, sufficient coal should be accommodated to supply the boilers for at least three weeks or a month, and of course, if space be available, the greater amount of coal storage capacity the better.

2. *Boiler House.*—A convenient arrangement is for the boiler house, where practicable, to run parallel with the coal bunkers, also with the engine house—it is usual to sink the level of the boiler house floor some 8ft. or 10ft. below that of the engine house, so that the steam pipe from the crown of the boilers may be conveniently placed with regard to the engines; also so that coals may be shot down from the ground level into the coal bunkers beneath, the flooring whereof necessarily being at the same level as the boiler house floor for ease of stoking. The space required in the boiler house depends upon the type and size of boilers, but there should be at least a space of 16ft. to 18ft. between the boiler and wall opposite fire door for convenience of stoking, also so that boilers, drums, and tubes may be conveniently removed, swung round, and replaced with new ones; and for this purpose also large doors must be provided for ingress and egress of new and old boilers, as may be required in the course of years.

The boiler house should be lofty, well lighted, and ventilated by a continuous skylight running from end to end of the building, with louvre boarding at the sides, the skylight being glazed with one of the many patent systems of glazing, rather than by the old fashioned wooden bar. Space must be provided in the boiler house for further engineering plant in addition to the boilers, such as feed water heating and detartarising apparatus, economisers, &c., depending upon the scheme adopted, and particulars of space required for these must be obtained from the engineer when planning the building. Stokers' lavatory and urinals should be provided, readily accessible from the boiler house; also a stokers' mess room, with cooking range, &c.

With regard to the chimney shaft or shafts, if a single shaft is decided upon, it is best to place it in the centre of the range of boilers, with the horizontal flue running right and left thereof, so that boilers may be added as the works grow; and in selecting the position of the shaft, future extension must be borne in mind. It is, however, advisable, where funds and space permit, to have two shafts of smaller capacity rather than one shaft of large capacity, so that in the event of repairs being necessitated through damage from lightning or other causes, one may be shut down whilst the other is working. The area of the shaft should also be amply large enough to provide for all future boilers that may be required, and in the London districts particularly it is advisable to carry up the shafts at least 150ft. to 200ft., so as to distribute the products of combustion at as high a level as possible. The shaft must also of course be designed in the London districts in accordance with the regulations of the Building Act I fear it would be wearying, and extend this Paper too much, to touch upon the calculations requisite in designing a shaft relating to draught, wind pressure, stability, all of which, however, are of much interest, but I must content myself this evening by making a few general remarks relating to construction only. There is a diversity of opinion as to the best form of chimney, some authorities arguing that a circular chimney is better than a square, but the shape usually adopted for electrical stations, however, is an octagonal form of unequal sides, or rather a square chimney with the corners taken off. In calculating the area it must be borne in mind that the actual effective area of a chimney is less than the entire internal superficial area of the shaft, as the velocity of the gases is retarded by friction on the sides of the shaft, and it is usual to take for the effective area the total area less 2in. all round. The horizontal flue conveying the gases from the boilers to the shaft should be of a larger sectional area than the shaft, as these get constricted by deposit of soot, and if entering the shaft from opposite sides, a midriff or central division wall should be carried up the centre of the shaft some 15ft. or 20ft., constructed of firebrick. The shaft foundations of necessity are of vital importance, and must be of sufficient area to carry the load, which is usually very great, without sinking into the ground beneath. They should be allowed to stand some months before the brickwork of the superstructure is commenced, as it takes some time for a large body of concrete 30ft. or 40ft. square by 8ft or 10ft. deep to set. The bricks should be specially selected, particularly at the base, to withstand the load, which often amounts to 8 or 10 tons or more per foot super: they must not, with the exception of the cap and footings, be laid in cement, on account of its unyielding nature and its not withstanding heat so well as lime mortar; also a shaft built in cement usually cracks. The materials should be frequently tested during the erection of shaft, particularly bricks, for crushing strains. An extremely good mortar for shafts which I have used, and which is used largely in the North, is composed of blue Lias lime, sharp sand, and foundry ashes, in the proportion of one of lime, two of sand and three of ashes. The joints should be kept thin, and to prevent the shaft being blown out of the upright before the mortar has set, the brickwork should not be carried up too quickly. A special bond is often adopted for shafts, in which a large number of stretchers are used, as longitudinal tenacity is required to prevent a shaft splitting: for this reason hoop iron bond, well tarred and sanded, should also be built in at frequent intervals. In selecting the position for a shaft it is preferable that it should stand alone and not be attached to any buildings. If, however, from necessity of plan it must be in continuation of walls of a building, there should be no bond between the shaft and the wall adjoining, but a straight joint, to allow the shaft to expand and contract; also, it should be built first, so that any settlement may take place before walls are built adjoining. The cap should be of simple design, not of too great projection, and little or no stonework employed in its construction, as in the event of this becoming disintegrated by frost it is costly and difficult to repair, and a heavy cap causes the shaft to oscillate in a wind with longer pulsations, and there is more chance of its being overthrown. A cast-iron capping, built up in sections and bolted together, forms to my mind the best finish at the top, and to this the lightning conductor may be readily fixed and stayed. The shaft should be frequently plumbed, to ensure a uniform batter, and great care should be taken in its construction to see that no bats are used. A firebrick lining is necessary, which should be carried up according to the height of the shaft some 80ft. to 100ft., the firebricks being laid in fireclay, and usually carried up perpendicularly (*i.e.*, with no batter) with a space averaging about 2in. between the outer wall and the lining. It must have no bond with the outer wall, and to steady it headers are usually projected through the 2in. space at intervals to touch the lining with sand joints. To prevent soot and cinders falling and blocking up the 2in. cavity, the brickwork of the shaft must be racked out to cover up the cavity at the top; but room must be left to allow the firebrick lining to expand. It is essential in firing a chimney for the first time that heat should not be applied too suddenly, or there is danger of the chimney splitting; so it is well to allow a little heat to pass up for some weeks before it is necessary to use it to its full capacity. Foot irons are usually built into the interior of the shaft from base to cap, to afford access for repairs, &c, and in most electric generating shafts the exhaust steam pipe is carried up the centre of the shaft; and the stays to keep same upright must not be bonded into the firebrick lining or main walls, but should rest on the offsets where the brickwork is reduced in thickness, to allow the exhaust pipe to expand and contract. As this exhaust pipe and the heated column of steam inside forms the readiest path for a flash of lightning, it must be carefully earthed and connected up the lightning conductor.

The boilers usually adopted in London stations are of the water-tube type, as with these steam may be more quickly got up than with any other form, and this is an essential where sudden fogs and consequent darkness are so prevalent.

3. *The Engine House.*—This, as I before said, should be parallel, if possible, with boiler house, so that steam pipes from boilers are as short as possible, and may be carried direct through the wall separating same from engines: its dimensions of course depend upon the number of engines and type proposed, and here the engineer must again be consulted. It must provide accommodation not only for the engines and dynamos, but for switchboards; and should also either contain engineers' mess room and lavatory, or have same conveniently adjoining. It should be lofty, well lighted, and ventilated by either skylights or ranges of windows so planned that thorough ventilation may be obtained, as it is essential not only for the personal comfort of the staff, but also for the plant, that the temperature should not be too high. Cleanliness is of extreme importance in the engine house, as dry, gritty particles in the atmosphere, or blowing about in the wind, would shortly do irreparable damage to the bearings of the machinery, revolving at such high speeds as it does. For this reason, therefore, it is usual to face the walls (and where stores and other departments are over the engine house, the ceiling also) with glazed bricks, which are cleanly and reflect the light, ensuring a bright engine house.

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These may also be easily wiped down, and therefore save the annual cost of distempering or painting the wall surfaces that would otherwise be necessary. Window frames in the engine and boiler house should be of steel or iron rather than wood, as the unavoidably high temperature causes the latter to shrink and wind; and the former are also more fireproof. An overhead traveller is essential in an engine house, for erection and removal of engines, dynamos, &c.; and corbels should be built in the walls as the works proceed, or some provision made for carrying rails thereof upon which it travels. The flooring of engine house must receive careful consideration. It should be carried entirely independently of the engine beds, so that the vibration set up by the engines may not be transmitted thereby; and it should be paved with some cleanly, insulating material, if possible, not slipping. Wood block flooring soon gets greasy and unsightly, and the best material I have found so far is unglazed red tiling, although this has the objection of not being a good insulating material.

The engine beds are usually constructed of a continuous block of concrete (not separate beds for each engine), which is carried down 6ft. or 8ft., and carefully constructed and planned so that vibration shall not be transmitted to the ground beneath. Many methods have been tried, successfully and otherwise, to prevent the transmission of vibration; and that adopted at the Chelsea station, which has proved very satisfactory, is to first construct a foundation of concrete 9in. deep: on this sheet lead is placed, then two layers of continuous matting similar to an ordinary door mat but very much thicker; on this lead sheeting is again laid, and on these insulating layers the concrete superstructure of the engine bed, about 7ft. deep, is erected. The position of the holding-down bolts for the engines must be ascertained, boxes constructed and accurately placed in the right position before the concrete is shot into the beds, so that after the concrete has set the wooden boxes may be taken out and the holding-down bolts, with anchor plates attached at the bottom, may be let into the cavities thus formed and grouted in with fine concrete and cement. Switchboards should be constructed of some fireproof material, slate slabs in timber framing being one of the best forms of construction. The switchboards should be raised one step above the engine house floor level, on a continuous platform, so as to isolate the switches and enable the operator working same to have a good view of engine and dynamos. Indiarubber mats are provided to stand on when operating the switches. A convenient office should be arranged, if practicable, for the electrical engineer in charge, with a window looking into and commanding the working of the engine house.

4. *Workshops* must be provided for carpenters, engineers, and fitters, &c., with lavatories, messroom, and office for foreman, the floor space for these depending upon the size of the works; and there is little in the construction of these of special interest.

5. *Stores.*—These are an essential department of an electrical station. They should be conveniently situated near the workshops; also, if on the upper floors, lifts and hoists must be provided in connection with same. Racks are requisite for the various articles stored, and an office for storekeeper at the entrance. The stores generally, like the whole of the building, should be of fireproof construction, and a special store provided, with iron doors, for oil. In calculating the strains and stresses in steel construction carrying floors of stores, it is well to err on the side of excess, as the loads carried are usually very great.

6. *Meter and Testing Rooms* have nothing special to call for remark. Stoves should be provided here for warming purposes, and benches for storing meters, testing, &c.

7. *Engineers' Apartments* should be situated naturally with the best outlook, and if over the engine house made soundproof as well as fireproof as far as possible. The accommodation required of course depends on the number of the staff.

8. *Offices* are often situated away from the generating station, and must provide accommodation for secretary and staff, chief engineer and staff, draughtsmen's rooms and board rooms, and have nothing special to call for note.

Battery rooms must be well ventilated to allow of the escape of gases, and the floors should be of cement or acid-proof asphalte, with channels therein to carry off contents of the cells if they should get broken. Accommodation must be provided on the roof, in some convenient and accessible position, for water tanks, as a large storage of water is essential, so that in the event of burst mains or other causes preventing supply no inconvenience is occasioned.

With regard to construction generally, an electrical generating station should be substantial and of fire-resisting materials, as it is of extreme importance to prevent fire, not only on account of the damage done to works, but as a fire would damage plant and prevent the supply of current, which is a most serious matter. Also the premiums charged by insurance companies for electrical buildings are extremely high in any case, and would be more so unless the building throughout were of a fireproof nature. A system of fire hydrants should be fitted throughout the building, and in most electrical stations the staff are exercised in fire drill. All walls (at any rate, those of engine house) should be carried down to same level as foundations of engine beds, and a clear space should be left all round the building between external walls and those of adjoining buildings, to prevent transmission of any vibration.

There are many other points in the planning and construction of electrical generating stations that require consideration, but I hope to have given some general idea of the special matters to be thought of, which may prove of interest.

THE ELECTRIC WIRING OF BUILDINGS.*

BY W. A. CHAMEN.

The greater part of the wiring of buildings *up* to the present time, and perhaps even *at* the present time, is carried out by means of indiarubber insulated wires run in wood casing, and it is well to lay some stress upon this point at the commencement of the Paper, as the largest experience obtainable has necessarily been in connection with this system of wiring. It is a system which has much to commend it, and it has undoubtedly done remarkably good service for many years past. It has, however, long been felt by many engineers that it is not the best or soundest mechanical job that can be made, and many different systems have been devised from time to time with the object of superseding wood casing.

The objections which are raised against this old established system are:—

1. That it is extremely unsatisfactory in damp or wet places, as the wood casing becomes sodden, and the insulation of the rubber-covered wires, although supposed to be permanently waterproof, often breaks down if perpetually subjected to moisture.

2. That it affords no mechanical protection against nails, screws, saws, chisels, &c.

3. That two distinct classes of tradesmen are required for its fitting up—viz., the joiner for fixing the casing and the wireman for laying and jointing the wires.

In enumerating some of the various improved systems which have been invented, the author must be forgiven if he should omit any, as the object of this Paper is to refer principally to those systems which are mostly in use rather than to deal historically with the subject.

Of the newer systems, the one which is perhaps most frequently met with now is the lead-covered cable system. This is used in various ways: (*a*) in some instances simply consisting of lead tubes into which indiarubber-covered wires are drawn; (*b*), of wires insulated with paper or fibre or sometimes with indiarubber, the lead sheathing drawn tightly over the insulation, each wire having its own insulation and lead sheathing; (*c*) the same as (*b*), except that two insulated wires have one lead covering drawn over the pair; (*d*) also like (*c*), except that the two conductors are concentric and usually that the outer conductor is not insulated at all from the lead sheathing.

The first of these (*a*) seems to present but little advantage over the wood casing, except that in damp or wet places, if the joints are properly soldered, the lead tubing forms a satisfactory protection against moisture. It is obvious that the protection offered by the lead tubing against mechanical injury is no better and indeed not so good as that offered by the wood casing; and there is the further objection that a nail driven into a lead tube containing conductors with no space between them may quite possibly cause a direct short-circuit, which in the wood casing would not occur.

The next variation (*b*) offers some advantages, inasmuch as it is possible to separate the two conductors so that one nail cannot very well cause a direct short-circuit, except in the manner which will be referred to later on. It, however, affords no better mechanical protection than the others, but it possesses the advantage that there is no space between the insulation and the lead in which moisture can lie, and that it is much more easy to arrange so that no joint occurs in a damp place. Wires not insulated with indiarubber, however, require special boxes or other special arrangement or treatment at the ends for the purpose of preventing the access of moisture to the insulating material, which in most cases is hygroscopic to a considerable extent.

The third variation (*c*) appears only to present the advantage over (*b*) that it is far less unsightly when used upon the surfaces of walls than two separate wires would be. The chances of mechanical injury to wires run upon the surface are generally less than when they are buried in the plaster and obscured from view, though otherwise easily accessible to the point of the nail. This arrangement has of course in other respects the advantages of the second variation and the same disadvantages if the insulating material is hygroscopic.

The fourth variation (*d*) is practically only used for isolated installations, no one as yet having proposed to use wires of the concentric construction in which both conductors are insulated. The fact that the outer conductor is uninsulated is one which presents difficulties and conflicts with the present Board of Trade regulations

* Abstract of a Paper read before the Institution of Engineers and Shipbuilders, at Glasgow, January 23.

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if used with public supplies, as the Board of Trade insist on earthing the neutral conductor of the three-wire systems most generally in use at one point only at the generating station. The introduction of concentric systems, in which the outer conductor is uninsulated, into consumers' premises, would probably mean the earthing of the middle wire of the supply system at a great number of points. Whether it is desirable that the Board of Trade rule should be maintained or altered is a queston entirely beyond the scope of the present Paper and cannot now be discussed.

On a public supply, one conductor at any rate is connected to earth, and if the insulation of a wire is injured, and the wire itself put in contact with the lead sheathing, that sheathing immediately rises or falls to the same potential as the conductor with which it is in contact. Only, if the contact happens to be on the neutral wire of the system, nothing happens, as that wire is at earth potential. In the concentric system last mentioned, if the outer conductor were insulated from the lead no serious result could happen, as the nail would first of all connect the sheathing with the neutral conductor, doing no harm, and then, if driven further, cause a direct short circuit between the outer and central conductors, which would be purely an internal affair and produce no greater mischief than the immediate blowing of the safety fuses as if they were properly arranged. If, however, the system is not a concentric one, it is clear that the lead sheathing may be raised to such a potential above the neighbouring compo gas pipe that an arc may be established between the two, resulting in burning a small hole in the gas pipe and igniting the gas. Special attention should be given to this point, as it is not merely theoretical but one which does happen in practice.

Before passing from this section it is perhaps as well to point out two remedies of a common-sense kind for the purpose of preventing such accidents. The first is to avoid laying electric conductors near gas pipes at all, and to prevent gas fitters from running their gas pipes close to the electric conductors. The other precaution is to connect the lead sheathing in a thoroughly substantial manner with a water pipe, preferably at some point in the lower part of the building near its entrance. It is practically useless to make such an earth connection on an iron gas pipe, as it has often been found that the red or white lead used in the screwed joints for keeping them tight has resulted in making a perfect insulation between consecutive lengths of pipe.

In some of the various systems of lead-covered wiring special joint-boxes are used with the object of making a sound mechanical job of the joints without relying so much upon the skill and care of the workman. Where, however, these boxes are used without sweated joints between them and the lead sheathing of the wires they are a source of danger, as the lead sheathing often draws out of them, thus straining the joints and leaving them accessible to moisture.

The next and perhaps most important departure from the wood-casing system is that of running indiarubber-covered wires in iron tubing. There are several variations even of this system: (*e*) ordinary iron gas barrel with screwed joints and cast-iron junction boxes; (*f*) ordinary unwelded sheet-iron tubes or skelps with cast-iron junction boxes fitted with sockets, the joins, however, not being screwed or fixed in any way; (*g*) welded iron tubes lined with some insulating material, having joint boxes, bends, and fittings similarly lined throughout. All these variations offer a more or less substantial protection against mechanical injury which neither the wood casing nor the lead sheathing offers. As regards damp places, however, no protection is offered by the system (*f*), and, in fact, in any of the alternatives special precautions require to be taken in making the joints, both in the tubes themselves and in the joint boxes and connections, to exclude moisture. It is also desirable that a fall should be given to all pipes and a proper means of exit provided for water which may obtain entrance to them by condensation or in any other way. Probably tubes lined with an insulating material prevent internal condensation entirely, and they also have the advantage that any damage to the insulation of a wire cannot result in a direct contact with the metal pipe. There is no apparent reason why any of these three alternatives should not be made an extremely satisfactory job of, except perhaps the thin unwelded skelps, but experience has proved that trouble arises with (*e*) and (*f*) owing to carelessness in fixing. For instance, the thin sheet iron skelps (*f*) have frequently been found simply threaded upon the wires and hanging entirely unsupported except by the wires themselves. The tubes have sharp edges, which in these circumstances usually cut through the insulation, and the state of the job is worse than if no protection whatever had been attempted. This system is sometimes even used out of doors, where it must do more harm than good, as obviously moisture cannot be excluded, and it prevents wet or moisture getting away from the wires, as it would do if they were entirely open. To be a real protection therefore against fire the tube must be sufficiently thick to avoid being melted away by any arc which may be started and maintained by a current not sufficiently large to blow the protecting fuses on that section. The ordinary gas barrel arrangement (*e*) has much to commend it, but at the same time it is capable of being so misused as to give a great amount of trouble. It will no doubt seem unnecessary to call attention to the fact that all ends of tubes should be rounded or bell-mouthed, so that the insulation of the wires passing through them shall not be cut; yet the author has recently experienced a number of earths and faults due to this cause, and also to the fact that cast-iron boxes containing switches and fuses had been so defectively arranged that the point of entrance of the tube into the box was not opposite the terminal into which the wire had to be clamped, thus resulting in jamming the wire hard over on to the sharp edge of the tube or hole in the side of the box and cutting the insulation completely through.

In considering the iron-tube systems, it must again be remembered that, where they are used in conjunction with a public supply, in the event of a contact between a positive or negative and the iron tubing an arc may occur between the tubing and an adjoining gas pipe, just as in the case of lead-protected systems. The remedies against such accidents are the same as in the former case, but the metallic continuity throughout the whole system must be made perfect for these to be of avail. The author's experience has been, however, that in many cases no joints whatever are made, the end of a tube being simply projected through the side of a cast-iron box, sometimes with lock nuts on both sides, but more often with one lock nut missing or with none at all. It would seem quite possible and not an expensive matter to design an ordinary gas tube system with joint boxes and switch and fuse boxes, arranged with proper projections cast upon them, which would be drilled and tapped to receive the ends of the gas barrel, and these, if screwed together clean and dry, would probably make sufficiently good contact to secure continuity from one end of the system to the other and througoout all its branches. With such an arrangement, and with the switch boxes and fuse boxes intelligently designed to have the entrances of the wires opposite the terminals, and ample clearance to avoid the possibility of sparking from the fuse terminals to the cast-iron case, when fuses may happen to blow from any cause, an electric light installation should be the safest thing imaginable both as regards fire and possible extinction of light from faults in the wiring.

The author has had but little experience of the use of tubes with insulating lining, possibly because contractors find them too expensive for ordinary use, but there can be no objection to them as compared with unlined tubes, if they are properly made, although it is not clear that there is any real necessity to go to the extra expense. It is the usual practice, if not the universal one, to draw rubber-insulated wires into iron tubes, and if no injury is caused to the insulation in the act of drawing in, through internal feather edges in the tubes, arising from defective welding, or from sharp edges at tube ends and other defects in joint boxes, indiarubber-covered wires should have a very long life indeed, as they are not subjected to mechanical movement or to alternate conditions of damp and dry which seem to produce breakdowns in all indiarubber-covered wires of the present day after being in use for a year or two.

The wooden casing system is one which lends itself very readily to the protection and hiding up of bad work in the way of defective joints, badly insulated and even of defectively insulated wire, and there is but little doubt that a dry building might be wired with dry wood casing and with bare or cotton-covered wires and still test fairly well, and give but little or no trouble, though fire office inspectors would be quite horified if they knew of the real condition of things. There is but little danger of actual short circuits in wood-casing systems, except where T branches are taken off, but such places are usually made apparently safe by cutting out the centre fillet of the wood casing, and by putting in between the wires which cross each other a sufficient thickness of insulating material, usually of a hygroscopic nature, which, so long as it remains dry, gives no trouble whatever. While, however, it gives the best protection against actual short circuits of wires, it encourages bad work and opens up the serious risk of starting electric fires through leakage from bad joints and defectively insulated conductors when subjected, as any place may be at some time or another, to dampness.

In the interests of safety, it is desirable to use some system which shall break down immediately and put out the light without risk of fire, rather than go on leaking and smouldering away in some hidden corner with the probability of breaking out into a genuine electric fire at some time or another. Probably it will be thought that this is a good enough theoretical argument, but that if it is to result in the extinction of the lights at frequent intervals the remedy is worse than the disease. But surely an analysis of the actual causes of failures and extinctions of light arising from the use of metal-sheathed systems must only prove to any engineer that it is necessary to carry out the work in a reasonable and proper manner; and that, if so carried out, the metal-sheathed systems—more especially the iron-sheathed ones—possess very great advantages over the old wood casing. It is doubtless to be regretted if we cannot rely upon our workmen to do their work properly, but surely such troubles as have been already referred to cast some reflection upon those who superintend the work. But little has been done in the way of standardising

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cast-iron fuse and junction boxes and bends and connections, &c., for use with wrought-iron gas barrel, and nothing seems to have been done with regard to providing workmen with simple tools for rounding out the edges of tubes after cutting them off; and if some one would display some enterprise, after the manner of our American cousins, a most complete, safe, and satisfactory system of iron tubing could be introduced, which, at the same time, would not be too expensive for general use. It is usually the labour spent upon the actual job which costs the greater part of the money in fitting up an installation, but if things could be standardised so as to reduce the amount of time which it is necessary to spend in consumers' houses (to their great annoyance) it might still be possible to carry out the work at an even less cost, though the materials might be a little more expensive. The author has long hoped for the introduction of a concentric system of conductors, in which the outer sheathing is of wrought-iron tube, which contains, built up as an integral part of it, the two conductors with their insulation, the whole of the tube being filled up solid—that is to say, a cable like the concentric lead-covered cables referred to in this Paper, but covered with iron instead of lead. The difficulty, however, of jointing with such a system has seemed unsurpassable, and as it would not be workable to have the conductors made in lengths longer than 15ft. to 20 t., the joints would be of frequent occurrence. The difficulties would be much reduced if the outer conductor could be uninsulated, as the iron tube itself might then be used as a return conductor, leaving only the one wire to be jointed and insulated. The connection between the iron tubes could be made either by long screwed sockets or split slees or glands, in either case being secured in place by grub screws; or, again, by a plain bored length of tube screwed taper on the outside, having saw cuts at each end and nuts to screw down and make it tightly grip the tube ends which it encloses.

The original conception of wiring was to run a pair of conductors from the point of entrance to the building up through the various floors, taking off branches at each floor and reducing the section of the mains after the tapping of each branch. This system has been generally spoken of as the Tree system, presumably from its resemblance to the growth of a tree, the mains or trunk being thick and heavy, but getting thinner and thinner as they go upwards and as each branch leaves them. The branches also taper down after each tapping of a smaller branch. This system is a simple one in as much as it makes use of the minimum possible *length of wire*, but it becomes complicated when the question of fuses is considered. Fuses are inserted with the object of preventing the overheating of any wires which may be served with current through them, the fuse itself blowing and cutting off the supply before the current be increased to such an extent as would cause the serious heating of the wire. Theoretically, therefore, it becomes necessary to place fuses at every point where a branch is taken off from a main or from a larger branch. This arrangement, if carried out consistently, results in scattering fuses throughout the building in an indiscriminate manner, and in all kinds of awkward places.

To obviate this objection the distribution board system was introduced. In this system conductors are led from a main distributing board near the point of entrance of the supply to various other distributing boards placed at suitable centres within the building, and from these distributing boards, small circuits, supplying only a few lights each, are carried away in all directions, surrounding each centre as required. In this way fuses are fixed firstly upon the main distributing board, and secondly upon each of the local distribution boards, and practically no other fuses are required. This system possesses the great advantage that if a circuit of lights is extinguished through any petty accident to a lamp-holder or flexible any one knows at once where to go to find the fuse, and as distribution boards are generally fixed in some convenient and accessible position, the fuse can be replaced and the light again put on with the least possible delay. The small wires which come away from the local distribution boards are not supposed to be reduced in section throughout their entire length nor on any of their branches until reaching the fittings to which they carry the supply. If flexibles, having a smaller section of copper than the branches which supply them, are used for pendants or portable lamps, fuses are required in the ceiling roses or in the wall or floor sockets unless matters can be so proportioned that the current which would be required to burn up the flexible is ample to cause blowing of the fuse at the distribution board, even when none of the lamps on the circuit are lighted. The distribution-board system has obviously some very considerable advantages over the older or tree system, but at the same time, if large distribution boards with great numbers of circuits are used, it becomes a matter of some difficulty to get so great a number of small wires away from the distribution board in any convenient manner. In order to avoid unsightliness, what is technically termed "bunching" is resorted to, and while this is not objectionable to a reasonable extent, it may easily become very troublesome if carried too far. If wires, even of the same polarity, are bunched together, an accident may occur which connects them all together at a certain point, though they may not at that point be also connected to "earth." One of the wires continuing past that point may, however, get connected to "earth," and if it happens not to be a neutral wire, as there are two chances to one it will not be, that wire may then be burnt up, as it is supplied not only through its own fuse but through all the fuses which belong to the other wires, connected in paralled. Again, if only one wire of a bunch be damaged, and an arc be started between it and some "earth" or, in case of broken continuity, between the two ends of the wire, then the whole of the wires in the bunch are likely to be damaged by the accident which happened to one of them only, and if the wires so bunched are of mixed polarity, the result will be more serious still.

It is clear therefore that if bunching is to be allowed at all it must be limited. A convenient and fairly safe limit may be set at two wires only when of opposite polarity and in iron or other suitable metal tubing, and four wires only when of the same polarity, either in metal tubing or in wooden casing; in each instance the circuits not to carry more than three amperes each at 250 volts.

There is a strong tendency with many people to treat small branch circuits of about three amperes each just as electric bell or telephone wires after they have left the distribution board, as though the fact of passing through the fuses robbed these small circuits of all power for mischief of any kind. This is a most erroneous idea, and must lead to trouble and annoyance, if not indeed to disaster if habitually put into practice.

It is extremely desirable to have no bunching at all, though there are admittedly cases where some compromise within safe limits must be allowed. The apparent necessity for bunching can usually be remedied by providing more distribution boards and placing them at more frequent intervals. In doing this, however, the question of connection between these boards and the mains requires to be looked into. If the distribution-board system is to be maintained from start to finish it will become necessary to run a considerable number of main branch circuits from the main distribution board to the numerous smaller ones. The same difficulty will arise here, and serious temptation to "bunch" immediately follows. Bunching, however, in the case of these larger circuits, should be absolutely prohibited, for the simple reason that, do what one will, the amount of current which may pass for destructive purposes must be so much greater than in the instance of the three-ampere circuits before referred to.

The remedy in such cases is to be found by departing from the distribution-board system, so far as the main circuits are concerned, and introducing a common sense compromise between it and the tree system. Take the case of a building of four floors in height. Let there be one, or if the quantity of current requires it, two pairs of mains running up the building from bottom to top. The section of these mains should not be reduced, and if possible they should be run perfectly straight and without joints, except where the branches come off. At each floor let there one or two branches taken off as the case may require, each branch having its own pair of fuses fixed as close as possible to the main.

One or two distribution boards with three-ampere circuits can be fixed immediately on each branch, or, if the building is so large that bunching beyond the reasonable limit of four wires of same polarity would require to be resorted to, these branches may be continued along the corridors, and have several distribution boards tapped off each of them at convenient intervals, the section of the branch not being reduced throughout its length. Where a building contains a large number of offices occupied by different tenants, each of whom is an independent consumer with a separate meter, &c., it is generally far simpler to discard the distribution-board system altogether except perhaps within the offices themselves, and to run a pair of branch mains along each wall of each corridor, taking simple tappings off for each consumer, with a pair of fuses outside his wall, accessible only from the corridor, and arranged so that they can form the sealed fuses of the supply authority.

INSTITUTION OF ELECTRICAL ENGINEERS.

The following is an abstract of the conclusion of the discussion on the report of the Swiss Visit Committee:—

Thursday, January 25.

Mr. S. Z. de FERRANTI had not read the report nor the discussion at the last meeting, so that he knew little of what had been talked about. The principal thing that struck him with regard to the Swiss visit was the great facility for doing all sorts of electrical work on a large scale. It was not merely the fact of their having water power available, but the customs of the country seemed to enable the people, or groups of people, to carry out without too much obstruction very considerable work most beneficially to the country and most beneficially to the electrical industry in the way of developing it. It certainly made him very much regret that we had not that desire in this country for something new that the smaller country of Switzerland seemed to have. The whole tendency seemed to be for everybody there to help everybody else to get forward with the great industry

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and what struck him more than anything was the difference between that and the terrible obstruction that anything new in this country met with. There were so many vested interests, so many people whom it was the business of this country to protect, that the country at large suffered, with the result that we were in the unfortunate position of seeing Switzerland in many ways far better developed in this new electrical business than we at home were. We had any amount of cheap coal; we had very good supplies of gas—in fact, in almost every large centre of population in the country there was a cheap supply. The Swiss, on the other hand, had dear coal, and water powers, which were easily developed in many cases but not in all. But he did not see that this put us to any great disadvantage. Coming to the details of work that they saw over there, he was very impressed with the complication of the arrangements at the central stations they visited. Take that admirable installation for running the Burgdorf-Thun railway. The generating part of the business, with turbines and multiphase dynamos, was as nice as it possibly could be; but there was a sort of chamber of horrors upstairs that made one quite ill to think what it all meant. It seemed to him exceedingly complicated. The handling of these machines, with their switching and regulation, was in itself a big problem. The greatest difficulty, to his mind, that attached to the system which they saw at the Burgdorf-Thun railway was the complication involved in the apparatus connected with it. He was speaking a few days ago at Manchester, and had drawn attention to the great expense and complication involved in such an installation as that at Glasgow, where, in order to save copper and to get the advantages of the multiphase system for supplying the tramways, an immense mass of complicated apparatus had to be used. He did not say it was altogether bad, but at present it was exceedingly expensive; and, as far as one could see, the direction for improvement lay in the further simplification of these systems. The idea was very fine, and the results were good; but there was an intermediate stage, which was very costly and complicated: and if it was possible to reduce the complication and the expense, and simplify the matter generally, they would then be in a very much better position from the point of view of electrical distribution over large areas.

Mr. E. K. SCOTT exhibited a number of slides showing the Oerlikon locomotives on the Junfrau railway. The first was the locomotive truck; the second was another view of the locomotive in which the rotor was under cover The first reduction gear was 4½ to 1, and the second 2 to 1. The third view showed a ¾ H.P. motor of the locomotive, on the top of which was a fan which forced air right through the resistance coils. The fourth showed the resistance in position. This had an automatic gear for switching in the resistance. The next slide was one of the complete locomotive, which weighed 19 tons. The first locomotive on this line was a Brown-Boveri 15-ton engine.* In order to get better adhesion, the coach had only one bogie, the other end of the coach resting on the locomotive. The next view was a diagram of the connections. The current was not collected by four trolleys, as in the Brown-Boveri motor, but by slippers. There was a resistance in every motor, while in the Brown locomotive there had been one resistance for both motors. In going up hill the resistance was on the rotor; in coming down hill the resistance was in parallel with the stator. The next slide was of the back of the switchboard. Then came one of a drill driven by a small motor. This drilled out 2mm. every revolution, and could drill a hole 1 metre deep in 10 minutes. He next showed two drills working together, and a small drill driven by a three-phase motor. The final slides were a view of the high-tension line, in which the three wires were plainly seen, and a view of the entrance to the tunnel.

Mr. M. B. FIELD said Mr. Crompton had expressed surprise at the great simplicity of the overhead construction of the Swiss three-phase system, and would like to point out, for the benefit of the members who did not take part in the visit, the great simplicity which was effected by the use of the split stirrup. He sketched the arrangement on the board, and drew attention to the fact that it was almost impossible to get a short circuit. Some engineers who had visited Switzerland were, he thought, too apt to jump to the conclusion that many of our English roads, such as the Central London, Dublin, and the Middlesbrough, where rotary converters were used and the power distributed by three-phase current, would be better if they were equipped with three-phase motors on the coaches, thus avoiding the use of rotary converters. This opinion had been expressed without considering the great dissimilarity between the conditions existing. In traction work, as in nearly all other applications of electricity, there was a region where the claims of continuous current were paramount, and another region where the claims of alternating current were paramount; and there was probably another but undefined intermediate region where nobody could lay down a hard and fast rule. He supposed no one would question the advisability of the adoption of the series motor on lines such as those at Liverpool, Leeds, and a number of others. In England, and even on the Continent, where the area was comparatively small and where an economical distribution of 500 volts continuous current could be effected, everything was in favour of continuous working. But when they came to mountain railways they had, in most cases, to admit the claims of three-phase working. If they had, for instance, a mountain railway where the generating station was situated many miles away from the line because there was a small waterfall, and it fed sub-stations right away up in the mountains in inaccessible positions and often half covered with snow, one saw there could hardly be anything more suitable than transformers. Then, again, the stations on the line were very far apart, and constant speed was required. On coming down the grades, if the motorman could not exceed his specified speed, this to a large extent served to obviate panic among the passengers, which might occur when they saw themselves on a 25 per cent. gradient and the train running at all fast. The overhead construction might be slightly complicated, but this did not matter, as there were not many crossings. There was no doubt about it that this was the proper region of three-phase current. It was possible to supply the trolley wires at two or three thousand volts, and transform down with transformers on the engine itself, and supply say 750 volts to the motors on the axles. But when they came to a line like the Central London, where the distribution was by means of three-phase currents, they still required an efficient method of speed control and an economical system of obtaining great acceleration, as was afforded by the series parallel controller in combination with the series motor, rather than a wasteful method of inserting resistances in the rotor circuits. They could not afford to complicate the overhead construction in English towns, as the unsightliness of this was a feature to be avoided. With regard to the Central London railway, he drew a curve on the board which showed the sort of velocity time curve to be expected on this line. It must be remembered, he said, that on this line there were 13 stations on a six mile track, so that the distances could not be more than half a mile between each station. The average speed on the line was about 14, while the maximum was about 40. He then compared this curve with a similar curve of the Gornergrat railway in Switzerland; and from these two curves, he said, the proportion of lost power to useful power in the two cases could be obtained. Before jumping to the conclusion that three-phase currents were the best, even for the Burgdorf-Thun railway, let them consider the alternative that lay before Messrs. Brown, Boveri on equipping the line. They must not lose sight of the fact that they had not developed the series motor system in Switzerland, nor the series parallel controller, whereas the three-phase motor had been their pet speciality. On the one hand, they were absolutely certain of success if they adopted the three-phase motor; on the other hand, they would have had to develop a new system if they had had to work on the series system; and he thought that alone—apart from all other reasons—would have been sufficient to warrant the decision in favour of the three-phase system. If the series motor had been developed in Switzerland to the same degree as in America, he would not have been surprised if Brown, Boveri had not adopted rotary converters on the Burgdorf-Thun line.

Mr. A. E. LEVIN, referring to Mr. Hammond's suggestion that a few data as to the cost per kw.-hour, &c., of the water power schemes in Switzerland would be of interest, stated that this was a little difficult to give, for the simple reason that very rarely indeed was the charge for power made by meter. In Zürich and a few other large towns, where the load was principally for lighting and the conditions approximated more or less to the lighting circuits of English cities, meters were employed, but in all other cases the charge was made at a fixed rate per annum for every lamp installed or for every B.H.P. of the motors. In the case of lamps the charge was usually 20fr. to 25fr. for every 16 c.p. lamp. This was sometimes modified in the case of bedroom lamps which were seldom used, but the charge for motors was perhaps of more interest. In the case of small motors the price varied usually between 200fr. and 250fr. for every B.H.P. installed per annum, and in the case of larger motors 500fr. per B.H.P. per annum was charged. These prices were based on about 3,000 hours' use in the year, but it was only rarely that any special conditions were made for motors used intermittently or at night. A very fair average might be taken as 150fr. for 3,000 H.P.-hours, which worked out at about 5 centimes or ½d. for the B.H.P.-hour. The B.H.P.-hour, taking into account the motor losses, approximately corresponded to one kw.-hour generated at the power house. It was true there was one exceptional case, where power was sold for carbide production at the low rate of 60fr. per annum per B.H.P.-hour, but in this particularly happy case the financial and technical conditions were exceedingly favourable. (In reply to a question, he said this was for 24 hours a day and 365 days a year, which worked out at 1·14d. per kw.-hour.) Another point which had been very noticeable was the very great impression made by the three-phase traction plants in Switzerland. He endorsed Mr. Field's opinion that a much too favourable impression had been produced. The Burgdorf-Thun railway and the other traction plants had been seen working away merrily, but it was possibly a false idea to take away that therefore the system was the best for all cases. By dint of careful workmanship and good mechanical execution in general these railways could be made to work exceedingly well, but he believed the system had very serious objections in the main and quite apart from any question of mechanical design. In comparing the continuous-current series traction motor with the three-phase motor, there were many differences; but the most important was perhaps the behaviour of the motors when working under reduced voltage. In the case of a heavy motor, when the drop of voltage on the line was great the continuous-current series motor would run at a slower speed, and would have no difficulty whatever in giving its full torque; but the three-phase motor was limited in its torque by the voltage; in fact, the maximum torque which could be exerted by a three-phase motor fell off as the square of the voltage. In designing the line and spacing the transformers of a three-phase traction line, it was necessary, therefore, to bear in mind not only—not even chiefly—the economical distribution of material, &c., against the cost of the power lost, but one must take into account the fact that the drop of voltage may not at any time become so heavy that the motors would refuse to do their work. Now, it might and frequently did arise that, in order to prevent the refusal of the motors to do their work, a large amount of copper was put into the lines, or the transformers put closer together than would be warranted by questions of load alone. And even with these precautions a contingency might arise, such as an exceptionally heavy holiday traffic, which would upset things. With a continuous-current system, whatever the load might be and whatever contingencies might arise, if there was any voltage at all on the line the motors would slowly move and give their torque. It had often been urged that a great advantage of the three-phase system lay in the fact that a higher voltage could be adopted. But was it quite certain that the limited voltage of continuous-current work had been reached? Was there any reason why continuous-current motors for traction work should not be built for 750 volts quite as well as three-phase motors?

* Described in *The Electrician*, Vol. XLI., p. 706.

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It was true that the Board of Trade limited the pressure to 500 volts, but it also limited alternate currents to 300, so that in either case they were within the limits. The objection that the standard city lines were built for 500 volts was scarcely of great importance, for there seemed to him no reason why inter-urban lines should not be made for running at a high speed of 750 volts, while the same car on entering the city limits could run on the 500-volt network at a reduced speed. If they could only be allowed to use 1,000 volts, then indeed there were advantages before them. A line was under construction in North Italy where 3,000 volts was to be employed on the trolley lines. Messrs. Ganz and Co. were constructing the line, but no actual runs had yet been made. If no good results were obtained from this line, then a very strong case indeed was to be made out for three-phase traction, but until they heard more of this line he maintained that the general applicability of three-phase traction must be regarded at least as not proven.

Mr. A. P. TROTTER said that most of the points which he had intended to raise had been answered by the other speakers that evening. On such lines as the City and South London and the Waterloo railways the question of speed was of enormous importance. The three-phase systems they saw in Switzerland were splendid and most interesting pieces of work, but economy on these lines was not of much importance, whereas on lines such as he had mentioned economy was the great thing. He hoped those who talked about three-phase working on London railways would give some idea how they proposed to do it. Mr. Ferranti had already spoken of the enormous complication of the switching arrangements; but surely the diagram seen that evening of the gearing on the locomotive showed what an enormous handicap they had to struggle against. It seemed that there was room for a considerable amount of simplification in the locomotive switchgear, to say nothing of the immense amount of work which was spent on the resistances.

Mr. G. L. ADDENBROOKE, referring to Mr. Swinburne's remarks at the last meeting as to the way German electrical industry was financed, said it was a curious fact that, although a very large proportion of the lighting in Germany was done with capital provided by the towns themselves, it was done in such a way that it had actually very much strengthened the electrical profession and industry, whereas in this country it has been done in such a way that it has weakened the electrical industry and made it of as small importance as possible. The work in Germany had been very largely done by a town arranging to carry out the lighting. They then let their contracts to one large firm, with some arrangement for running the whole thing for a series of years. That firm then obtained finance from the banks, and had the whole thing in their hands. That method of working had certainly resulted in some very successful installations, and it had also had the effect that the great German manufacturing companies had become very powerful, and naturally succeeded better financially than their English competitors. The consequence was that they had very large sums of money at their disposal. They were in touch with the finance of the country, and it was very much easier to get electrical projects of all sorts carried through than it was in England, quite apart from the question of the attitude of the Legislature. Of course there was no doubt that the attitude of the Legislature in this country had been most unfortunate. They hoped something would be done to remedy this later on, as it had had a most detrimental influence. Coming to the point upon which Mr. Hammond was speaking at the last meeting—viz., that when they went to Switzerland and saw the electrical power there, the obvious question was that, even if we had not the water power here, could not we do the same thing by steam? But it was desirable to point out that that was not a fair inference to draw. The conditions were not absolutely the same. In Switzerland they had very expensive coal, and water power at a low price. Therefore, if they were to have power at all, it was necessary for them to utilise their water power. On the other hand, in England we had cheap coal and we had steam engines. Therefore the problem was, could steam engines be replaced by power generated in the central station? These two problems were different, and if they did not want to have a financial wreck it was very important to distinguish between them. It was not a mere question of the cost of coal. This came in to a very small amount. When he was working out the figures for the Midland Electric Corporation, he went to a friend who was the engineer of a large steamship company, and asked him what were the figures being used now in the design and running of marine engines. He told his friend he did not want mere test figures, but the sort they expected to get on ordinary runs. The result of this inquiry had been to learn that this particular steamship company were building five steamers on a basis that they should give 1 H.P. for 1·45lb. of coal in actual running. In a power station they would employ purer coal than on steamers, and more of it; but if they took about 1,000 H.P. hours per pound of coal, and if this could be got for something like 5s. per ton, the cost of coal affected the problem only to a very small extent. It was largely a question of capital cost. He had, on the occasion of Mr. Crompton's Paper on cheap fuels, shown a table in the discussion which showed that the cost of a 50 H.P. steam engine complete came to something like £20 per horse-power. Now, if they put up a large central station to do the work of that steam engine, they would have to put in a capital expenditure of something like £50 or £60, and the trouble was whether the saving which they would get in generating steam in a central station would justify the difference in capital expenditure. Were the conditions such as to justify that extra capital expenditure and pay interest on it. That was a matter which required very careful consideration in any power scheme.

Mr. LEON GASTER said he could not let this opportunity pass without saying that if any of his Swiss colleagues came over to England, they would find the English people as they are and not as they are painted by the Continental press. They would also find enough work in England to appreciate, and not only would they go back as happy as they ought to be, but they would be proud of their new colleagues.

Mr. W. M. MORDEY, as a member of the Swiss committee, said that practically the whole of the work was done by the President and his very able lieutenant, Mr. McMillan. He thought they ought to draw a few general conclusions from this visit. They had seen a great deal during the tour, and they would watch with very great interest the development of everything new they had seen going on there. One of the lessons they had to learn was, as he had said on an occasion when they met their Swiss hosts, was that they had to look to Switzerland rather than to America for guidance for future work. He felt that the Americans, although they had done a great service in the development of electrical engineering, were rather settling down to a fixed idea that their only duty in life was to sell what was American standard stuff at the time. We were still under this influence, and it had really had a prejudicial effect both here and in America. We were being forced to adopt American methods, although they were admittedly obsolete, because our manufacturers were not able to produce apparatus required to supply the demands in this country. The English manufacturers were therefore preparing to meet the demand by following American customs rather than by developing what the Americans themselves would like to produce now if they could start with a free hand. Let them watch the experiments in Switzerland, and they would ultimately see a great deal of this complicated machinery which was now being put in to transform swept away. As the President had said in his address, they used alternating currents on the motors, and they ought to be able to get rid of the intermediate steps by which they transform and re-transform in order to make them alternate currents. The chief thing he had been struck by in Switzerland was the difference in business methods, and he had noticed the same thing whenever he had been in Switzerland, or Germany, or Austria. People asked why in Germany and Switzerland the bankers supported the manufacturers. They did so because they knew the men who controlled the business part of the undertaking were practical men, and they had confidence in them doing their work well; and they also knew that they were simply working for the good of the industry on sound engineering lines rather than under the control of men whose objects were very often entirely different. It was often the case in this country that the men who ran the businesses were not practical men, and very often had no business knowledge. This was one of the reasons why the bankers supported the manufacturers abroad and not here. Another thing was—and he was glad to see Mr. Trotter present—they had seen in Switzerland how very well they got on with the minimum control by the authorities. In London a few years ago they had had a strong opposition to an underground railway because it would disturb third year students from working with instruments that were not being used on any useful work. In Berlin, if the instruments in the colleges were not correct, they made them meet the conditions. They felt they were there to help the industry. Another thing in favour of the manufacturers in Switzerland was that they were working under no restrictions. They had no consulting engineers, or at least those they did have were tame ones, who specified what could be obtained easily and cheaply, and did not specify all sorts of conditions. Therefore they saw the Swiss engineers manufacturing things with very much more freedom as to design than was possible in this country. With regard to the equipment of the Central London line, he did not think the engineers could have done anything else. They had to put in something which they knew would work, and could not afford to experiment. He mentioned this because some of the remarks on this subject seemed to cast a reflection on the engineers of the line. The Burgdorf-Thun line was started a few months ago, but the Central London was schemed years ago. If ever it was possible to take the alternate current direct to the motors, they had the alternate current there to do it with. In conclusion, he offered, on behalf of the committee and Institution, their very great thanks to their Swiss hosts and fellow engineers for the splendid way in which they had been received, and for the very good time they had had generally, and he would give one reason why they should repeat these foreign visits. It was a reason given by Byron:—

How much a fool who's been to Rome
Excels a fool who stops at home.

CORRESPONDENCE.

TELEPHONIC VOLTAGES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It is known to some of your readers that I have been engaged for several years in endeavouring to perfect a system of alternating measurement. This system, after very careful consideration, I based on the use of electrostatic instruments. The general type of instrument I have evolved for the purpose, particularly of an alternating wattmeter, I showed at the Physical Society last May. Owing, however, to the delightfully businesslike way in which the Physical Society conduct their affairs the description of this instrument has not yet appeared in their *Journal*.

During the last year it has become increasingly apparent to me that in connection with this system of measurement it would be desirable to have what I call an "electrostatic ammeter." Strictly speaking, of course, such a term is a misnomer though convenient in use, what is meant being really an electrostatic voltmeter capable of showing the small

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fall of potential across a low resistance. For this purpose I have, during the last years, been engaged in trying to increase the sensitiveness of an electrostatic instrument which can be used either as a simple voltmeter or as an electrometer, and suitable for use with alternating currents.

Some time since I succeeded in getting readings as high as 30mm. for one volt difference of potential on a reflecting instrument with the scale at two metres distance. Lately I have still further improved the sensitiveness, having been able to secure readings as high as 80mm. for one volt with an instrument coupled up idiostatically or as a voltmeter, and with some care I think this deflection could be doubled.

Before the Physical Society I stated that my instrument was then about 12 times as sensitive as the types of electrometers usually employed. As now arranged, the instrument is about 200 to 250 times as sensitive as the Mascart type of instrument. Under these circumstances it is possible to detect voltages as low as one-tenth of a volt alternating, and as the capacity of the instrument is of the order of one-hundred-thousandth of a microfarad the quantity or amount of electricity which can be detected is extremely minute.

Having got so far, it struck me that I must be in the neighbourhood of being able to measure the voltage of telephone line currents, an object on which I started working about 15 years ago. Accordingly, a fortnight since, I coupled up a telephone transmitter to the instrument and commenced singing sustained notes into the mouthpiece. I am gratified to say that the first attempt was successful, and I succeeded in getting a good deflection. Having since repeated the experiment before several well-known engineers, I now feel justified in making the results public.

I estimate that with the usual type of instrument the impressed voltage on the circuit when speaking into the transmitter in the ordinary way is between $\frac{1}{4}$ and $\frac{1}{2}$ of a volt. This is the average voltage produced on the secondary of the transmitter coil by singing into the transmitter a note of about the same loudness and pitch as the average voice.

Knowing the other conditions of the circuit, a number of deductions can readily be made from this fact, but I prefer to wait a little to admit of the matter being gone into more carefully before generalising further.—Yours, &c.,

London, S.W., Jan. 22. G. L. ADDENBROOKE.

SMALL WATER POWER UTILISATION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: We note in your December 22nd issue an article entitled "Columbus Arc Light Plant." In the December 28th issue of the *Engineering News* there is something further about this plant, and since then we have received letters from all parts of the country, some of them expressing their views that the plant is impracticable. Of course, none of them can cast any reflections upon our wheels, nor do they. We simply supplied what we were asked to, and our work is giving entire satisfaction. But to a certain extent they are wrong as to the practicability of the plant, because certain conditions make such use of water-wheels quite practicable. We recently received a letter from a Californian engineer, who states he has an overflow from his pumps, for which he has no use except to gather in a tank and use the fall of water to run water-wheels to run dynamos. Whether he uses this excess water or not, the overflow goes on. We have another case similar to this one, where we have used our wheels in one of the principal hotels in a large city, the water being supplied from a tank in the roof. In this case the machinery they had before they came to us created such a noise that it disturbed their guests. Since using the design we got up for them, they write us: "The wheel you sent us is a veritable blessing to our hotel and guests, as there is no noise, smoke, and little attention is needed." So there are certain conditions in which water-wheels used in small plants, as the Columbus (Ohio) plant, are distinctly of advantage.—Yours, &c.,

AMERICAN IMPULSE WHEEL CO.,

New York, Jan. 11. By H. P. CAMPBELL, President.

LEGAL INTELLIGENCE.

Rücker v. London Electric Supply Corporation (Ltd.).

On Friday last the proceedings of this action were resumed. A full report of the proceedings up to Thursday appeared in our last issue.

Mr. FLETCHER MOULTON, in opening the case for defendants, said that his learned friend, Mr. Bousfield, had made excuses for a patent which had been worked broadcast over the country by half the electric lighting companies which are in existence, and had been so worked for several years, and the action was brought in the last few months of the patent's life, the case being tried after it had actually expired. That was a very remarkable thing. Mr. Bousfield had made excuses which, standing simply on counsel's statement, would be really not relevant at all to the litigation abroad. Mr. Bousfield had referred to the result of such litigation, and he had no right so to do.

His LORDSHIP: He has not proved it.

Mr. MOULTON: No: and after all it is incorrect. He asked the Court to distinguish carefully between what was invention and what was merely the realisation of something that was already known. People did not commence an industry of this kind until there was an accumulation of knowledge promising so much that they could step from the individual, sporadic use of the means at disposal to large schemes of combined action. That accumulation of knowledge, applied to the new circumstances, would produce striking new results; but it did not follow that there had been one atom of invention in producing those new results. It might simply be that that knowledge, working on a small scale, had now the opportunity of working on a large scale, and that the results were due to no new invention, no new knowledge, but simply to the power of applying the existing knowledge to new means and new circumstances. The change produced by this change of field was most marked when they went back to the infancy of an industry of this kind. The contrast between a year before and a year afterward was so great that they were inclined to speak of those years as years of great invention. As a rule, however, they were only years of great development. Electricity had been studied at the date of the patent on a more or less large scale for many years. Its real development had been due to a large extent to Faraday, between the years 1830 and 1850, and its laws were thoroughly known. If they went to a book, he doubted very much whether they would find one which would take higher rank than one which he himself (Mr. Moulton) had studied at college, by Clerk Maxwell. But the practical use of electricity, except in such a thing as plating, where it was indispensable, was small, because the main sources of it were chemical and came from a battery, and those methods were expensive on any large scale of action. The great change came by the discovery, in 1870 or thereabouts, of the dynamo machine. Gramme was one of the first to discover it, and his patent was sent out from beleaguered Paris by pigeon-post in 1870. At the same time that they discovered that they could get electricity from mechanical power, they also found that they could get mechanical power from electricity. Thereupon the question arose, Can it produce light cheaply? and the arc light—which had its disadvantages, of course, because of its heat, but which was wonderfully cheap—attracted attention. In 1877 and 1878 that light was beginning to take an important position in industrial work. At the same time Edison and Swan—and both of them deserve the credit for it—gave a much more manageable light by the incandescent lamp. From 1876 onwards they worked at that, and in 1878 Edison brought out his incandescent lamp, just about a week before the Swan lamp was patented in England. When that lamp, which required a certain pressure to work it, and which therefore was put to straddle two different conductors, with the advantage that if you turned one light out the others continued to receive the supply, was devised, then there was initiated the idea of electrical distribution. He used the word "initiated" carefully. He denied that it was an invention. When it was suggested that there should be lines through a town kept at certain tensions, going through each house at certain tensions, so that people could put their lamps across these lines in multiple arc, it was not an invention, but something that Edison and others had already done. He would refer to the analogy of water. In olden times each householder provided himself with water, but to get it to the top of the house he pumped it up through the different storeys. When waterworks were constructed the water was delivered at a certain pressure to each of the houses, and there was no invention in that. Suppose a man has said, "Oh, I will take out a patent for supplying water to the upper storeys: you used to pump up to the upper storeys, but I will take a pipe up, and so provide supply to the upper storeys." The answer to any application for a patent for that would be that this was intended to be done by water under pressure, and that it was no invention to do that with water under pressure which was being supplied in that house. There was no novelty unless they changed the source of power. When Edison found that there was a use for electricity so universal in its application—the incandescent light, which required constant pressure—he set to work with the view of laying on electricity for the community at constant pressure, just as water had been laid on at constant pressure. That was not an invention. It was found, when application was made in 1881 to the Legislature for powers to inaugurate this kind of distribution, that that question—whether the need was a public one of sufficient importance—was a question which had to be looked into, and in 1882 the Legislature decided that it was. In that year the Legislature laid down certain rules in regard to it which admirably showed what the then state of knowledge was as to distribution. The important thing that they laid down was this. They said that they would not allow any company to control the use of electricity; that they did not know what future uses might be invented which might be largely for the good of the public; that the only thing

they contemplated was electrical energy, so that as water was sent into houses so electrical energy might be sent into houses in such way as that every individual might have it under his own control, just as he had the water under his own control, and that Parliament would not allow any company to interfere with that control. This showed that according to the knowledge of that day it was perfectly recognised that by generating stations they could give supplies of electrical energy just as they could give supplies of water: and therefore the analogy between water and electricity held good to that extent. That was all that Parliament could permit; and that was a general Act. But in the following year, on the demand of an immense number of applicants, the Legislature had to face the problem of how they could arrange that the energy could be supplied. It had to be supplied in a way which would leave it open to any man to use it as he liked; and what Edison had been exhorting was so obviously the right thing that the Legislature specially recognised that as a possible way of supplying energy. In provisional orders under the Electric Lighting Act they did not confine themselves to saying what systems might be used. They mentioned two systems, and any other that they might approve; but the only one they worked out carefully was Edison's idea of distributing electricity at a definite pressure. They stipulated that if a person chose that method, then he must undertake that at two poles in a customer's house there should be a pressure which should be what was called a standard pressure; and the company was not to ask what the customer did beyond those poles. Everybody had a right to look upon those two poles as being a machine giving electrical energy at that potential. He would submit with the greatest confidence to the Court that there was not and could not be any invention for using those two poles for any purpose for which an electrical machine had been used before. He might call it a new statutory machine. He submitted that the then position of distribution in electrical knowledge cut out distribution absolutely from being an element of invention. They had to start behind their poles if they were to have an invention. Let his lordship see what that meant. These transformers—if he might put it so—were dead things. They could only work from a source of electric energy. But it was said that the poles were never thought of as a source of alternating current at constant pressure. So little was that true that both continuous and alternating current were separately legislated for in 1883. Continuous current was first treated, and was rather petted because it was felt to be more generally useful. But the alternating current, being cheaper to make and more useful for other things, was separately legislated for and separately described. Well, these transformers had been used with alternating machines and put on the poles of such machines; and so they had got their statutory alternating machine and put their transformers upon it. So that, down to that point, he would submit that there was no invention, and that this was a claim for drawing off electrical energy simply by straddling transformers over the mains. But what did the plaintiffs say beyond that? They said, "Yes; but we put on our lamps in parallel in the secondary." In reply he would say that the plaintiffs' claim was not only for electric lighting but for any purpose; and could he say that putting lamps in parallel on a circuit was going to be held for 14 years? They said that it was the secondary circuit of an induction coil; but one of their own witnesses had told the Court that that was the way they were put on by Gaulard and Gibbs years before. To tell him that he was not to use his secondary circuit, which there was no invention in getting, for any purpose he liked, for sending the current through a group of lamps, appeared to him ludicrous. The plaintiffs said that they must not put lamps in parallel. Why? The plaintiffs also claimed the position of the transformer. But that claim was impossible, for machines in that position were contemplated by the Legislature, and legislation was the most conclusive evidence of common knowledge. Counsel then quoted from the evidence on the question of common knowledge in 1885 of instruments that would raise or lower the tension, to show that they were known and that the legislative customer could make his own circuit at whatever tension he pleased. The plaintiff had relied on the words "system of distribution." But system of distribution was simply scale, and scale did not make a patent. If merely to do a thing on a large scale would render a patent valid, then company promoters would be the greatest inventors in the world. To assert that the mains were to be high pressure and the transformers low pressure was merely to state scale of pressures. If it could be said that these patentees pointed out for the first time the advantage of saving copper by distribution at high tension, there would be something in this claim, but Edison and Deprez both had pointed out that it was best to distribute at high pressure. So that, taking into account the then knowledge of machines, the defendants were only using known machines, which were in known use and in known ways, and the then knowledge was such that they were only using them for their ordinary purposes. Witnesses (Mr. Mordey and Mr. Swinburne) on the other side had admitted that drawing off from parallel mains and using the current in the secondary was old. He (counsel) impressed on his lordship that that was the real invention, if the specification was read. A new use for an old thing was not subject matter for a patent. Here they had the very thing applied to arc lights. That was suitable for incandescent lamps. Why should it not be put on if it was suitable for incandescent lamps, and why not for a group of lamps? It seemed to him (counsel) that Brush*, in a previous patent, had told everything. Brush said his lamp could be used for alternating machines or not. That seemed to him absolutely fatal to the present claim. Referring to an article on Fuller* in *The Times*, counsel said that Fuller told to intelligent readers how to arrange their mains. It was admitted that what Fuller told them was parallel distribution. He called his lordship's particular attention to the fact that Edison* had done all that the patentees in the present case did, and more. Edison was, and always was, a great enthusiast for the continuous current. He wanted to get the advantage of distributing at high tension, but he had not a machine which would transform down a continuous current. As the current entered his transformers it was an alternating one, and it was of the same pressure, only it was always going in opposite directions. It was an alternating machine at a constant pressure. Although he got it out at one end as alternating current, Edison reversed again, and the consequence was that he sent it out pieced together, like overlapping pieces of paper, so as to make it continuous. Edison actually did that so as to get a high-tension alternating, which he turned into a low-tension alternating.

His LORDSHIP: Was the effect of all that that he had transformed down?

Mr. MOULTON: Yes.

His LORDSHIP: And was successful?

Mr. MOULTON: Oh, absolutely. And the important thing is that when he has transformed down he treats it as an incandescent light circuit of constant pressure, and he puts his lamps in parallel. What the patentees claimed was that they had invented a system by which tension was made as constant as possible. In the circumstances that looked like a general claim, and his submission was that it was bad. It was a new doctrine to him (Mr. Moulton) that judicial cognisance was to be taken of English electricians as being more ignorant than those of other countries. Edison showed them the high-tension constant and the low-tension constant, and he did not think it necessary to tell English engineers that there was a constant relation between them. Deprez unquestionably treated it as a thing of common knowledge. It was only when the thing came into court that Zipernowsky and Déri told the world everything. Apart from this, there were books written on the subject, and the rights of the public were not based on the sluggishness of people to learn the knowledge which existed.

The learned counsel then read and commented on the plaintiff's complete specification. Referring to the passage, "But the distinctive feature of our system of distribution is that each group of induction coils or transformers of the several stations of second order shall merely constitute branch circuits of the main line for the primary current—viz., the primary circuits of the several local centres—any one of these being taken as a whole, are connected in multiple arc," counsel said the patentees might have said that the distinctive feature was admitted to be Brush's Fig. 9. A man did not get a patent because a curious phenomenon took place.

LORD KELVIN, examined by Mr. Moulton, said he had taken great interest in all economic developments of electricity during his lifetime. He remembered the first Electric Lighting Act in 1882. At that time the idea of distributing electricity was very prominent to the public mind. The ordinary method of distribution proposed was called parallel. Parallel distribution by alternating currents was actually carried into effect in 1882, in the Health Exhibition and at the college of Peterhouse, Cambridge. The characteristic of distribution in parallel was that the tension at the poles remained constant, or as constant as could conveniently be had. A transformer was a new name for an induction coil. It was a name about 17 years old. It was known that induction coils would transform up or down, he thought, in the years 1850 or 1860—certainly long before 1885. The laws of induction were known and calculations made from them by Maxwell in 1868, and by electricians ever since. There was nothing with regard to the behaviour of induction coils that was known now that was not known in 1868. Improvements had been made on the very earliest induction coils, especially on the subdivision of the coil—that was made certainly before 1870. Of course there had been improvements according to the new needs, but those were improvements in design, but not in principle. At the date of the patent, or before, if a man wanted to multiply up the tension of alternating current it was known how to do it, also how to multiply down. Speaking of Brush's Fig. 9, the witness stated that there was no novelty in substituting for an arc lamp ten ordinary incandescent lamps, such as were used in 1882, in parallel. The incandescent lamps were not known at the time of Brush's specification. The only lamp known was the arc lamp. The witness also stated that Fuller did all that the plaintiff claimed to do. Edison also did what the patentees in the present case did, and more. The fact of transformers being put across the poles was known before the date of the plaintiff's specification.

Mr. MOULTON: Aye or no, would it be known that that would multiply either up or down the tension of the circuit?—Perfectly well known.

Was there any novelty, then, in the consumer getting a circuit of a different tension to his primary?—No.

Do you find anything in this specification which in your opinion was novel at that date?—The witness said it may have been novel in the sense of not being generally known, but not novel to a person with scientific knowledge. Any person who was versed in Edison or Fuller would know that there was nothing novel in it.

Cross-examined by Mr. BOUSFIELD: The parallel arrangement with feeders in a network was well known in the year 1885.

Mr. BOUSFIELD: That was within an area not too great? That was a thoroughly practical system of distribution?—Yes.

Within an area not too great?—Yes.

As we have heard, as you extended your area, trying to cover a wider area, you would get your conductors larger and larger, and at a certain point it would become unpractical, having regard to the cost of copper?—Yes; the object of the feeder arrangement of course was to keep the potential approximately uniform over a considerable area. The feeders might then lose a great deal of energy on the way. In 1883, 1884, and 1885 incandescent lamps had been recognised as a practical mode of applying electric light for general purposes. For those it was necessary that the mains should be kept at a potential as nearly constant as possible. The desirability, if it were wanted to cover a large area of being able to distribute at a high potential and use at a low potential was also recognised.

Mr. BOUSFIELD: And the means of doing it—the only means of doing it which is recognised in the Act, I think—is by having storage batteries—secondary stations, as it were, with storage batteries, those

* Extracts from these are given below.

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storage batteries being charged by mains distributing at a high potential, and then a consumer's supply being taken off those storage batteries at a low potential?—That was a method which I am not aware was recognised in the Act, but it is a recognised method.

In further cross-examination, witness stated that he himself took out a patent for such a method, and, if he remembered aright, also described it at a meeting of the British Association at York. He had himself, before 1885, patented an appliance for changing systematically and automatically the connections from those for charging at high tension to those for discharging at low pressure. This storage battery system with charging and distributing mains was not adopted to a large degree. Storage batteries were too costly, and at first they came to pieces.

Mr. BOUSFIELD: There were many difficulties which one need not go into. Electricians were hard at work in 1880 to 1883 and 1885 endeavouring, if they could, to find a better system for distributing electricity at high tension and utilising it at low tension?—Yes.

There were a great many discussions in learned and unlearned papers, and at meetings of electrical engineers, and so on?—Yes.

I need not refer to them all, but the only one which stepped out of the area of experiment, so far as one knows, was that of Gaulard and Gibbs?—Yes, I believe so.

They had an idea, and they worked on the idea that by the use of transformers or coils they hoped to solve the problem?—Yes.

And they initiated the system which we know was tried at the Aquarium, on the Metropolitan Railway, and on a much larger scale at Turin, before the year 1885, was it not?—Yes.

And they met with very partial success, did they not?—Yes.

In reply to further questions, witness stated that he did not then know of Brush's suggestion, Edison's patent, or the article describing Fuller's idea of lighting a town; but he and a good many people knew all that was to be known from the text-books and from scientific papers.

Mr. BOUSFIELD: And the desire of everybody being to get a practical system of distributing electricity at high tension and use it at low tension by means of transformers and otherwise, how was it that no one at this date had thought of this simple system of the plaintiff's patent?—Because I believe people were satisfied with the continuous current, and believed that continuous current would be better for all purposes than any other. I think many of the ablest electricians did not think it advisable to use the alternating-current system even after it had been brought into use in very many important works in London and elsewhere.

But what I want to point out to you is this: The continuous-current system with a feeder arrangement enabled you to solve the problem within a more or less limited area?—Yes; and by multiplying the central stations a very good result was obtained.

Of course that did very well with regard to multiplication of central stations; but when you had scattered consumers it would not do, would it? You could not put up a central station to supply a few odd consumers?—That is rather a difficult question. It would have been very much better, in the opinion of many, that a direct current should have been used in cases where an alternating current was actually used.

Are you still prejudiced in favour of the direct current?—No, I am not prejudiced at all. The first installation I ever used at all was in my own college at Peterhouse, which was an alternating current.

I believe at that time direct-current machines were hardly obtainable for giving a constant potential?—By 1883 they were obtainable. In 1881 and 1882 I think not. I remember in my own case I had great difficulty in getting from Messrs. Siemens in 1881 a direct-current machine, but about two years after that the difficulty had ceased.

At all events, it was in those years—1882, 1883, 1884, and 1885—recognised that the feeder system even with a three-wire system superadded only solved the problem of distribution practically within limited areas?—Limited to a great many miles.

Witness went on to say, in further cross-examination, that Fuller had suggested using transformers with low-tension mains in order to get a high tension in his lamps. That could be done, and the opposite could also be done. Referring to the specification, witness characterised the passage "The apparatus for the actual utilisation of electricity, as incandescent and arc lamps, electro-motors, &c., are in all cases connected up in multiple arc in the local secondary circuits," as a useful piece of information. One of the commonest applications of electricity was to have four, five, or six mock candles for electric light standing up looking like wax candles. These were perhaps 10 or 20 volt lamps, and five of them in series from the mains, and in almost every house in London you would find a mixed series and a parallel system in the local secondary circuits. Gaulard and Gibbs had the lamps on the secondary circuit in parallel.

Mr. BOUSFIELD: Now, if you used transformers in the way proposed by Gaulard and Gibbs, the resistance in the coils of the transformers has nothing to do with self-regulation, has it?—I have not thought that out.

At all events, you agree as regards this matter of relatively low resistance that it is a matter of vital importance in the construction of the coils under this system, if you are to get the effect of having constant potential in your circuit?—It is no more important than in other electric dynamo machinery.

That is not my question. It may be of vast importance in others, or not. But I ask you if it is not in this transformer system absolutely essential, in order to get constant potential in your lamp circuits, that you should obey this direction?—The resistance of the transformers must be relatively low.

Provided only you have sufficient turns of wire and strength of induction, it cannot be too low?—That is quite true.

In answer to further questions, Lord Kelvin said he supposed it was largely owing to his own influence as a practical electrician that the idea of distributing at high tension for electric lighting and using it at low tension was brought to the front. He had put forward the idea as an essential, as something necessary for transmission to a great distance, and in the Gaulard and Gibbs case he had said something to that effect.

Mr. BOUSFIELD: Your practical working out of that idea was to have secondary batteries charged at high tension and from them to have consumers' mains at low tension?—That was the plan I proposed. I saw no other plan except step-down dynamos—that is, transforming down—using high-tension power to drive a motor which gives low-tension power. My own idea was to do it by direct current. I had no idea then of doing it by alternating current. I did not put it into practice. I simply gave the idea, and a year or two after giving the idea I lost confidence in thinking it was the best way of doing it, or that it would be practically useful. It is partially used to this day, but not for transmitting to great distances.

I suppose you would agree that in making a useful invention you have first of all to conceive the idea and look upon it as a hypothesis worth trying, and then put it to the test of experiment to see whether it would answer your expectations?—Yes.

As regards the system described in the specification of distributing by means of a high-tension alternating current with transformers across the mains in parallel, and with a secondary circuit in which the lamps are arranged in multiple arc, you do not find any trace of that in any of the prior specifications?—I find that in Edison's specification. I find there that very idea, but with continuous current instead of alternating current. I find the idea anticipated in every detail, except the idea of transforming down; although in those anticipations the inventors may have thought of transforming up.

You know that the difficulty was the weight of copper, and that was to be solved by transforming from high tension into low tension somehow?—Yes.

As a means of solving it, had anybody thought of a system of high-tension alternating-current mains with transformers consisting of simple coils, the secondaries of which were connected to low-tension mains, with lamps in multiple arc?—The apparatus for doing it is suggested in Brush's patents, and Gaulard and Gibbs came so near to it with their multiple arc on central circuit that it was only necessary to straddle to secure the result. That was the only alteration (to put the primaries in multiple arc instead of series) necessary to make it effective. All the invention required was that, while the lamps in Gaulard and Gibbs were in parallel, they had also to put the primaries in parallel in the mains.

But I ask you, having regard to the increasing size of areas and the increasing weight of copper, what was the problem to be solved if anybody—as a means of solving that problem—had conceived the idea of using the mains with a high-tension alternating current, with transformers, with simple coils and a secondary potential?—The method would have occurred to me in an instant if I had seen the previous specifications and had been asked how would you carry out that object. Any person with Brush's specification or Gaulard and Gibbs before him would have seen it. You would only have had to change from one of the well-known modes—series—to the other well-known mode—parallel.

In answer to Mr. Justice Farwell, Lord Kelvin said he first saw the series system of primary transformers in use at the Grosvenor Gallery, and soon after—he thought in 1886—there came the change by Mr. Ferranti from series to parallel.

In further cross-examination, Lord Kelvin said that, almost without exception, practical electrical engineers at the date of this patent considered that the loss by keeping transformers always in connection would be great. Until Mr. Ferranti took the matter up almost everybody thought that it was not a practical or economical system. A system of having a transformer in the house for every user was not approved; but Mr. Ferranti saw that the use of a transformer for each house was practicable and absolutely essential.

Mr. BOUSFIELD: Ferranti himself regarded the alteration, from placing the transformers in series to placing them in parallel, as one of the most important improvements made in the apparatus?—A very important improvement, but also an improvement in the transformers; and I believe that that led to the initial partial success of the Grosvenor Gallery system. In the Gaulard and Gibbs case he (Lord Kelvin) said on May 22, 1882, that there was an important congregation of gentlemen connected with electricity supply who gave evidence before the Select Committee on the Electric Lighting Bill. Sir William Siemens' idea, and his own, then was that small areas of say a quarter of a mile were the right thing for lighting towns. That practically would be the Edison system, and he (witness) then said that it might be dangerous to bring wires of high tension into houses at all. He first saw the application of induction coils in parallel at the Grosvenor Gallery in 1886, and he then saw how it could be applied to a town.

Mr. BOUSFIELD: And so far from this alteration being obvious in 1886, even after this had been proposed and Ferranti had seized upon the idea, there were many prominent electricians who still regarded this suggestion as an unpractical thing?—Yes.

Prof. Forbes, for instance?—Yes

I have here an article by Prof. George Forbes, in *The Electrician* of Feb. 26, 1886, on "Some Points of Electrical Distribution." He there discusses this very system of Zipernowsky and Déri, and comes to the conclusion that it was an unpractical system, and suggests another means of using the transformers instead of putting them in parallel. Does not that confirm the view that electricians even of the first order had had their minds attracted to this system, but still found difficulty in regard to it?—No; I do not remember having read the article by Prof. Forbes. If Prof. Forbes had known what was stated in an article in the German journal *Electrotechnik*, he would not have written as he had done in *The Electrician*. Prof. Forbes might have known of Zipernowsky's patent, but if he had seen that article he would have known better about it than he could know from the patent itself.

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But in 1885, wherever we can find references to Zipernowsky's patent in the literature of the time, we can find many electricians of high repute who thought the system would not do; and before Ferranti took it up very few electricians thought it would do?—I do not know that that is so. Zipernowsky's article was in anticipation of his patent, and it described his experiments. The subject had been fully investigated before this patent.

In re-examination by Mr. Moulton, Lord Kelvin stated that the plaintiff's specification added nothing to the knowledge of the world as to the arrangement of the coils in parallel. He found nothing in the claim which had not been done before. The success of coils in parallel was due to the fact of the electromotive forces in the secondary being independent of the resistance. If that was so, current would increase as demanded. There was no evidence to show that Dr. Hopkinson did not know of this. Parallel distribution was well known in 1885.

Now, when parallel distribution was known, was there any invention in proposing to do at 20 places what was done at one?—No.

Was there any invention in exciting the induction coil from the two poles in a consumer's house?—No.

And, remembering Brush, was there anything novel in suggesting that you should draw from parallel mains by transformers in parallel?—No.

M. EMILE FESQUET (examined by Mr. Fletcher Moulton) said he became acquainted with Mr. Gaulard in 1882, when he was first working on transformers. Witness was an electrical engineer, now carrying on business in Paris. When Mr. Gaulard came to him he was working for the Jablochkoff Co. Witness was at the Aquarium exhibition of 1883, when Mr. Gaulard had an exhibit there showing distribution of electricity by transformers. It was worked at the exhibition, and witness helped to work it. There were two machines of four columns. The secondary wire was four times thicker than the primary, and each column was a separate induction column, and could be connected either in series or in parallel, and the lamps were put in parallel on the secondary wire. He had done it there himself, both in series and in parallel. That was done many times every day, and was a common thing—common knowledge. They were quite familiar with the induction coils, and knew what the tension would be on the secondary.

In cross-examination by Mr. Bousfield, witness said he had made transformers for Gaulard and Gibbs in 1884.

Mr. BOUSFIELD: Mr. Mordey found, with one transformer of Gaulard and Gibbs, that when you varied the total current in the lamps from no amperes to 27 amperes, the voltage in your lamp circuit fell by about 25 per cent.?—Yes, and that would be bad in practice.

That would be due to the resistance being too high?—Yes, in the transformer.

When you are working on a constant-current system instead of a constant-potential system, the difference of resistance in the system is of small importance?—Of course.

But in the Zipernowsky system the question of relative resistance in the transformer is of great importance?—Yes, when you work in parallel.

Now, do you suggest that in any text-book of that time such a phenomenon had been pointed out?—I cannot say about the text-books, but I know that we all knew about it.

Witness was shown an illustration, and asked if it was a picture of what was exhibited at the Aquarium?—Yes. There are shown four columns, and there is a little switch at the base of the instrument. The purpose of that switch was to put a plug on the main line. The switch only affected the primaries. If they put it on the first point, there would be one primary working: if on the second, there would be two primaries; and so with the others, but not necessarily in series.

Then will you tell me what that switch is for, and what it did when you put it on the first, second, third, and fourth columns?—When you put it on the first you put the first column on the circuit on the main line, and when you put it on the second column you put the second column on the main line. I do not say in series, because it might be in parallel or in series, but you must first switch with this switch in order to get them on the main line. You could put all the four columns on the main line by means of that switch. If I connect them on the top, one after the other, I can connect them in series; and by connecting them in another way I can put them in parallel. I know that the Gaulard and Gibbs system was the series system, and that their purpose was to confine their energy to one very long wire and give each customer a constant current.

In re-examination, witness said the machine shown at the Aquarium was capable, by its terminals, of being coupled up either in parallel or in series.

Mr. S. Z. DE FERRANTI (examined by Mr. Cripps) said he was an electrician, and a manufacturer of electrical plant and apparatus. He was the inventor of dynamo machines which were still largely used for electric lighting. He had had a great deal to do with the theory of electricity, both as a practical manufacturer and as a practical electrician.

Mr. CRIPPS (reading from the specification): "Now, the object of this invention is to make all individual points of consumption of electrical energy quite independent from one another, all necessary regulation being made by or at the generator of electricity." Was there anything novel in that when this specification was published?—I do not think so.

Was there anything novel in getting the necessary regulation by or at the generator of electricity?—There might be something novel in the details for making the voltage of the generator approximately constant.

It would have been given by any alternating machine?—Yes. Their machine at that date gave approximately constant voltage—that is, within a small percentage.

I need not read the next words to you, because that is merely a form of grouping, but then it goes on: "The apparatus for the actual utilisation of electricity, as incandescent and arc lamps, electromotors, &c., are in all cases connected up in multiple arc in local secondary circuits." Was there anything new in that?—Nothing whatever.

Then the specification proceeds: "In this manner we have conductors distributing the primary (high-tension) current in as many branch circuits as there are local centres, and any desirable number of secondary (low tension) circuits." Was there anything new in having the conductors distributing the primary high-tension current, and in having the desirable number of low-tension secondary circuits?—I can see nothing novel in that.

I want to particularly call your attention to the next passage: "Now the electromotive forces of the two coils of a transformer bear a constant ratio to one another." Was that known at the time the specification was published?—It was known by a great many people.

You knew it yourself?—I did.

Further examined, the witness said that there was no novelty at this time in saying the internal resistance should be low on the secondary—the lighting circuit. A great many years before witness saw an apparatus of Gaulard and Gibbs at work on the Metropolitan Railway, in which it was evident that the secondaries had a very low resistance: they were made of copper of considerable section, and they must have had a low resistance. Another reason why they must have had a low resistance was because they would not have carried the current for doing the lighting without getting too hot unless their resistance had been very low.

Mr. CRIPPS.—Now, looking to the claim, "In the application of induction coils or transformers for alternating electric currents," was there anything new in that at this time?—No.

Then he says: "The arrangement of several stations of second order as branch circuits of the main line"?—That is certainly not new.

Is there anything new in supplying to the main line as constant as possible?—It is only what he would get from any of the well-known forms of alternating machines. I really cannot see any invention in it on any part.

Referring to Brush's Fig. 9, witness said that he saw no difference whatever between that Fig. 9 with its arc lamps and the plaintiff's specification, reading in arc lamps. Mr. Ferranti went on to state that he was referring to some electric lighting at Brighton when there was a company there supplying arc lamps throughout the town. In most cases each shop had one or two or more arc lamps in a series circuit from what was known as a Brush 40-light machine. Many people preferred to have 10 incandescent lamps in place of one arc lamp. They then took away the one arc light, substituted 10 incandescent lamps, and provided apparatus so that those lamps could be turned on or off. He believed that was in 1882. It certainly was not later than 1883, because he made apparatus himself at Hammond's works in Finsbury in 1883 for carrying out that work. As to Edison's specification, he agreed with Lord Kelvin that it described all that there was in the plaintiff's specification, and a good deal more besides—the method of producing the alternating current, and the method of collecting the alternating current, generating it, and using it. He thought that that machine would work practically for distribution on a small scale. In fact, he had seen a model of it working very successfully on a small scale, and his experience with commutators or rectifiers satisfied him that it could be so worked.

Shown *The Times* article regarding Fuller's discovery, witness said that he found described in that article a system of distribution from alternating mains, using the transformer and then taking the secondary current, the transformers being in parallel. The only thing not described was that it did not say that the transformers were to be of low internal resistance, otherwise it was a description of a complete parallel system.

Mr. CRIPPS: Now I take you to Rankin Kennedy's article in the *Electrical Review*, and to the last words of that article. He there says: "In parallel arc, however, the secondary generator is a beautiful self-governing system of distribution; but what about the size of conductors for such a system?" Now, so far as the system or arrangement which we find in the plaintiff's specification was self-regulating or self-governing—upon which he relies—do you find that described by Rankin Kennedy?

WITNESS: Yes. He states it most clearly, and he understands its action fully. He says it is "a beautiful self-governing system of distribution"—that is to say, it transformed in parallel and was self-regulating.

Would it put the lamps in parallel too?—Clearly; that follows from the article. In the article by Zipernowsky and Déri I find an actual description of what is in the plaintiff's specification. That description could not be read in any other way. Even in regard to the point of low internal resistance, there was no invention in the plaintiff's specification. We had been doing it before.

Cross-examined by Mr. BOUSFIELD: You infer from Zipernowsky's article practically everything that is in the plaintiff's specification?—Yes.

You have it stated that the number of lamps could be altered without altering or diminishing the brilliancy of the remainder?—That shows that there was low resistance. I knew in 1883 that low resistance was essential.

Not for transformers?—For all electrical apparatus, and I had experience of transformers. In 1883 I supplied two of my dynamos to the First Avenue Hotel. The installation was two dynamos and about 1,000 lamps. With a few running the light was bright.

When the whole lot were running were they not like red-hot hairpins?—No, not at all; but there was a drop in brilliancy. We had an alternating current.

I put it to you that the main difficulty was that your dynamos were made with too much resistance in them?—No; they were made with as low resistance as reasonably could be. Those dynamos were ultimately taken out, and continuous-current machines put in and storage batteries used. It meant re-wiring the whole place to keep the alternating current.

Now, with regard to Rankin Kennedy: in your view, there was no invention at all about the plaintiff's system?—Yes.

According to you, it was perfectly obvious to any electrician?—To any electrician thinking about it.

Rankin Kennedy clearly stated where the Gaulard and Gibbs system is defective?—Yes; and so he had evidently thought about it, and he even saw to some extent that the blocking action which was had in Gaulard and Gibbs' system would have a good effect in a parallel system, and he was evidently thinking of systems of electrical distribution.

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And yet he came to the conclusion, with all this knowledge in his mind, and with the knowledge that the blocking—which was bad—could be put to good account if put in parallel, that "these phenomena indicate a vast objection, or rather obstacle, in the way of the distribution of electric lights by secondary generators, because, although the main current is beyond the reach of hand or of any instrument, it can be reduced to nothing or increased to its maximum without in any way interfering with the wires or coils conveying it." Was not that condemning secondary generators for the purpose of distributing electricity?—Yes; there was a certain distance to which he had not gone.

Then, in his last paragraph, Rankin Kennedy says: "In parallel arc, however, the secondary generator is a beautiful system of distribution; but what about the size of conductors for such a system? Prodigious!" So that I may state his view roughly thus: That the blocking effect in the Gaulard and Gibbs system was condemned by him, and that, although it might be useful in the parallel system, it was objectionable on other grounds?—It is hard to say exactly what was passing through the mind of Rankin Kennedy when he wrote the word "prodigious," but I take it that what he was afraid of was the details of manufacture of transformers to take a very high tension within themselves.

Mr. BOUSFIELD (referring to Brush's patent): I put it to you that the specification shows that Brush was ignorant of the fact that the current would be blocked to a certain extent when lamps went out, and that the same current would go on passing?—I do not see that it does.

Can you point out anything in the specification to show the contrary?—I say everything points to that view. He may have been partly wrong with regard to the description of Fig. 8, but he was perfectly right with regard to Fig. 9.

Assuming that he is substantially right, and that the going out of a lamp does not materially affect the current passing through the coils, then the same effect would take place in Fig. 9, and it would not materially affect the current passing through the coils?—Yes.

Re-examined by Mr. Moulton: In your opinion, does Brush's Fig. 9 show any electrician of 1885 parallel distribution by induction in multiple arc?—Clearly it does. Furthermore, one Brush lamp would require enough current to work ten incandescent lamps. That was known prior to 1885.

Further re-examined, witness said it was not true that the alternating apparatus which he put up at the First Avenue Hotel failed because the resistance was not low enough in his machine.

Mr. ELI COLLINS, librarian of the Patent Office library, gave formal evidence as to when certain publications were put in the library.

This closed the defendants' case.

Mr. MOULTON proceeded to sum up on behalf of his clients. Counsel said that for the purpose of assisting his lordship in dealing with the mass of material now before him, he should put his case in the form of propositions. The first thing they had to do was to get the background of public knowledge on which the patent was to be considered. His first proposition was that at this date the parallel system of distribution giving at each consumer's premises a supply of electrical energy at constant potential, to be drawn off in multiple arc, was perfectly well known, both for continuous and alternating currents. That proposition was not really contested. The Acts of Parliament spoke for themselves clearly about it. The next question he would put before his lordship was that the transformer was known as a machine which multiplied up or down the tension of the primary. He read the evidence given by Mr. Swinburne on the point. His third proposition was that the exciting of an induction coil by a machine for the purpose of utilising its secondary circuit was not novel. Edison actuated a coil by alternating current, and used a secondary current. That was not contested. He then came to the article of Zipernowsky and Déri. Beyond question then the secondary was used and the primary was excited. Nobody doubted that. The consequence was that at those dates they had got primaries being excited and secondaries being used. Therefore it was old to use an induction coil, excite the primary, and use the secondary for what purposes you wanted. If it was common when you used a machine to excite it, there was no novelty in using your poles to excite it. The plaintiffs then said, "Oh, the lamps in the secondary were not in parallel." That was what it all came to. Was there any novelty in that? His fourth proposition was that putting machines in parallel on the secondary of an induction coil was not novel. He read the evidence on this point, and said that when once parallel distribution was admitted, it was implied that you drew off in multiple arc. Parallel distribution meant drawing off by "straddling." He then proceeded to deal with the plaintiff's attack on the alleged anticipations. These anticipations showed that lamps were put in parallel on the secondary of induction coils actuated perhaps by machines or by poles of parallel distribution, which he (counsel) said was exactly the same thing. The plaintiffs did not deny that there was parallel distribution in Brush. There was no objection to the completeness of Zipernowsky and Déri. The simple question was whether that was intelligible. He then came to Edison. He thought Lord Kelvin put it quite rightly when he said that Edison did all that the plaintiff did, and more. And all the criticisms were in the "more." The learned counsel then referred to the article in *The Times* about Fuller's system, and contended that the article showed the world plainly that Fuller had adopted that system of distribution. Counsel read the claim of the plaintiff's specification: "In the application of induction coils or transformers for alternating electric currents the arrangement of several stations of second order as branch circuits of the main line—*i.e.*, connecting up the local centres with the main line in multiple arc, to which main line is supplied an alternating electric current of a tension as constant as possible, substantially as described and shown in the drawing." He submitted that this only meant: "I am not going to do what Gaulard and Gibbs did, and put my transformers in series. Put them in parallel." The "stations of second order" were exactly the same as Gaulard and Gibbs'. But he would admit that this specification contemplated using them with lamps in parallel. He however, doubted whether it was limited by that. He did not admit that it was. But it was admitted to be the common knowledge of electricians that the tension in the secondary circuit was independent of resistance, and there was no question that people would put lamps in parallel on such a circuit. So that it would be the ordinary way of doing it, and therefore he need not trouble to enlarge upon that point. But what was meant by this claim was—stepping from Brush's Fig. 8, which had been done by Gaulard and Gibbs, to Brush's Fig. 9 then already known. This specification commenced by saying what had substantially been done in Brush's Fig. 8; and then the plaintiff gave wise advice about how to use Fig. 9. But he claimed Fig. 9; and that was his (Mr. Fletcher Moulton's) interpretation of the claim. There were things perhaps in the specification which were not arrangement, but were merely rules showing the scope which to the engineer the arrangement gave. These were not limitations; they only gave assistance in using the arrangements, and there was not one word in the specification which limited the breadth of the claim, or which entitled the other side to say that they had not got to defend the whole system of putting the transformers in multiple arc and parallel circuit. The mention of "low resistance" in the specification did not limit the claim; it could not limit the claim, because it was too vague. First of all, therefore, did this apply to the secondary and to the primary?

Mr. BOUSFIELD: Yes.

Mr. MOULTON: My learned friend says "Yes." If your lordship will look at the provisional specification you will see: "The several places of consumption in the local circuits are independent from each other, in consequence of their distribution as branch lines of the secondary circuit line if only the interior resistance of the induced bobbins is proportionally small, and if the primary tension of the station does not change." I say that until the plaintiffs came into court all this referred to nothing but the secondary, and I believe it does refer to the secondary. The learned counsel continuing, said, Was it novel to say that the resistance in the secondary must be low? He (counsel) felt positively indignant at this point being raised by his learned friend, Mr. Bousfield. It was saying that the whole world was beholden to the plaintiff for telling it something that a boy ought to have learnt in the first six days of his study of electricity, and which was universally and must have been universally applied by everybody who was entrusted to make an installation at all. It was merely Ohm's law as one had got to apply it when calculating the effect of every simple arrangement of electrical circuits. He had now dealt with all the points raised in the specification and would just deal with some of the points outside the specification, which Mr. Bousfield had brought up as skirmishers to protect his flank. One was as to back electromotive force. It was proved that the current would increase as the demand for it increased in the secondary. Mr. Bousfield had said that this was due to back electromotive force, but he (Mr. Moulton) did not care what it was due to. The only important thing was that it was so and that it was old. Then it was said that it was known that secondaries were self-regulating, but what had that got to do with the case? Mr. Ferranti knew all that the plaintiff did, and he (counsel) could not understand because a man improved a thing that therefore he did not know how good it was. The learned counsel then referred to the three-wire patent, which he said had nothing to do with the present case. Primarily he thought it to be the real issue in the case that if you took the claim and read it, and considered the interpretation which any man would put upon it as a document, he would deem it to be a claim for arrangement only, and that arrangement was known to be old. The claim was a broad one, and he submitted that the patent must be held to be invalid.

Mr. BOUSFIELD replied on the whole case on behalf of the plaintiff. He said that, assuming he was wrong about there being any novel idea or discovery being imported by the patentees, and assuming that every principle was old and that there was nothing more in the realm of scientific discovery to be done to make the combination, still he should be on firm ground, and he did not know that his case would be very different to what he had represented it to be. The way he should base his case, even taking the worst against himself—viz., that there were no scientific principles to be discovered, and that everything which had been done followed known principles of calculation—the putting the thing together and applying it for practical purposes constituted the invention. The learned counsel claimed to have made out the essential practical direction of low resistance, without which, he said, the system could not have been made to work. He should endeavour to show his lordship that the patentees had been the first to elucidate a vital point in the construction of a transformer on which the possibility of this system as a system of distribution absolutely depended. It did not matter one straw whether the principles involved in an invention were well-known principles. In the law of patents it did not matter if the patentee took well-known principles and ideas, and put them together and made his system practicable. Gaulard and Gibbs tried to solve this question for years, and never solved it. Edison had his mind on the problem of distribution, and failed to show a practical solution of the thing. The same thing could be said of Rankin Kennedy. Lord Kelvin never solved the question until he saw the plaintiff's system at work. His learned friend on the other side had constantly been alternating between a construction of this specification which would make it one simply for putting transformers across the mains and which would include any prior application, and a construction which narrowed it down so that it would be practically worth nothing at all. As to that narrower construction, his learned friend had got hold of a mare's nest. The patentees described two or three alternative forms of apparatus by which the generator kept its own potential constant, and when that was not done automatically it was done at the generator. It was to regulate at the station, and that was done by keeping the pressure constant.

Mr. Justice FARWELL reserved his judgment.

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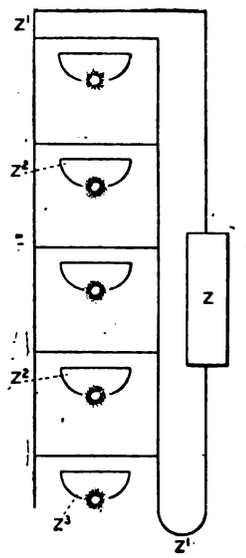
Below we give Fig. 9 of Brush's United States patent, No. 219,209 of Sept. 2, 1879, alluded to so frequently during the case. The reference to this figure in Brush's specification is as follows: "Figs. 8 and 9 of the drawings show in a diagrammatic manner a battery or preferably a dynamo-electric machine, Z, designed to maintain a current through the circuit Z^1. . . . I propose, if desired, to operate the lamps by an induced current, due to and generated by the current in the circuit Z^1. I shall not here specify any particular electro-induction apparatus, reserving such a description for a proposed subsequent application. . . . It is well known that when an electric current is started in one of two parallel and adjacent con-



Brush's Fig. 9.

ductors, an inverse current is induced in the other conductor, lasting only until the induced current has attained its maximum strength, and that when the inducing current is stopped or diminished a direct current is induced in the neighbouring conductor. I propose to utilise these facts in the construction of my induction apparatus alluded to, whereby a current through the circuit Z^1 will set up an induced current in each circuit Z^2 of an electric lamp, Z^3, as diagrammatically illustrated in Figs. 8 and 9." [Fig. 8 is a series connection.]

The following is the main portion of Edison's United States patent 278,418 of May 29, 1883, which is alleged to anticipate the plaintiff's patent:—

Apparatus for Translating Electric Currents from High to Low Tension.

The object of this invention is to produce simple and efficient means for reducing the tension of a continuous current flowing in a main circuit, and supplying consumption circuits with a continuous current of lower tension, whereby a large saving can be made in the investment for conductors by using small main conductors, and obviating excessive loss of energy by the use of a current of high tension in the main circuit, while lamps, motors, or other translating devices requiring a continuous current can be supplied, and by the use of a current of lower tension in the consumption circuit the translating devices can be placed in separate multiple arc circuits and made independently controllable. The object is accomplished by the use of induction apparatus located between the main circuit and the translating devices, and transforming a continuous current of high tension into a continuous current of lower tension by the employment of a magnetic core or cores having two sets of wire coils, one of high resistance connected with the main circuit, and one of lower resistance connected with the consumption circuit, the connections of the main and consumption circuits with their respective sets of coils being changed or advanced simultaneously so that the inductive action of the magnetic core or cores will cause current to flow in the consumption circuit always in the same direction.

In carrying out the invention a number of magnetic cores are preferably employed, which cores are preferably arranged in pairs to form horseshoe magnets, and have plates closed up on their poles. These magnetic cores are wound with two sets of wire placed on different portions of the cores or coiled one upon the other on the same portions of the cores. One set of coils is of high resistance, while the other set is of low resistance, and each set of coils is connected in a closed circuit, independent of the circuit of the other set. The closed circuit of each set of coils is connected with the bars or plates of a stationary commutator cylinder at points between the pairs of magnetic cores, there being a bar an each commutator cylinder for each pair of magnetic cores. Upon each commutator cylinder travels a pair of commutator brushes or springs. These commutator brushes are mounted upon a common shaft, which is revolved by any suitable means, an electromotor being used for the purpose, or a spring or weight-actuated mechanism. The brushes travelling on the commutator cylinder connected with the coils of high resistance are connected with the consumption circuit. The current in the fine-wire or high-resistance coils flows from one commutator brush to the other in two directions, one-half the pairs of cores having their coils receive current in one direction, while the other half of the cores have their coils receive current in the opposite direction. Now, the revolution of the commutator brushes will cause the pairs of magnetic cores to have the connections of their coils reversed two at a time, thus causing a reversal of magnetic polarity. This change in magnetic polarity induces a current of lower tension in the coarse or low-resistance coils, the connections with which being advanced simultaneously with those of the fine-wire coils, the induced current is made a continuous current, or a current flowing in one direction. The action may perhaps be better illustrated by considering the points at which the current flows into and leaves the closed circuit of the fine-wire coils as in the neutral line. This is advanced by the revolution of the commutator brushes, and the opposite pairs of magnetic cores are crossed by the line simultaneously. The same result would be produced if the magnetic cores were mounted upon a shaft and revolved with the commutator cylinders, the commutator brushes being held stationary.

Instead of using a number of double-wound magnetic cores, a single annular core can be used, similar to a Gramme ring, the annular core being provided with two sets of continuously-wound wire coils, one of high resistance and the other of low resistance, connected at the intervals to the bars of separate commutator cylinders.

The coils of high resistance are connected through the commutator and brushes with the main circuit, while the coils of low resistance are similarly connected with the consumption circuit. The double-wound ring and the commutator cylinders may be revolved, and the commutator brushes or springs held stationary; or the commutator brushes may be revolved together and the ring and cylinders held stationary. The double-wound ring is preferably surrounded by a ring of iron to carry the magnetism between the ends of the neutral line.

The following are the claims:—

1. The combination, with a main circuit having a continuous current of high tension, of a consumption circuit of low tension, provided with translating devices arranged in multiple arc, and an intermediate induction apparatus for reducing the tension of the current, substantially as set forth.

2. The combination, with a main circuit having a continuous current of high tension, of a consumption circuit, an intermediate, double-wound magnetic core or cores, and commutator for simultaneously changing or advancing the connections of the circuits with the windings of such core or cores, substantially as set forth.

3. The combination, with the main and consumption circuits, of a magnetic core or cores provided with two sets of coils, one of high and one of low resistance, connected in separate closed circuits, and two commutators, one connecting the high-resistance coils at intervals and one connecting the low-resistance coils at intervals with the consumption circuit, the connections of the main and consumption circuits being changed or advanced simultaneously, substantially as set forth.

4. The combination, with the main and consumption circuits, of the double-wound stationary core or cores, the stationary commutator cylinders connected at intervals with the windings of such core or cores, and the simultaneously-revolving commutator brushes or springs connected with the main and consumption circuits, substantially as set forth.

5. The combination, with the main and consumption circuits of the double-wound stationary core or cores, the commutator cylinders, and the exterior iron ring, substantially as set forth.

Below we give that part of the article in *The Times*, referred to as the Fuller article, which has a bearing on the case. It is from *The Times* of March 22, 1879:—

"The third lamp for household use has been invented within the last year, and nearly perfected. One of the early friends and associates of Edison was a young man named J. B. Fuller, a Connecticut Yankee, in whom the inventive faculty was active from boyhood. Fuller made a great deal of telegraph machinery, and invented many industrial processes, such as modes of utilising wood pulp in paper making, &c. Ten or fifteen years ago Fuller separated from Edison, because it would no longer do to have them work in company. The inventions of the one might easily have been said to be due to the suggestions of the other, and so the two men parted, never to see each other again. . . . Fuller evolved a whole system of lighting—the generator, a lamp, and a meter. He proposed to use two large street mains, one of them insulated, disconnected at the outward ends. The positive main was to throw off a branch wire into each building to be lighted, the wire entering the meter, performing a certain service there, and then returning to the street to the negative main. The main current was not to do the lighting, but it was to generate another current in a series of induction coils, and each lamp was to be lighted by the current from one of these coils. An alternating current was to be used. The induction coils were thus made: Two magnet cores, arranged parallel to each other, were connected magnetically at the ends. Around the centres of each of these cores was a soft iron head, and at a proper distance from this a head of insulating material. The outward ends of the cores were coiled with insulated copper wire, and so connected together and to the main wire (or generator) as to produce two opposite magnetic poles. Between the soft iron heads and the coils were wound smaller coils of insulated wire, the fineness of which would depend on the tension required. To one of the iron heads was hinged an iron arm, so made as to swing over upon the other, connecting magnetically the poles north and south. In a coil so made, if a current be sent through the main wire rapidly changing in opposite directions, the magnetic cores will change polarity, and the change will induce a current of great tension in the smaller coils, and this second current, if conducted by proper wires to a lamp, will maintain platinum or carbon in a high state of incandescence; two induction coils or four can be coupled together for lights of stronger power. A graduated switch is used in this lamp, so as to permit its brightness to be varied at will. A great many experiments were made with this style of lamp with platinum burners, and they operated admirably. A number of capitalists of Booklyn, hearing about these experiments, organised a company, with $1,000,000 capital, last December, to adopt Fuller's inventions and introduce his light throughout Brooklyn. A new shop was fitted up for the inventor on Broadway, near

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36th-street, in New York city, near his residence, and in this shop Fuller toiled for six months almost literally day and night. His whole system was in a most promising shape, when last February an incident occurred which put a stop to the progress of experiments in household lighting—[Fuller died.] . . . The death of Mr. Fuller has retarded the perfection of his lamp for household lighting, and may possibly postpone it for years. Very nice principles of induction were involved in the invention, and no one now living in America understands those principles so well as he did. . . .

"For factory lighting the point-to-point lamps are coming into use very fast: 20 factories and hotels are now employing them. The Brush light is leading at present. The carbon rods in this lamp are covered thinly with copper to increase their conductivity, and 18 lamps of 2,000 c.p. each are kept burning on one circuit, with 16 H.P., at a cost of $1.65c. per hour and the interest and depreciation on an investment of $3,750. Brush is the only maker of lamps of this class who tries to operate several lamps with one machine. The others—the Fuller Co., Arnoux and Hochhausen, Wallace and Maxim—prefer to employ a single small machine with each lamp, believing that power is saved thereby."

The Ferranti patent, No. 15,251 of 1885, was also put in by the plaintiff after Mr. Ferranti's cross-examination. Claim 1 of this patent is as follows:—

"1. The improved means for distributing electric energy consisting in providing high-tension mains and low-tension mains, and causing each low-tension main to be fed from the high-tension main through two or more convertors which are connected and disconnected as required."

Postmaster General v. Glasgow Corporation.

In the First Division the Court of Session, Edinburgh, on Friday, judgment was given in the appeal of the Glasgow Corporation from an order of the Railway and Canal Commissioners authorising the Postmaster-General to put down telegraph wires without the consent of the Corporation.

The LORD-PRESIDENT (Lord Adam) said that by sec. 17 of the Railway and Canal Traffic Act, 1888, it was enacted that no appeal should lie from the Commissioners upon a question of fact or upon any question regarding the *locus standi* of a complainant; but that, save as otherwise provided, an appeal should lie from the Commissioners to a superior Court of appeal. The Corporation of Glasgow was a body within the meaning of the Telegraph Acts, 1862 to 1892, having power under those acts to give or withhold their consent to the placing and maintaining by the Postmaster-General of telegraphs under the streets of Glasgow, and by notice in writing, dated Dec. 21, 1898, the Postmaster-General required the Corporation, within 21 days to give their consent to the placing of certain lines of telegraph in, under, upon, over, along, or across certain streets or public roads in Glasgow. On Jan. 10, 1899, the Corporation informed the Postmaster-General in writing that they were prepared to give their consent, provided the consent was not to be made applicable to the purposes of any private company or individual, whose application, if made direct to the Corporation, could be refused by them without right of appeal, and on Feb. 17, 1899, the Postmaster-General notified the Corporation that he objected to this condition. A difference thus arose, and this difference was, under the Telegraph Act, 1878, referred to the Sheriff of Lanarkshire, and heard and determined by him. He awarded and ordered that the condition above-mentioned ought not to be attached to the consent of the Corporation, and he further consented that the Postmaster-General should be at liberty to place the lines of underground telegraphs in or under the streets mentioned. On May 5, 1899, the Corporation notified the Postmaster-General that they were dissatisfied with this award, and required that the difference which had arisen between the Postmaster-General and the Corporation should be referred to the Railway and Canal Commissioners. Reference was therefore made to the Railway and Canal Commissioners, and by order, dated Aug. 12, 1899, the Railway and Canal Commissioners determined that the conditions demanded by the Corporation ought not to be attached to the consent, and further ordered and consented that the Postmaster-General should be at liberty to place lines of underground telegraphs under the streets mentioned. The Corporation then appealed to this Court against the order of the Railway and Canal Commissioners, and the Postmaster-General maintained that the appeal was incompetent, and this view his lordship now upheld. He held that the question brought before them by the appeal was not one of law, but of fact, and, consequently, that they had no jurisdiction to entertain it. The other judges concurred. The appeal was therefore dismissed, with costs against the Corporation.

Western and Brazilian Telegraph Co. (Ltd.) v. South American Cable Co. (Ltd.)

This case came before Mr. Justice Kennedy in the Commercial Court on Tuesday, and was an action brought by plaintiffs to recover £475 balance alleged to be due from defendants in respect of the interchange of telegraphic traffic at Pernambuco.

Mr. LAWSON WALTON, Q.C., said the question in issue turned on the construction of an agreement contained in certain letters. The plaintiff company owned a telegraphic system in Brazil, including a local system and a submarine cable running north and south from Pernambuco along the coast of Brazil. In 1891 plaintiffs entered into an arrangement with the Brazilian Submarine Telegraph Co.—which company owned a cable from London to Pernambuco *viâ* Madeira—the arrangement being that telegraphic messages of the two companies should be interchanged at Pernambuco, and that the entire receipts of both companies should be "pooled," and, after paying expenses, the profits were to be divided; the plaintiff company taking 48 per cent., and the Brazilian Submarine Co. 52 per cent. of the profits. Defendant company owned a cable which at one time only went from Europe to Sénégal in French West Africa. In 1891 defendants extended their cable from Sénégal to Pernambuco, and thus came into competition with the Brazilian Submarine Co. Negotiations were entered into between plaintiffs and defendants as to the interchange of messages at Pernambuco at a through rate and a great deal of correspondence took place as to the division of the rate. The agreement which was arrived at was that defendants should accept "the same proportion" as plaintiffs paid the Brazilian Submarine Co. for outward and homeward messages, and defendants in which they agreed that the plaintiffs' "proportion of the total charge" should be that received by plaintiffs in exchanging traffic with the Brazilian Submarine Co. Plaintiffs now argued that the true meaning of these terms was that the charge for oceanic cables should be divided between them and defendants in the proportion of 52 per cent. to defendants and 48 per cent. to plaintiffs. Defendants however contended that they were entitled to be put upon the same footing in all respects as the Brazilian Submarine Co., viz., to be paid not only 52 per cent. of the through rates for international traffic, but also a similar percentage in respect of local rates received by plaintiffs.

Mr. JUSTICE KENNEDY, in giving judgment, said that although there was much to be said in support of defendants' view as to the true construction of the agreement, he was of opinion that plaintiffs' contention was the right one. He thought the words "same proportion" in the defendants' letter meant the proportion of the total charge made in respect of through messages which was received by plaintiffs. The agreement with the defendants referred to international messages only and did not admit the defendants to all the advantages of the pooling agreement which the plaintiffs had entered into with the Brazilian Submarine Co. He accordingly gave judgment for plaintiffs with costs.

Birch v. McFarlane.

This case came before the Court of Appeal, on Tuesday, to restrain defendant from intercepting and penning up and then releasing the water of the river Chess in Hertfordshire, or from otherwise interfering with the continuous and natural flow of water to plaintiff's property. The plaintiff was tenant for life of Rickmansworth Park and Scot's-bridge Mill, and the river Chess, which flowed through the property, was stated to be a valuable trout stream. The mill was worked by water from the river. The defendant was owner of a property purchased in 1837, called Glen Chess, and upon that property there were formerly paper mills worked by a water-wheel and turbine. These works were stopped in 1886, and the ground of complaint was that defendant had utilised the turbine to drive a dynamo for lighting his house by electricity. It was said that, for the more effectual working of the turbine, the water was intercepted and penned back for several hours daily, thus substituting an intermittent for a continuous flow. Mr. Justice Kekewich granted an injunction, and from that decision defendant appealed. The Court now dismissed the appeal, but modified the form of the injunction so as to make it less oppressive to defendant.

ON THE LEAST POTENTIAL DIFFERENCE REQUIRED TO PRODUCE DISCHARGE THROUGH VARIOUS GASES.*

BY THE HON. R. J. STRUTT, B.A.

The investigation of which an account is given in this Paper deals with the potential difference required to produce sparks in various gases, between large parallel planes at a fixed distance apart, and at various pressures. It was found by Mr. Peace† that the striking potential between two parallel plates in air diminished as the pressure diminished, till a certain point was reached, and then began to rise very rapidly. The pressure at which the striking potential was a minimum depended on the distance between the plates, and increased as the distance was lessened. The minimum potential itself, however, varied very little with the distance between the plates. This minimum potential was of the same order as the cathode fall of potential in air, as has been pointed out by Prof. J. J. Thomson.‡ The following explanation may be offered of the fact that there is this minimum striking potential, and that it is approximately constant.

The negative glow in any gas, as has been shown by Warburg,§ requires for its production a definite difference of potential (about 340 volts in the case of air) independent of the pressure and constant, so long as the glow is not crushed into a smaller space than that which it would naturally occupy. If the glow is crushed the necessary potential is greater. Let us now suppose that the discharge takes place between two parallel plates. A part of the space between these plates is occupied by the negative glow, a part by the positive column. So long as any of the positive column remains, it is clear that the negative glow is not constricted, and consequently it only requires 340 volts to produce it. The greater the length of the positive column, the greater the corresponding potential difference, so that the striking potential will be the least possible when the

* Abstract from a Paper read before the Royal Society.
† Royal Society *Proceedings*, Vol., LII., p. 99.
‡ "Recent Researches in Electricity and Magnetism," p. 158.
§ *Wied. Ann.*, Vol. XXXI., p. 579.

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pressure is low enough to make the negative glow occupy the whole space between the plates, but not low enough to make it require more.

My experiments have been undertaken with a view to obtaining further experimental evidence on these ideas. The sparks were taken between large metal plates 1mm. apart. For details of the apparatus and method of experimenting, the original Paper must be consulted. There also will be found curves showing the relation between spark potential and pressure for the following gases: atmospheric air, hydrogen, nitrogen, helium. I give here only the minimum value of the spark potential found for each, together with the cathode fall of potential given by Warburg:—

Nature of gas.	Cathode fall.	Minimum spark potential.
	Volts.	Volts.
Atmospheric air	340—350	341
Hydrogen	300	302, 308
Ordinary nitrogen	Variable, 315—340	347, 351, 369, 388
Nitrogen specially freed from all traces of oxygen	230	251
Helium	226	Variable, 326—251

It will be seen that, on the whole, the evidence is in favour of the views explained above. It was found impracticable to get accurately consistent results in the case of helium. Some cause, the nature of which has not been traced, made the results different with different samples of the gas, although in each case care had been taken with the purification. The helium curve, however, shows very peculiar features, the spark potential being, for a wide range of pressure in the neighbourhood of the minimum, almost independent of the pressure

MEASUREMENTS OF THE SELF-INDUCTION OF SUBMARINE CABLES.*

BY DR. F. BREISIG.

[A Communication from the Testing Office of the German Government Telegraphs.]

In long cables it is chiefly the large capacity that is antagonistic to a fast speed of signalling, this property in conjunction with the high resistance flattening the electrical impulses. A reduction of the capacity or resistance cannot be effected, owing to the cost of doing so. One can, however, try to counterbalance the evil effects of capacity by introducing self-induction, and proposals in this direction were made long ago. A self-induction of the correct value would compensate the effect of the capacity, and would thus permit the speed of telegraphing to be increased considerably. Two proposals have been made of methods in which self-induction may be introduced. One is to connect in the cable at several places special apparatus with comparatively high self-induction (S. P. Thompson); the other is to increase the self-induction of the cable itself by the employment of iron. For reasons of security, the first-mentioned method seems less promising than the second.

The firm of Felten and Guilleaume has recently carried out experiments for the purpose of ascertaining to what extent the self-induction of cables is increased by the employment of iron in the core. A number of samples of different nature were made, some of them without iron, others with iron wire, and one sample, proposed by one of us, with iron ribbon. We took part in the experiments by carrying out measurements of self-induction.

All the conductors were at first in the form of plain gutta-percha core. Part of them were covered with iron ribbon by hand for the purpose of the preliminary measurements, while for the final tests three cables of different construction were armoured with steel wires, as it is proposed to do in the actual cable. The cables were manufactured in lengths of from 460 to 500 metres, and for the purpose of the tests were laid out in a large loop in a field. On leaving the testing room the two ends of each cable were led, about 3 metres apart, over a street about 15 metres wide, and the remaining part laid out in a square with rounded corners. It follows from these dimensions that the cable can be considered as laid out in a straight line, for the radii of curvature and the distance between the out-going and in-coming ends are very large compared with the cross dimensions of the cable. Therefore an electromagnetic or electrical action between the parts of the cable need not be considered.

Method of Measurement.—The employment of alternating currents of different frequencies, a method already frequently employed for the determination of the electrical properties of conductors, offered in this case the greatest prospect of success. The greatest advantage of this method over the galvanometric one is that one gets the values of the electrical properties not for continuous but for pulsating current; one could say that it gives the dynamic and not the static values. In order to be able to make the necessary calculations, one cannot employ a current wave of arbitrary form. Obviously it would be logically the best to use the exact form which telegraphic currents have in practice, but this cannot be attained with short conductors, and, moreover, it would not lead to measurements from which results can be calculated. On the other hand, a regular sine wave affords results easily calculated.

The self-induction of a conductor can be determined by measuring separately both the amplitude and phase of the pressure at its ends and of the current flowing through it. From the quotient of pressure by current the self-induction can be calculated. If we apply this to the cable, we must connect each end in turn with the poles of a source of alternating current and then measure the current and pressure. In this, however, account must be taken of a property appertaining peculiarly to cables. If an alternating current flows through a cable having capacity, a weakening of the current generally takes place along the conductor, which is greater as the distance from the end is greater. This diminution of the current is due to the individual parts of the conductor acquiring an electric charge, which is taken from the main current. The change of current from one end or the other of the conductor is the greatest when the far end is insulated, and it is smallest if the two ends are directly connected to the two poles of the source of electricity. To measure the current at the second end, an inductionless resistance was connected at the end of the cable; this represents a case between the two limits mentioned above. Even then no difference could be observed with certainty between the current at the two ends of the cable if the resistance at the second end was 10 to 20 times the resistance of the cable. Therefore the self-induction of this cable may be measured as that of any other conductor.

The second pole of the source of current was always connected, during the measurement, to the gas pipe and to the wires of the armouring at both ends of the cable. In order to measure the capacity of a cable, the second end of the copper conductor is insulated, and the first end is connected to the free pole of the source of current. If then the pressure and current are measured, the capacity can be calculated from the quotient of these two. This method is only correct so long as the length of the cable is not too large. If this is not the case, all the elements of the cable do not get charged simultaneously and uniformly, but the charge of those lying farther off will be delayed as well as weakened by the resistance of the cable. In the case of sine currents, as is known, there must be a phase difference of 90deg. between charging current and pressure. In a long cable this phase difference will be diminished, and can be brought down to 45deg. In the instance mentioned above phase differences of over 89deg. were always observed, so that the capacity of the cable can always be calculated from the ratio, current pressure. The measurement of pressures is made by compensation by a measurable adjustable E.M.F. of the same frequency.* The armature furnishing this E.M.F. is connected to a telephone or electro-dynamometer at the points whose pressure is to be determined. The adjustable E.M.F. is so added that the current in this branch conductor vanishes, and so no alteration is made in the current flowing through the main to be tested. Thus the test can be made at any two points at which the difference of potential is to be determined.

As a current indicator we first employed the telephone exclusively. This instrument is extraordinarily convenient for the testing of alternating currents by the null method, but it necessitates the employment of fairly high frequencies, as the ear is not sensitive to small currents of low frequency. For that reason we did not use lower than about 230 oscillations† for the first experiments. The calculation of results showed that the values which we had found for oscillations over 230 did not suffice to interpolate with certainty between 230 and 0. For further measurements, therefore, we employed a Siemens electrodynamometer for weak currents, using it for frequencies between 50 and 170 ∿ per second. Throughout these measurements the values of the self-induction were determined with sufficient accuracy for all frequencies up to 170 ∿ per second—*i.e.*, for all speeds of signalling which need be considered in cable telegraphy.

Description of Conductors Tested.—Seven different samples of cables were made for testing, two of which were unarmoured core. For the final measurements the following three samples were employed, all with steel wire armouring:—

I. (Fig. 1) A circular copper wire of 2·3mm. diameter surrounded by four flat wires forming a cylinder. The core so formed of 4·46mm. diameter was wound with an open spiral of iron ribbon‡ 8mm wide and 0·16mm thick, and the whole covered with gutta-percha in three layers to a diameter of 11·59mm. The length of the cable was 500 metres, and factory galvanometer tests gave the resistance at 15°C. 1·124 ohms per kilometre, and the capacity 0·221 microfarad per kilometre.

II. (Fig. 2) A circular copper wire of 3·10mm. diameter, surrounded with nine copper and three iron wires of 0·8mm. diameter

*From the *Elektrotechnische Zeitschrift*.

*This method was described in the *Elektrotechnische Zeitschrift*, 1891, p. 448.

†[The author is somewhat vague in his use of the expression oscillations or number of oscillations. Presumably he means 230 alternations or half-periods per second.—ED. *E.*]

‡Not seen in the figure.

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to form a strand 4·70mm. diameter. This was covered with three layers of gutta-percha to a diameter of 11·76mm. The length of this cable was 490 metres. its resistance 1·112 ohms per kilometre, and its capacity 0·236 microfarad per kilometre.

III. (Fig. 3) A circular copper wire of 2·8mm. diameter, surrounded by 10 circular copper wires of 1·0mm. diameter, making a strand of 4·97mm. diameter. This was covered with gutta-percha to a diameter of 11·66mm. The length of this cable was 463·75 metres, its resistance 1·125 ohms per kilometre, and its capacity 0·212 microfarad per kilometre.

Besides these cables, other samples were examined in the preliminary experiments. These were two armoured with iron ribbon, one of which (IV.) had a core similar to I., but without the iron ribbon round the copper, and the other (V.) was made somewhat similarly to I. In addition, two unarmoured cores were made, one with a conductor of copper only, and the other a core similar to II., but unarmoured. A further description of these cables and wires is unnecessary.

Results of the Measurements.—We give first the results of capacity measurements made more or less by the way. Since these measurements were carried out, the question of the capacity of gutta-percha cables has received considerable attention, owing to the opinion recently expressed that, besides capacity, the absorption of gutta-percha is of importance to the propagation of the waves, and that the marked difference between cables in this respect is to be attributed to the greater or less success in removing this property. In the cables tested, no absorption of charge was observable to any extent. If such an effect had been present, it would have shown itself by a dependence of the value of the capacity upon the frequency. The values for high frequencies would have been smaller than those obtained by a galvanometric measurement, and the values would have decreased with increase of frequency.

Fig. 1.

Fig. 2.

Fig. 3.

For practical reasons, the measurement of capacity could only be made with the telephone for oscillations numbering from 230 to about 500, for the method is not accurate for smaller frequencies. Nevertheless, the values obtained for these frequencies agree fairly well among themselves and with the values obtained galvanometrically. For the different cables and different numbers of oscillations the following results were obtained :—

I.		II.		III.		IV.		V.	
318	0·229	276	0·225	270	0·201	234	0·205	264	0·217
410	0·221	336	0·231	341	0·209	316	0·202	314	0·216
		428	0·233	526	0·206	427	0·211	450	0·215
		530	0·231						

The mean values of the alternating-current measurements are placed together in the following table :—

	I.	II.	III.	IV.	V.
Galvanometric measurements	0·221	0·236	0·212	0·207	0·235
Alternating-current measurements	0·225	0·231	0·205	0·207	0·216

The above figures make it not very probable that the gutta-percha employed in these cables has an appreciable absorption.

We now proceed to the results of measurements of the self-induction, or rather the impedance of the cables. The phenomena of self-induction are complicated in armoured cables by the fact that the currents flowing through the core of the cable generate induction currents in the armouring. To maintain these, the cable must give up energy, and for equal currents the greater the frequency the greater is this energy. If the armouring were absent, the consumption of energy within the cable for a given current would be proportional to the resistance of the cable; the increase by the induction is characterised by an increase of the resistance in the calculations. Further, the induction currents weaken the magnetic field of the cable currents, and this is corresponded to in the calculation by a decrease of the self-induction with the frequency. Thus the cable has similar properties to a transformer, or to the coil of an electromagnet with a sufficiently subdivided iron core. As the frequency increases in such apparatus, the resistance increases and the self-induction diminishes. In the case of measurements at high frequencies by means of the telephone, we obtained very much altered values. The cables IV. and V., tested above, gave :—

IV.

n	Resistance.	Self-Induction.
0	0·482*	
234	1·425	0·000568
316	1·500	0·000530
427	1·420	0·000403

V.

n	Resistance.	Self-Induction.
0	0·548*	
231	1·390	0·000788
314	1·476	0·000630
450	1·486	0·000498

No conclusions can be drawn from these measurements as to the properties of the cables for frequencies occurring in cable telegraphy. For the future, therefore, we used an electro-dynamometer instead of a telephone, and this proved sufficiently sensitive to obtain observations at frequencies at which the telephone could not be employed. The fixed coil of the instrument was excited by an E.M.F. of constant amplitude and of the same frequency as the alternating current employed. The movable coil was connected to the compensating adjustable E.M.F. The latter had to adjusted until the spot of light from the instrument was brought to zero.

In this connection a phenomenon occurred which is interesting enough to devote some words to. It was found, in fact, that the deflection of the dynamometer could be brought to zero for more than one particular adjustment. With the telephone this is not the case; it is silent only when the current is zero, and this only happens when both phase and amplitude of the compensating E.M.F. are the same as those of the E.M.F. to be compensated. On the other hand, the dynamometer returns to its initial position, in addition, when there is flowing through the movable coil a current differing 90deg. in phase from the exciting current. In order to enable a correct adjustment to be made, a self-induction bridged by a short-circuiting key was connected in series with the wire leading to the fixed coil. The correct adjustment is recognised by the spot of light remaining at zero whether the key is open or closed.

In order to prevent errors as far as possible, each measurement of amplitude and phase was made with four different numbers of windings, and adjustments of the armature made for the compensating E.M.F. The results of these measurements show a satisfactory uniformity. Thus, the measurements of amplitude of the cable with iron ribbon at 51 σ were as follows :—

Potential at Terminals.

Of cable.	Of one ohm.
0·287	0·353
0·284	0·348
0·285	0·351
0·280	0·356

For each of the three cables three such measurements were made for different frequencies, which gave the following values for the impedances :—

I. Cable with iron ribbon.			II. Cable with iron wires.			III. Cable without iron.		
n		Impedance.	n		Impedance.	n		Impedance.
51	...	$0{\cdot}814e^{+42°i}$	50	...	$0{\cdot}689e^{+32°i}$	54	...	$0{\cdot}669e^{+32°i}$
89	...	$1{\cdot}301e^{+58·6°i}$	94	...	$1{\cdot}000e^{+48·6°i}$	94	...	$0{\cdot}833e^{+45°i}$
170	..	$1{\cdot}850e^{+61·5°i}$	166	...	$1{\cdot}450e^{+51·2°i}$	160	...	$1{\cdot}254e^{+49·5°}$

If one divides the impedance into actual and imaginary parts, the actual part must agree with the resistance W and the factor of i with the reactance R. Both magnitudes are functions of the frequency. One can then write

$$W = W_0(1 + a_1 n + a_2 n^2),$$
$$R = 2\pi l(n - bn^3)$$

If one takes, in addition to the results of the measurement, also the fact that for $n = 0$ the resistance is equal to that galvanometrically measured and the reactance is equal to 0, then one obtains for resistance, as for reactance, four points. According to known principles, for each magnitude that curve is determined whose four points are closest together. Thus the following values are obtained :—

	Resistance.					*Reactance.*	
Cable.	W_0	a_1		a_2		Galvan' resist.	$2\pi l.$	$b.$
I.	0·564	0·34	10^{-3}	17·7	10^{-6}	0·562	0·01163	0·00107
II.	0·537	1·05	10^{-3}	18·3	10^{-6}	0·545	0·00805	0·00081
III.	0·514	0·72	10^{-3}	17·0	10^{-6}	0·522	0·00686	0·00083

The agreement of W_0 with the measured resistance affords a check that the measurements have given fairly good values in spite of all the difficulties. From the magnitude $2\pi l$ one gets, on dividing by the length of the cable and 2π, the coefficient of self-induction for small frequencies and one kilometre, viz. :—

Cable.	Self-induction.
I.	0·00370
II.	0·00262
III.	0·00235

* Galvanometrically measured.

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By winding with iron ribbon the self-induction of the cable is raised to 1·57 times the original value, and by the iron wire laid on the outside only 1·11 times. On the other hand, it must be remembered that cable I., in order to have the same conductance as cable III., would have to be larger, on account of the core being partially made of material of lower conductivity, so that its capacity would be increased by 10 per cent. The amount of iron in the core already amounts to $\frac{1}{4}$th of its whole weight. The magnetic arrangement is also favourable. It is therefore quite correct to say that with this increase of self-induction the limit is attained.

In order to draw a practical conclusion from these measurements, an endeavour was made to calculate the amount of damping of an alternate current whose frequency corresponded to the speed of 160 letters per minute, in a cable containing only copper and with normal self-induction, and in a cable with self-induction increased by iron. The direct results of the measurements could not well be used for this, as the employment of the space for the copper in different samples is not equally good, so that the value of the capacity for similar conductances is different. Therefore two cables were taken of like inner and outer diameters, so that the capacity of the two cables was the same. The core of one was only of copper, and the other had a copper core surrounded by iron 0·16mm. thick, and it was assumed that the first had normal self-induction and the latter a self-induction 60 per cent. higher. The damping of alternate currents in such cables is given by the magnitude $e^{\lambda L}$, where L is the length and λ the actual part of the expression

$$\sqrt{imc}(w+iml).$$

m is the frequency in 2π seconds and c, w and l the capacity, resistance, and self-induction respectively for 1 kilometre. For the two cables there are different values of λ. That for the cable without iron is 0·00342 and for the cable with iron 0·00329. As ml is small compared with w, λ is approximately proportional to $\sqrt{m}$. In order, therefore, to attain in the cable with iron an equal damping to that in the cable without iron, the frequency would have to be increased in the ratio of $(0{\cdot}00342/0{\cdot}00329)^2$—that is, by 8 per cent. For equal E.M.Fs. and equally high waves at the far end, the cable with iron would therefore have an 8 per cent. higher signalling speed. This calculation does not take into account the influence of the apparatus at the end of the cable, and consequently gives for the increase in speed a higher value than it would actually have in practice. But even for an 8 per cent. increase of speed one would not incur the risk of a cable of untried design.

As it is not probable that one would be in a position to increase the self-induction of the core in any other manner than here described, it may be concluded from the results of these measurements that the hoped-for improvement in the speed of long cables by increasing their self-induction is not to be accomplished.

TRADE NOTES AND NOTICES.

[Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.]

NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers, or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London:—

READY-END OF NEXT WEEK.

"The Electrician" Electrical Trades' Directory and Handbook for 1900.—The New Edition of the "Big Blue Book" will be ready at the end of next week (corrected to January 31st, 1900). See important announcement on page xxv.

"Submarine Cable-Laying and Repairing."—By H. D. Wilkinson M.I.E.E., &c., fully illustrated; price 12s. 6d. This work gives a detailed technical summary of modern practice in manufacturing, laying, testing, and repairing submarine telegraph cables.

"Practical Notes for Electrical Students."—By Messrs. A. E. Kennelly and H. D. Wilkinson. Price 6s. 6d., post free. The authors give in a clear and concise manner a good summary of the general principles of electrical science.

"Magnetic Induction in Iron and other Metals."—By Prof. J. A. Ewing. Price 10s. 6d., post free. *New Edition nearly ready.*

"The Incandescent Lamp and its Manufacture."—By Gilbert S. Ram. Price 7s. 6d., post free. The principles underlying the manufacture of the incandescent lamp are carefully and fully dealt with in this volume.

"The Steam Engine Indicator and Indicator Diagrams."—Edited and enlarged by W. Worby Beaumont. Price 3s. 6d., post free. This work is a concise guide to the objects, construction, and use of the steam engine indicator and to the interpretation of indicator diagrams.

"The Art of Electrolytic Separation of Metals."—A second issue of Dr. Gore's book is now ready, price 10s. 6d., post free. The author treats fully both the theoretical principles of the art of electrolytic separation of metals and the practical rules and details of technical application on a commercial scale. The work is adapted to the use of the manufacturer as well as the student.

"The Manufacture of Electric Light Carbons."—A Practical Guide to the establishment of a Carbon Manufactory. Fully illustrated, price 1s 6d.; post free, 1s. 9d. In this work the author gives useful hints as to the manufacture of electric light carbons, including the preparation of material, firing, saturating, and coring, together with a description and estimate of cost of the plant required.

"The Centenary of the Electric Current, 1799-1899."—By Dr. J. A. Fleming. Price, paper covers, 1s. net, post free 1s. 3d.; strong cloth, 2s. 6d., post free.

"Localisation of Faults in Electric Light Mains."—By F. C. Raphael. Price 5s., post free. The book deals with the important subject of localising faults in electric light and power cables; and the various methods of insulation testing are here collected and discussed.

"Motive Power and Gearing for Electrical Machinery."—By E. Tremlett Carter, C.E., M.I.E.E. Price 12s. 6d., post free. In this comprehensive work an account is given of the scientific principles and modern practice in the use of engines for dynamo driving, not only for isolated power plants, but also for public electric lighting and power stations. The various forms of gearing in the power station and for electric motors are also dealt with; and the book contains, in addition, numerous tables giving exact data of the equipment and working of electric power stations.

"The Manufacture of Carbons for all Electrical Purposes."—by Francis Jehl. 10s. 6d., post free. This is a practical handbook, giving a complete description of the art of making carbons for electric lighting, electrodes, &c., with particulars of the various gas generators and furnaces used in carbonising. The work also contains particulars of the cost, &c. of erecting and working carbon works, and plans of a model factory.

'Drum Armatures and Commutators," by Mr. F. Marten Weymouth, also ready. Price 7s. 6d., post free. Prospectus on application. This is a complete treatise on the theory and construction of drum winding, and of commutators for closed coil-armatures, together with a *resumé* of the principal points involved in their design, and an exposition of armature reactions and sparking.

"Wireless Telegraphy: Signalling across Space without Wires by Electric Waves." A Review of the Work of Hertz and his Successors.—By Dr. O. J. Lodge, with a large number of illustrations. New and Enlarged Edition, 5s. nett. *Now ready.*

"Electromagnetic Theory."—By Oliver Heaviside. *Vol. I.*, 12s. 6d. *Vol. II.*, 12s. 6d.

"Laboratory Notes and Forms."—We have ready a set of 40 Elementary and Advanced Exercises for use with Electrical Engineering classes. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators and Students. The object of the series is the saving of the time of the Teacher and his Assistants, and to serve as a record of the work done by the Student. Each Form is supplied either singly at 4d., or 3s. 6d. per dozen net; in sets of any three, 1s. net; or the set of Twenty (Elementary or Advanced) Exercises can be obtained, price 5s. 6d. net. The complete set of Twenty Elementary and Twenty Advanced Exercises are price 10s. 6d. net; or in handy portfolio, price 12s. net; or bound in strong cloth case, price 12s. 6d. net. Strong portfolios can be had, price 1s. each.

NOW READY.—The cheaper edition of Dr. J. A. Fleming's "Electrical Laboratory Notes and Forms." These cheaper Forms have been prepared for the use of students and teachers at the Polytechnics and other Science classes throughout the country. The demand for the original set of these Notes and Forms has led to a request for a cheaper set for use at the day and evening classes at many of the technical institutes. These new Forms, which differ only from the higher-priced set in being printed on smaller and cheaper paper and with less space for tabulated records, are issued at half the price of the original set.

"Electric Motive Power," by Albion T. Snell, contains the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. Price 10s. 6d., post free; abroad, 11s.

"Electrical Testing for Telegraph Engineers."—By J. Elton Young, M.I.E.E. The scope of the book aims at furnishing a fuller treatment of the subject, from the standpoint of the Telegraph Engineer, than it has hitherto received, whilst it endeavours to facilitate a thorough comprehension of the theory of testing as applied to electrical lines in general. Demy 8vo, fully illustrated. 10s. 6d., post free.

"Electro-Chemistry."—By Dr. G. Gore. Third Edition. Price 2s., post free.

"The Potentiometer and its Adjuncts": A Universal System of Electrical Measurement.—By W. C. Fisher. Fully illustrated. Price 6s., post free.

"The Students' Guide to Submarine Cable Testing."—A new edition of this book, by Messrs. H. K. C. Fisher and J. C. H. Darby, is now ready, price 6s. net; abroad, 6s. 3d. This work is intended to serve as a guide to operators already in the telegraph service, and to those who desire to enter that service. The great cable companies now insist that their operators and probationers shall pass certain examinations in electrical subjects. The book is very fully illustrated.

"Bibliography of X-Ray Literature and Research."—A valuable compilation. Being an attempt to classify the data relating to X-Ray work. This work contains a quantity of general as well as special information bearing upon the whole subject of electrical discharge research. Edited by C. E. S. Phillips. Price 5s., post free.

"Armature Windings of Electric Machines."—By H. F. Parshall and H. M. Hobart. This work has been compiled from notes made by Mr. Parshall in his capacity as Chief Designing Engineer of the Edison and General Electric Companies of America, and is intended to serve as a working treatise on dynamo design. Large 4to, 370 pages 140 full-page illustrations and 65 full-page tables, 30s., post free.

"Electrical Engineering Formulæ," a pocket-book, by Messrs. W Geipel and H. M. Kilgour; price 7s. 6d.; by post, 7s. 9d.; abroad, 8s *New Edition in the press.*

"The Alternate Current Transformer. —By Prof. J. A. Fleming, M.A., D.Sc., F.R.S. Vol. I.—*New Edition.* Price 12s. 6d., post free, Vol. II., price 12s. 6d. post free, is also ready.

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"ELECTRIC LAMPS AND ELECTRIC LIGHTING," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is handsomely bound, and full of original illustrations, designs, initials, &c. *New and Cheaper Edition now ready.* 6s., post free.

"THE ELECTRICIAN" PRIMERS.—In Two Volumes. Vol. I., Theory. Vol. II., Practice. Price, stout paper cover, 2s. 2d. each, post free; cloth. 2s. 9d. Single Primers, 3d. each, post free.

IN THE PRESS.

"THE ELECTRIC ARC."—By Mrs. Ayrton.

"SECONDARY BATTERIES, THEIR DESIGN AND MANUFACTURE."—By E. J. Wade.

"PRIMARY BATTERIES: THEIR CONSTRUCTION AND USE."—By W. R. Cooper. *Nearly ready.*

"PRACTICAL TELEPHONY."—By Dane Sinclair and F. C. Raphael.

"'THE ELECTRICIAN' WIREMAN'S POCKET-BOOK."—Edited by F. C. Raphael. *Nearly ready.*

TENDERS INVITED.

The *Rochdale* Corporation invite tenders for the supply and delivery of electricity meters, which are to be in accordance with the specification of the consulting engineers, Messrs. Lacey, Clirehugh and Sillar, 2, Queen Anne's-gate, Westminster, S.W. An advertisement contains further particulars, and tenders must be delivered at the office of the town clerk (Mr. James Leach) by Wednesday, 26th inst.

The Electric Light committee of the Vestry of *St. Mary, Newington* (London), require tenders for the supply and erection of two water-tube boilers, feed pump, and sundry extensions to the steam and water mains for the electricity works at Penrose-street. An advertisement contains further particulars, and specifications, &c., can be obtained at the offices of the consulting engineers (Messrs. Kincaid, Waller and Manville), 29, Gt. George-street, Westminster, S.W. Tenders to the clerk to the Vestry (Mr. L. J. Dunham), Vestry Hall, Walworth-road, London, S.E., by 20th inst.

The New Tramways committee of the *Newcastle-upon-Tyne* Corporation require tenders for the supply of 130 car bodies, trucks for same, and for electrical equipment. Further particulars are set out in an advertisement, and general particulars and conditions of contract may be obtained from the consulting engineer, Mr. Charles Hopkinson (Messrs. Hopkinsons and Talbot), 26, Victoria-street, London, S.W. Tenders must be lodged at the office of the town clerk (Mr. Hill Motum), Town Hall, Newcastle-upon-Tyne, not later than March 2.

The *York* Corporation invite tenders for the conversion of the wiring of the Guildhall and the public library to suit the higher voltage of the mains. Tenders must be sent to the city electrical engineer (Mr. C. A. Midgley) by Feb. 15. See advertisement.

The Town Council of the Royal Burgh of *Inverness* invite tenders for the supply and erection of electricity generating plant. Tenders to town clerk (Mr. Kenneth MacDonald) before Feb. 8.

The *Coalbridge* Town Council invite proposals for constructing a tramway in the town. Particulars from town clerk (Mr. John M. Alston).

The *Dudley* Electric Light committee invite tenders for the supply and erection of pumps and feed-water heaters and pipework. Tenders to the town clerk (Mr. Henry C. Brattall) by noon, Feb. 8.

The *Kingston-upon-Hull* Corporation invite tenders for the supply of 35 double motor equipments and 10 car bodies (double-decked) to seat about 51 passengers. An advertisement contains further particulars. Specifications, &c., may be obtained from the city engineer, and tenders, addressed to chairman of Works committee, must be in by Monday, Feb. 19.

The *Bedford* Electric Light committee invite tenders for the supply and erection of a surface condenser, with air-circulating pumps, &c. Tenders to Mr. T. S. Porter, Town Hall, Bedford, by Feb. 6.

The *Bootle* Corporation require tenders for supplying and laying underground electric cables. Tenders, addressed Chairman Electric Power and Lighting committee, Town Hall, Bootle, by Feb. 17.

The *Glasgow* Corporation invite tenders for the supply of (1) 200/300 motor car trucks, (2) 200/300 motors and equipments, (3) supply, delivery and erection of overhead trolley constructional work. Tenders to Sir J. D. Marwick, City Chambers, Glasgow, by Feb. 17.

The Corporation of *Hastings* require tenders for the supply and delivery of twelve 20 kw. alternating-current transformers and high and low-tension switch gear. Tenders to Mr. B. F. Meadows, Town Hall, Hastings, by noon of Feb. 12.

The *Bath* Corporation invite tenders for high and low-tension cables, arc lamps, transformers, switchboards, &c. Tenders by Feb. 12.

The *Postmaster-General* invites tenders for the work of laying underground conduits and pipes for telephone purposes in several parts of the Metropolis. Forms of tender from the Controller of Stores (Mr. Chas. E. Stuart), G.P.O. Tenders by noon, Feb. 15.

The *West Ham* Guardians invite tenders for the supply and erection of plant for the electric lighting of the workhouse and school premises at Union-road, Leytonstone, and for erecting an engine and battery house. Tenders to Mr. Fred. E. Hilleary by 4 p.m., Feb. 7.

The *Belfast* Electric committee invite tenders for the supply and erection of 400 kw. steam dynamos. Tenders to Sir Samuel Black by noon, Feb. 8.

The Corporation of *Great Yarmouth* invite tenders for the supply and erection of two water-tube boilers and three 200 kw. continuous-current steam dynamos. Tenders by 10 a.m., Feb. 15.

The *Leyton* Electric Lighting committee invite tenders for the supply and erection of switchboard. Tenders to Mr. F. Harman Lewis by Feb. 14.

The *Stoke-upon-Trent* Guardians invite tenders for the electric lighting of a portion of the workhouse premises. Tenders to Mr. C. Daniel, Union offices, Stoke-upon-Trent, by 9 p.m., Feb. 13.

Middleton require tenders for erection of their electricity station building. Tenders to town clerk by 7th inst.

Belfast and Northern Counties Railway Co. require tenders for telegraph ironwork, batteries, signal fittings, &c. Tenders to secretary, Belfast, by 12th inst.

Salford requires tenders for supply and fixing of iron and steel work at the Strawberry-road electricity station. Tenders to town clerk by 12th inst.

The *Walthamstow* District Council invite tenders for the supply and erection of plant for the electric lighting of their Isolation Hospital at Chingford. Tenders to the clerk by 23rd inst.

The *Prussian* State railway authorities, Altona, invite tenders until Feb. 15 for the supply of 210,000 arc lamp carbons and 2,000 incandescent lamps. Particulars from and tenders to die Königliche Eisenbahn Direction.

The *French* Minister of Posts and Telegraphs invites tenders for the supply of 585,250 metres of paper-insulated electric cables, in 12 lots. Particulars from and tenders to le Sous Secretariat d'Etat des Postes et des Telegraphes, 103, Rue de Grenelle, Paris, by 15th inst.

Tenders are being invited until the 15th inst. by the municipal authorities of *Piedrahita*, Spain, for the concession for the electric lighting for 15 years. Tenders to el Secretario del Ayuntamiento.

TENDERS RECEIVED AND ACCEPTED.

The tender of Messrs. W. H. Allen, Son and Co. has been accepted by the Bedford Electric Light committee for the supply of a 420 B.H.P. inverted compound double-acting engine at £1,600, and that of Messrs. Rosling and Appleby for a 250 kw. alternator at £1,200.

The following tenders have been accepted by the Wigan Town Council: Bedford Engineering Co. (travelling crane); Messrs. R. W. Blackwell and Co. (pole planting wagon and tools, and for a Trenton tower wagon and tools).

The Lancaster Corporation have accepted the tender of Messrs. Meldrum Bros. for the erection of a refuse destructor at £5,025.

The Hackney Vestry have accepted the tender of Messrs. Hughes and Stirling for the erection of a refuse destructor at £24,495.

APPOINTMENTS VACANT AND FILLED.

A first-class electrical engineer is required for the Glasgow Corporation tramways. Particulars are set out in an advertisement elsewhere, and applications must be addressed to the manager of the tramways department (Mr. John Young), 88, Renfield street, Glasgow, or or before Feb. 24.

The Islington (London) Vestry require a draughtsman for temporary work for their electricity department. Applications to the vestry clerk (Mr. Wm. F. Dewey), Vestry Hall, Upper-street, London, N., by Feb. 7. See advertisement.

The Southport Corporation Electricity committee invite applications for the position of electrician-in-charge. Applications to Mr. Chas. D. Taite, by Feb. 8.

Mr. John W. Gibson, superintending electrical engineer to the Harton Collieries Co., has been appointed electrical inspector to the National Boiler and General Insurance Co., Manchester.

Mr. E. S. Saunders has been appointed departmental engineer to the Bradford Corporation electricity works, in succession to Mr. A. H. Roe, who has accepted the position of borough electrical engineer to the Corporation of Bury St. Edmunds. Mr. Saunders previously acted as Mr. Roe's assistant at Bradford.

Mr. C. M. Gardner has been appointed representative of the Marquand Accumulator Co. (Ltd.) (Cardiff) for London and district. The company's London offices are at 34, Victoria-street, Westminster, London, S.W.

BUSINESS NOTICES.

The business hitherto carried on by C. and A. Musker and Co. (Ltd.), at Dundas-street, Bootle, has been transferred to the new works at Tue Brook, Liverpool.

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BANKRUPTCIES, LIQUIDATIONS, &c.

Herbert Mitchell and Edgar Schofield, trading as electrical engineers, under the style of Mitchell and Schofield, at Huddersfield-road, Brockholes, near Huddersfield, have executed a deed of arrangement. Mr. T. H. B. Tate, John William-street, Huddersfield, is trustee. Liabilities £709. 13s. 3d., assets £489. 8s. 10d. The creditors include :—

Telegraph Mfg. Co.	£194	J. Mitchell and Sons	£20
Edison and Swan Co.	117	C. Booth and Son	16
J. Kaye and Co.	63	Gabriel and Angenault	14
Johnson and Phillips	41	Dorman and Smith	11
General Electric Co.	25	B. Oldfield	11

The following are the principal creditors in the bankruptcy of Alexander McTavish, electric light engineer and contractor, 15, Newbridge-hill, Weston, near Bath :—

Newton Electrical Co.	£40	Veritys Limited	£23
W. T. Glover and Co.	29	International Electric Co.	18
J. C. Lyell and Co.	27	Hodges and Todd	15

The liabilities amount to £321. 7s, assets £161.

The trustee (Mr. A. Mackintosh) in the bankruptcy of F. Jones (trading as F. Jones and Co.), electrical engineer, St. John's-hill and Darin-road, London, S.W., has been released.

In the bankruptcy of F. King, electrical engineer, the Stone Bridge, Bristol, the first meeting of creditors will take place on 7th inst, at Baldwin-street, Bristol, and the public examination on 9th inst, at the Guildhall.

Claims against B. Wild and J. H. Clarke (trading as Wild, Rothwell and Co.), electrical and general engineers, Atlas Works, Virginia-street, Southport, must be in by 12th inst. Mr. N. Yates, 4 and 6, Wood-street, Bolton, is trustee.

Claims against E. B. Pym, electrical engineer, 29, Bramham-gardens, London, S.W. (late of Scarborough), must be in by 10th inst. Mr. A. H. Wildy, Bankruptcy-buildings, Carey-street, London, W.C., is trustee.

The trustee (Mr. H. W. Cox, 4, Pavilion-buildings, Brighton) in the bankruptcy of D. W. Paine, electrician, 84, Gloucester-road, Brighton, has been released.

A meeting of the New Electricity Syndicate (Ltd.) will be held at 24, Harleyford-road, London, S.E., on March 2, to receive an account of the winding-up. Mr. F. King is liquidator.

A meeting of the Electric Lighting Extension Syndicate (Ltd.), will be held at Bartholomew Works, Lawford-road, London, N.W., on March 1, to receive an account of the winding-up. Mr. C. O. Bastian is liquidator.

Plant for Sale.—Messrs. Allbright and Wilson (Ltd.), Oldbury, near Birmingham, have for sale three Babcock-Wilcox boilers and a Crompton steam dynamo. See advertisement.

Tudor Accumulators.—Referring to the notice which appeared in our issue of 19th ult. (p. 446), that Mr. Edward Lomer, of 12, St. Mary-axe, London, E.C., had been appointed agent of the Accumulatoren-Fabrik A.-G. (of Berlin and Hagen) in this country, Mr. Lomer informs us that this announcement was due to a misunderstanding, as the Tudor Accumulator Co. (Ltd.) have the sole rights for the manufacture and sale in the United Kingdom of Tudor accumulators, which is the type of cell manufactured by the German company referred to.

Spiral Globes.—The Spiral Globe Co. have just issued a well-prepared catalogue and price list of spiral globes. Accompanying the catalogue is a print of some test results and supplementary diagrams made by the Electrical Standardising, Testing and Training Institution on the candle-power of an incandescent lamp with and without spiral glass reflectors.

Export Merchants Shippers' Directory.—The 1900 edition of this valuable directory and guide is just published, and will be found replete with a mass of information of value to shippers and those having or seeking business relations with countries outside the United Kingdom. While no fresh departure has been made in the present volume the task of bringing the various sections up to date has been carried out with great thoroughness. This is, perhaps, most clearly indicated by the fact that 2,700 new names have been added to the work, which is published by Messrs. Dean and Son, 160A, Fleet-street, London, E.C., price 17/6.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Jan. 24 to Jan. 30, with the ports of destination :—

Africa—Alexandria, £149 ; Beira. £36 (telegraph material) ; Cape Town, £1,294 (including £741 telegraph material) ; Durban, £248 ; East London, £81. *Argentina*—Buenos Ayres, £4,056 (including £1,636 telegraph material). *Australasia*—Melbourne, £115 ; Sydney, £472 ; Wellington, £409. *Austria*—Trieste, £70. *Canada*—Halifax, £503 (telegraph cable) ; Toronto, £35. *Ceylon*—Colombo, £1,157 (including £84 telegraph instruments). *Chili*—Boca, £176 (telegraph material). *China*—Shanghai, £101. *Denmark*—Copenhagen, £186 (telegraph wire). *Germany*—Hamburg, £250 (telegraph material). *Gibraltar*—£25. *Holland*—Amsterdam, £330. *Hong Kong*—£316. *India*—Bombay, £309 (including £200 telegraph material) ; Calcutta, £2,901. *Japan*—Nagasaki, £11,800 (telegraphic cable) ; Yokohama, £67. *Malta*—£159. *Mauritius*, £116. *Norway*—Christiania, £77 (telegraph wire). *Russia*—Batoum, £40 (telegraph material). *Straits Settlements*—Singapore, £44. Total £25,522, against £9,770 in the corresponding week last year (Jan. 25 to Jan. 31).

B T-H. Plant.—Pamphlet 45, issued by the British Thomson-Houston Co., describes direct-connected traction and power generators.

Calendar.—A useful month-by-month pad calendar for 1900 can be obtained from Messrs. Nalder Bros. and Thompson (Ltd.).

Catalogue.—Messrs. Pelland and Co., 5, St. Nicholas-buildings, Newcastle-on-Tyne, are sending out a new list of arc light carbons and dynamo brushes.

MUNICIPAL, FOREIGN, AND GENERAL NOTES.

Belfast.—The summary of electric light rental for the year ended Dec. 31 has been issued. The receipts for lighting for the half-year ended June amounted to £4,390. 2s. 8d., and in the December half-year to £6,092. 14s 10d. The units sold were 213,727 and 334,818 respectively. The rental from current for motors, &c., amounted to £845. 19s. 4d., against £630. 0s. 7d. in the previous year. The meter and motor rents amounted to £316. 13s. 9d., against £162. 13s. 3d. The total receipts thus amounted to £11,645. 10s. 7d., against £8,796. 0s. 9d. in 1898, an increase of £2,489. 9s. 10d., or 32·4 per cent. The total number of units sold amounted to 622,486, against 356,527 in 1898 : increase 74·5 per cent. The average price for current for lighting in 1899 was 4·586d. and for motors 2·746d. per unit, against 6·163d. and 3·369d. in 1898. During the half-year ended December, 1899, the maximum demand system of charging was in operation.

Bexhill.—An inquiry was held here last week into the application of the Council to borrow an additional sum of £5,000 for electric lighting. The clerk (Mr. E. Sholto Douglas) said that it was proposed to extend the electric lighting mains to a number of additional streets, at an estimated cost of £2,500, and in addition there was a sum of £800, the cost of promoting the order, and £400 additional cost of the site of the station. There had also been an excess expenditure of £600 in connection with the scheme. The consulting engineer (Mr. A. H. Preece) said in reply to the inspector that applications had not actually come in, but there were houses in the roads to which it was proposed to extend mains which would be likely to require current. In fact, some were being already wired. The Council also propose to substitute electricity for gas for public lighting.

Birkdale.—The Council have decided to oppose the Southport Extension and Tramways Bill, and also to purchase so much of the undertaking of the Birkdale and Southport Tramways Co. as lies within the district. The Council will transfer their provisional electric lighting order to the British Electric Traction Co.

Birkenhead.—An inquiry has been held into the application of the Council to borrow £3,500 for extensions of the electric light mains to Higher Tranmere. There was no opposition.

Bridgwater.—The Council obtained a provisional electric lighting order in 1898, but at a recent meeting of ratepayers it was decided to urge the Council to abandon the proposal to establish electricity works for the present.

Chorley.—The Council have applied for sanction to a loan of £23,000 for establishing electricity works to the plans and specification of the consulting engineers (Messrs. Lacey, Clirehugh and Sillar).

Custom Tariffs.—The new Rhodesian Custom tariff (Aug., 1899) admits free of duty : (1) Machinery fitted to be driven by electricity, including the spare parts, and apparatus and appliances used in connection with the generation and storage of electric power (excepting electric cables and wires and posts for carrying same, electric lamp posts and fittings) ; (2) materials and instruments for use in the construction and working of telegraph and telephone lines. Rebates of Custom duties are allowed on the following goods imported or warehoused on importation into Cape Colony whenever these goods are moved overland into Southern Rhodesia. A rebate of the whole Customs duty is allowed on electric cables or wires and posts for carrying same and their fittings, electric lamp posts and their fittings, electric lamps and switches (not including fancy or ornamental lamps or switches and fittings for indoor lighting).

A recent revision of the Spanish tariff includes, under Class XI. (instruments, machinery, &c.) : (1) Incandescent electric lamps, with or without mounts ; (2) voltaic arc lamps, electric meters, switches, safety fuses, and other similar apparatus ; (3) telephone apparatus and separate parts. A duty of 0·20 pesetas is imposed upon each article in No. (1), 2 pesetas per kilog. on No. (2), and 1.50 pesetas per kilog. on No. (3).

Edinburgh.—A report has been presented by the consulting engineer (Prof. Kennedy), in which the Council are recommended to put down additional plant at the McDonald-road electricity station, at an estimated cost of £17,295. The plant is to be delivered by

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Aug. 15, and will probably be in running order by the end of September. At the Council meeting on Tuesday the convener of the Electric Lighting committee (Bailie Mackenzie) said that last year it had been proposed to obtain six large generating machines, but Prof. Kennedy had thought it best to obtain four in the first instance, which would carry them over the winter, and to delay ordering the other two machines until it was seen whether those delivered were working satisfactorily. The last machine which had been set down had given complete satisfaction, and Prof. Kennedy now recommended that two additional machines be obtained as soon as possible. The same remarks applied to the boilers. The matter has been referred to the committee, who will present a report at the next Council meeting.

Electrical Progress in Germany.—During 1899 28 electrical companies, with a share capital of about 70,000,000 marks, were formed in Germany, and the capital of existing companies was increased to the extent of about 91,000 000 marks. Amongst the companies formed were the Deutsche Kraftgasgesellschaft (for the utilisation of blast furnace gases), the Norddeutsche Seekabelwerke, the Studiengesellschaft fur Electrotechnische Schnellbahnen, and the Gesellschaft fur Verkehrsunternehmungen (for the manufacture of electric autocars, &c.).

Fire.—A fire broke out at the Paragon Works of Messrs. Wenham and Waters, Vicarage-road, Waddon, Croydon, on Tuesday morning. The damage, covered by insurance, is estimated at £10,000.

For the Front.—Amongst the equipment being sent to the scene of hostilities is that for the Yeomanry Hospital. Messrs. Thomas Parker, Ltd., have presented Mr. Hall-Edwards, who is asking for gifts for the hospital, with a dynamo. Messrs. Mawson and Swan, of Newcastle-on-Tyne, have presented £10 worth of photographic plates. A considerable quantity of electrical fittings are promised, and there seems every probability that the hospital will, by the time it leaves this country, early in the present month, be well furnished. The entire equipment goes out in the "Majestic."

Mr. C. H. Kay, one of the workpeople employed by the Edison and Swan Co. at their Leeds branch, goes out with the Kings' Own Yorkshire Light Infantry, and his colleagues made him a presentation on the eve of his departure.

"Harness" Belts in Austria-Hungary.—A decree has recently been issued prohibiting the importation into Austria-Hungary of galvanic apparatus, purporting to be of hygienic value for wearing on the human body. The grounds for this prohibition are that the wearing of these articles may cause skin diseases and even blood poisoning. Trading in articles of this kind is forbidden, except under the directions of a properly qualified physician. A beneficent edict.

Iceland.—A dam is being constructed in the valley of Seydi-fjord which is to be filled with water in order to provide ample supplies of ice for packing fish. From the banks of this dam the ice will be conveyed to the Gardar Fish Co.'s depôt at Bodareyri by means of an electric railroad. The funds for this enterprise have been provided by British capitalists.

Kandy (Ceylon).—This town is now lighted electrically. Current is supplied by the Colombo Gas and Water Co. Some of the leading thoroughfares are illuminated by means of Jandus Arc Lamps, and in the side streets incandescents are employed.

Light Railways.—The Middlesex County Council have endorsed the principle of the scheme for the construction of light railways in the county. At the meeting of the Council last week the chairman (Mr. R. M. Littler, Q.C.) said he was convinced that light railways would materially relieve the rates, as the Council would obtain a sum of money from the leasing of the lines that would reduce the highway rates. The estimated cost of constructing the permanent way of the eleven lines now being promoted jointly by the Council and the Metropolitan Tramways and Omnibus Co. is estimated at £336,000, and that of the five other lines promoted by the Council itself is calculated at £263,000. These are the initial lines of a comprehensive scheme for the whole county, which is estimated to involve an outlay of £3,000,000.

An inquiry will be held on the 12th inst. into the application of the City of Gloucester Tramways Co. for power to construct light electric railways in the city. The Corporation have not yet definitely decided upon their attitude in relation to the application.

Limehouse.—The County of London Co. have lodged an objection to the application of the District Board of Works for a provisional order. A conference of the Limehouse, St. George's, Mile End and Whitechapel local authorities will be held to consider the opposition.

Limerick.—The Corporation have entered into negotiations with the Harbour Board for the purchase of land in Frederick-street as a site for electricity supply works.

Liverpool.—The Board of Trade inspection of the Aintree and Fazakerley, Cabbagehall and Oakfield, and the Stanley-road sections of the electric tramways took place on Friday.

Locomotive Regulation.—The City of London Corporation have issued bye-laws for the regulation of locomotives in the streets within the City area. These bye-laws can be inspected at the Guildhall.

London County Council.—At Tuesday's meeting the Finance committee reported application from Islington Vestry for a loan of £56,261 for electrical lighting. They propose that sanction be given to the borrowing of £38,000 only, as they required further explanation from the Vestry before dealing with the balance. Application was also made by the Islington Vestry for a loan of £13,200 for additional plant at the Vestry's electric lighting works, but the information supplied only enabled the committee to recommend sanction to £10,000. These recommendations were approved.

The Highways committee presented a report on the subject of the applications made to the Board of Trade by some of the London local authorities and supply companies for provisional electric lighting orders, including Limehouse, Mile End, St. George-in-the-East (local authorities), and Battersea, Lambeth and Marylebone (companies). As regards the price to be charged for current under all these orders, the committee recommended that the maximum should be 5d. per unit; and, as regards the system of supply, that it should be by continuous current, except with the express consent of the Board of Trade. Last year the Board of Trade did not see its way to adopt these suggestions, but the committee thought consideration should again be given to them. The following recommendations were also presented:—

(1) That the Board of Trade be informed that in the opinion of the Council it is undesirable that the clauses of the Electric Lighting Clauses Act, 1899, should be incorporated in provisional orders relative to London areas; and that the Board be asked to so amend the orders relative to (*a*) Limehouse, (*b*) Mile End Old Town, (*c*) Lambeth, and (*d*) Marylebone, now being applied for, as that each order may be in the same form as those previously granted as regards London areas, and may be complete in itself.

(2) That the Board of Trade be asked to so amend the Limehouse district and Mile End Old Town electric lighting orders as to make each of them conform with those previously granted to London local authorities in respect of the areas under their jurisdiction, and also to make in such order the amendments prepared by the Highways committee.

(3) That the Board of Trade be asked to strike out of the St. George-in-the-East electric lighting order the clause authorising the transfer of the powers to be granted by the order, and also to make in such order the amendments prepared by the Highways committee.

(4) That the Board of Trade be asked to so amend the Lambeth (part of) electric supply order, applied for by the South London Electric Supply Corporation, as to bring it into conformity with orders previously granted to companies in respect of areas within the county of London, and also to make in such order the amendments prepared by the Highways committee; and further, to insert a provision so amending the order of 1892, granted to the Vestry of Lambeth and subsequently transferred to the company, as to place the company under the same obligations, as regards the area included in that order, as though the order had in the first instance been granted to the company itself.

The report and recommendations were carried.

Mr. Webb called attention to the inconvenience caused to electric light consumers in the neighbourhood of New Cross owing to the failure of the London Electric Supply Co. to carry out its obligations. He wished the Highways committee would take action. Mr. Benn said that in the case of Marylebone they had taken action and recovered penalties, and if Mr. Webb would send information to the committee, "they would be happy to do for Deptford what they had done for Marylebone."

Malvern.—In a report recently prepared by the Council's consulting engineer (Mr. Robert Hammond), the erection of electricity works at an estimated cost of £30,000 was advised. Opposition having been raised against such a large expenditure, an explanatory lecture was delivered by Mr. Hammond at the Assembly Rooms last week. Speaking, he said, from 20 years' experience, he advised the ratepayers not to let a company step in, as in every instance he knew of after three years' working electric lighting schemes were profitable. The probability of a company taking up electric lighting owing to the opposition to the Council's scheme was a bad thing for Malvern, especially as the ratepayers had invested £100,000 in their gas works, and a company would have the sole right to supply electricity for 42 years. He regarded the Council's provisional order as a valuable asset, which they ought not to lose. At the conclusion of the lecture Mr. Hammond answered various questions. He said the Malvern order differed from others, because of the size of the compulsory area, but he believed the order could be fully complied with for £40,000. If the Council proved its earnestness by spending £20,000 or £30,000, in making a start, the Board of Trade would not be likely to insist upon the order being literally complied with. As Malvern Link and West Malvern were not included in the order, the Council would not be compelled to supply current to those places. The whole of the compulsory area could be provided for by the low-pressure system. The Malvern order was obtained in 1890.

Musselburgh.—The agreement between the Town Council and the Drake and Gorham Electric Power and Traction Co. in connection with the electric lighting and traction scheme of the

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latter has been signed. The Council retain the option of purchasing the undertaking as a going concern at the end of 14, 21 or 28 years.

The Corporation have sanctioned the application of the Drake and Gorham Electric Power and Traction Co. for a provisional order for the construction of electric tramways in Musselburgh and adjoining districts. The company are not to come within the city boundary except by consent of the Council.

Private Bill Legislation.—The bill for the construction of the Liverpool-Manchester express railway has been passed by the examiners of private bills. The Liverpool terminus of the line will be on the site of the Bluce at Hospital, and the Manchester terminus will be in Quay-street, off Deansgate. The estimates for the construction of the proposed line give the total cost at £1,750,000. The length of the railway will be 34½ miles, and the railway will throughout its whole length be constructed as a double line, on the mono-rail system.

The bill deposited by the London United Tramways Co. seeks powers to construct tramway extensions of about 21 miles in length, chiefly from Hanwell to Chiswick, and from Twickenham via Teddington, Hampton, Hampton Court, Hampton Wick, and to Twickenham again. The proposed extensions are estimated to cost nearly £340,000.

In the preamble of the bill deposited by the Dublin Electric Lighting Co. the promoters propose to make "proper and adequate provision for the lighting by electricity of the City of Dublin and the adjacent urban districts." The capital of the company is to be £500,000, in 50,000 shares of £10 each, with the right to issue £160,000 debenture stock. The area of supply includes the City of Dublin and the urban districts of New Kilmainham, Drumcondra, Clonliffe, Glasnevin, and Clontarf. Power for supplying electricity in bulk beyond the company's limit of supply, and for the supply of electricity to the Corporation, the local authorities, and the Dublin United Tramways Co., is also sought.

The Brompton and Piccadilly Circus Railway Co, incorporated in 1897, have deposited a bill for an extension of time until August, 1902, within which to acquire the lands necessary for the construction of its railway, and an extension of time until August, 1904, within which to complete and open the line. It is proposed to increase to £50,000 the amount of capital which may be expended in the payment of interest out of capital.

The bill of the County of London Co. for authority to purchase sites and land in London compulsorily, to erect generating stations, &c., will be opposed, and a conference of local authorities has been called for the 13th inst. at municipal buildings, Lavender-hill, S.W. Representatives from Battersea, Bermondsey, Islington, Lambeth, Shoreditch, and Whitechapel will be present. In the bill powers are sought to acquire lands in Camberwell, Wandsworth, Southwark, Streatham, and St. Luke's (Middlesex) for erecting new generating stations. The bill also proposes to empower the company to abstract water for condensing purposes from the River Wandle, the Peckham branch of the Surrey Canal, and from the City-road basin of the Regent's Canal.

In the bill of the South-Eastern Metropolitan Tramways Co., powers are sought to construct 11 miles of tramway in Lewisham and the south-east of London. It is proposed to erect a generating station near the Crystal Palace gas works, and power is sought to enter into agreements with the local authorities of Croydon and Beckenham and the Blackheath and Greenwich District Electric Lighting Co. for the supply of electricity in bulk. The proposed capital of the company is £250,000, with authority to raise loans of £62,500.

Ross.—A syndicate has been formed to establish electricity works, and the Council have consented to a proposed application for a provisional order.

St. Helens.—A Local Government Board inquiry was held here on Thursday into the application of the Council to borrow £26,000 for electric lighting extensions. The town clerk (Mr. G. W. Bailey) supported the application, and explained that the Corporation had obtained sanction to expend sums of £10,000 and £16,000 in connection with the introduction and extension of electric lighting, and had overspent these amounts by £2,956. They now proposed to expend a further £17,043 in increasing their electric lighting plant and in extending the supply of current to new districts of the borough. Electric lighting had so far been an unbroken success. Mr. J. S. Highfield, borough electrical engineer, gave details of the proposed expenditure. There was no opposition.

An inquiry was also held on Tuesday, by Mr. A. P. Trotter, into the application of the Council to borrow £25,000 for electric tramways. The application was supported by Mr. G. W. Bailey, who stated that the Board of Trade had already sanctioned a loan of £25,000 and this had been expended, with £866. 7s. 11d. in excess. The £25,000 now required was made up of this amount, along with £6,875, completion of the Haydock section; £1,865, Derbyshire Hill section; £385, Rainford-street section; £2,950, Peasley Cross and Sutton extension; £3,126, Nut-grove section, Thatto Heath; £1,106, North-road to Windle City; £484, extension of the Prescot line in the direction of Rainhill; £347, underground feeder for Prescot section; and £6,995. 12s. 1d. for extra plant for these extensions. There are at present working about 10 miles of tramway, which by these extensions will be increased to 19. Mr. J. S. Highfield, borough electrical engineer, explained the details. There was no opposition.

Sevenoaks.—The Council propose to withdraw their opposition to the application of the Electrical Power Distribution Co. for a provisional order, providing the company agree to sell their undertaking at two years' notice at any time after 12 years from date of order.

Shipley.—It was decided by the Council on Tuesday to apply for a loan of £22,000 for establishing electricity works. Mr. R. C Quin is the Council's consulting engineer.

Smoke Nuisance.—At Lambeth (London) Police-court on Wednesday, the South London Electric Supply Corporation (Ltd.) answered to a summons, taken out by the Lambeth Vestry, complaining of nuisance caused by the issuing of black smoke from the corporation's chimney shaft at Bengeworth-road. The case differed in no way from similar actions, except that, in the course of his decision against the Corporation, the magistrate, Mr. Hopkins, said that the Public Health Act clearly laid down that dense black smoke must not be allowed to issue from chimneys in any place where the Act applied. He imposed a penalty of £10 and 2s. costs, with the remark that "the nuisance would have to be stopped, or the works would have to be closed!"

Sweden.—A large demand for electric machinery is imminent in Sweden as there is an important movement on foot to make more extended use of the numerous waterfalls of the country for generating electric power. An extensive electric power plant is to be put down at Trollhättan, and electric railways and tramways are projected at Gothenburg, Lund, Bjeriöd, and Jönköping.

Telegraphic Extension in India.—A direct telegraph line has recently been constructed between Calcutta and Madras, and is now open for traffic. Two lines have received Government sanction—Bombay to Poona and Poona to Dhond, the latter city being already in telegraphic communication with Madras. Oil insulators are used on the line from Calcutta to Madras, to minimise as much as possible the effect of the saline atmosphere along the east coast. During the recent drought in the Bombay Presidency the telegraph insulators are stated to have been so incrusted with salt deposit as to require constant scraping. In ordinary seasons the monsoon rains keep the insulators clear of these deposits.

Telephone at Edinburgh.—At Wednesday's meeting of the Edinburgh Corporation the town clerk intimated that he and the Lord Provost had signed the telephone agreement between the Corporation and the National Telephone Co. A new clause has been added, which provides that if the Government take over the telephones and buy up the National Co.'s undertaking before Dec. 31, 1911, the option which the Council have under the agreement of purchasing the pipes and wires shall not apply.

Telephone at Glasgow. The minutes of the special Telephone committee of the Glasgow Corporation, submitted at yesterday's meeting, contain a recommendation that a Government licence should be obtained for the establishment of a municipal telephone service. We have very fully reported the stages of this discussion up to this point. As a result of a meeting between the engineers of the Post Office and the Corporation, various alterations have now been made on the original specifications to meet the objections raised as to the cost of the Government scheme. In particular, the weight of wire to be employed in certain overhead circuits and in underground wires has been considerably reduced. As regards the area to be included, the Postmaster-General states that he will be ready, if the Corporation wish, to make it co-extensive with the existing Glasgow Exchange area of the National Telephone Co., without reference to the consent of the other local authorities within that area. The committee recommend that the licence, as now adjusted with the Post Office (given in full in our last issue), should be accepted by the Corporation, and that it should be remitted to the committee, in consultation with Mr. A. R. Bennett, the consulting engineer, to prepare and submit for consideration a scheme, with the necessary estimates, for carrying the licence into effect, the licence to start in March, 1900, and terminate on Dec. 31, 1913. The tariff has been fixed as under: Communication between an exchange and the premises of any exchange subscriber and the transmission of an unlimited number of messages—maximum, £10; minimum, £4. Communication between any exchange and the office of any exchange subscriber, exclusive of the transmission of messages—maximum, £4; minimum, £1. 10s. For the transmission of subscribers' messages to any office on an exchange in the exchange system, for every message—maximum, 1d.; minimum, ½d. For the transmission of a message from a call office to any other office on an exchange in the exchange system—maximum, 1d.; minimum, ½d. The committee's minutes also contain the correspondence which has passed between the National Co. and the Corporation, chiefly on the

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subject of a modification of the company's tariff. The committee report that, having considered this correspondence, they decided to recommend that they were of opinion that the terms indicated in the letter did not form a basis for further negotiations.

Tyneside Electric Power.—In reference to the note appearing in our last issue (page 487) on the bill to be presented to Parliament this session by the Tyneside Electric Power Co., it is pointed out that the prices per unit mentioned in the bill must only be taken as the maximum charges. The promoters realise that considerably lower charges per unit than those mentioned will have to be charged to large consumers where the company has to compete with steam power. As a matter of fact, the company has already offered a scale as low as 3d. per unit for the first 100 hours per quarter and 0·9d. per unit for subsequent hours for the supply of power in localities where consumers are likely to be large and numerous.

Water Cooling Plant.—The Middlesbrough Corporation has placed an order for the erection of a Klein patent water cooler for the condensing plant at the electricity supply works.

Workhouse Lighting.—The Local Government Board have sanctioned the proposal to light the Stoke-on-Trent Workhouse electrically.

PATENT RECORD.

The following list of Applications for Patents and Specifications published has been compiled for this journal by Messrs. J. C. CHAPMAN and Co., *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs, and Trade Marks may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after the acceptance of the complete Specification. The names within parentheses are those of communicators of inventions. When complete specification accompanies application, an asterisk is affixed.*

January 2, 1900.

92. A. H. HOWARD. London. Improvements in or connected with the manufacture and production of pipes or conduits for electrical conductors or for conveying liquid gases or for analogous purposes.
100. B. W. HOUNSELL. East Dulwich. Improvement in regulating the supply of gas, electricity, or any other matter for illuminating and heating purposes.
105. T. MASON. London. Improvements in electric lamps applicable for advertising purposes.
115. J. RICHARD. London. Improvements in advertising by means of electric lamps and apparatus therefor.
138. C. R. LOUBERY. London. Improved method of telegraphing, indicating time, or actuating mechanism electrically.
146. J. H. MCGURTY and T. MCEWAN, jun. London. Speed governor attachment for electrical apparatus.
147. W. L. TETER and J. A. HEANY. London. Improvements in electric water filters.*

January 3, 1900.

159. A. H. C. GIBSON and E. G. MILES. Birmingham. Improved means of taking up the slack of flexible wire, cord, or other material used in electric or other fittings.
163. P. C. MCFARLANE and D. REID. Glasgow. Improved automatic make and break for electric circuits.
164. C. M. STEAD and G. F. CARR. Leeds. Improvements in or in connection with electric incandescent lamps.
174. F. H. ROYCE. Manchester. Improvements in electrically-driven cranes and similar machines.
176. H. LACHENMEYER. Birmingham. A current receiver for electric railways.*
178. H. BAKER. London. Improved means of making the electrical connections with carbon electrodes.
182. P. W. NORTHEY and THE ELECTRIC MOTIVE POWER CO. (LTD.). London. Improvements in electric ignition devices for internal combustion engines.
184. M. B. FIELD. Lee. A new or improved method of determining the voltage obtaining at a near or distant part of an electric circuit, or the average voltage obtaining at several parts thereof, and apparatus therefor.
201. R. BELFIELD. London. Improvements relating to conduits for electric railways.
216. R. RODRIAN. London. Improved manufacture of active mass for accumulator batteries.

January 4, 1900.

246. F. H. HEADLEY. London. Improvements in automatic electric switches.
247. F. H. HEADLEY. London. Improvements in electro-magnetic mechanism suitable for use in indicators, relays, bells, and the like.
248. E. B. VILES. London. Improved electric switch mechanism.
254. J. LEVERSON. London. Improvements in subterranean conductors for electric railways. (J. Steinbach, Austria-Hungary.)
260. F. E. ELMORE. London. Improvements in apparatus for the generation and electrolytic application of electric currents. (Partly communicated by J. O. S. Elmore, India.)
261. H. C. GOVER and J. M. MOFFAT. London. An improvement in safety electric fuses.*
264. G. MARCONI. London. Improvements in apparatus for wireless telegraphy.

January 5, 1900.

293. W. DUTHIE. Aberdeenshire. Electricians' pocket companion.

January 6, 1900.

361. A. A. MCNAUGHT. Ayr. Double-link detachable chain for electric light purposes.
367. M. CRANKSHAW, A. CRANKSHAW, and H. CRANKSHAW. London. Improvements in or relating to the means for adjusting or regulating the shades or covers employed in connection with electric lights or gas lights and others for the purpose of concentrating and diffusing the light therefrom in any desired or required direction, and apparatus for effecting the same.
396. M. BEHRENDT. London. Improvement in electricity meters.
399. A. CHABAND and E. CHABAND. London. Improvements in telephone call stations to be rendered operative by the insertion of a coin.
410. C. A. LEE. London. Improvements in electric arc lights or lamps.

January 8, 1900.

4,931A. W. L. WISE. London. Improvements in and connected with telegraphy. (A. C. Crehore and G. O. Squier, United States.) (Date claimed under Patents Rule 19, March 6, 1899.)
420. H. BREMER. Germany. Improvements in electric arc lamps.*
434. A. S. BOWLEY. London. Improvements in and pertaining to phonographs, gramophones, telephones, and the like.
435. F. T. HOLLINS and H. C. T. AMENDT. London. Improvements in apparatus for electrically interlocking the doors or gates with the operative machinery of hydraulic or other lifts.
440. L. M. CHAPMAN and J. M. GELATT. London. Improvements in electric light sockets.
453. W. L. WISE. London. Improvements in electrical switches. (The Actien Gesellschaft Elektricitäts-werke vorm. O. L. Kummer and Co., Germany.)
466. W. J. WELLS and ALLAN and ADAMSON (LTD.). London. Improvements in apparatus for facilitating the escape of gas from electric storage batteries or accumulators.
467. B. M. FLETCHER. London. Improvements in or relating to electric light fittings.

January 9, 1900.

489. M. J. MYERS. London. Improvements in devices for locating earth contacts on electric circuits.*
507. A. CLARKE. Birmingham. Improvements in the construction and manufacture of electric bells.
516. J. VESELEY. London. Improved electric switch for electric trams and railways.*
524. E. A. GODDIN and J. T. ARMSTRONG. London. Improvements in and relating to variable electrical resistances.
559. W. L. WISE. London. Improvements in transformers. (The Actien Gesellschaft Elektricitäts-werke vorm. O. L. Kummer and Co., Germany.)*
565. J. G. LORRAIN. London. Improvements in and or connected with electric meters. (H. A. Macdonald, France.)

January 10, 1900.

591. L. M. TYACK and F. B. FAWCETT. Bristol. Improved apparatus for regulating the current in an electrolytic interrupter.
595. J. DE BURGUE and R. SUNYÉ. Paris. New process of total suppression of motive power as well as of electric energy in the industrial production of carbide.
610. C. F. KRONHEIMER. London. Improvements in electric order telegraphs for use on shipboard and elsewhere.
622. E. BONHIVERS. London. Improvements in incandescent arc and other lamps.*
623. R. F. BLACK. London. Improved carrier for wires or electric conductors, such as the trolley wires or conductors of electric railways, tramways, and the like.
630. J. R. DICK and THE REASON MANUFACTURING CO. (LTD.). London. A method of and apparatus for connecting electric meters in three-wire circuits.

January 11, 1900.

636. H. SIMPSON. London. Improvements in screens for incandescent electric lamps.
638. E. A. LE SUEUR. Canada. Improved electrode.
655. G. E. VAUGHAN. London. Improvements in or connected with electrically actuated mechanism applicable for various purposes, such as the steering of ships, the working of engine room or like telegraphs, or the training of guns. (J. A. Vaughan, South Africa.)
659. A. GARDY. London. Improvements in electric switches.
661. W. MOSELEY. London. Improvements in telephone apparatus.
675. H. H. LAKE. London. Improvements in or relating to electric batteries. (R. C. McCartney, United States.)*
683. V. I. FEENY. London. Alternating-current meter for small non-inductive charges. (Allgemeine Elektricitäts Gesellschaft, Germany.)*
683. F. MYERS. London. Improvements in sound transmitters or disseminators for phonographs.*
700. C. JUNG, A. BRECHER, and A. KITTEL. London. Improvements in compounds for dielectrical purposes.

January 12, 1900.

729. C. M. DORMAN, R. A. SMITH, and H. G. BAGGS. Salford. Improvements in electrical switches.*
750. F. J. COX. Birmingham. Improvements in and relating to dynamometers.
776. A. E. BENNETT. London. Improvements in electric fittings.

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758. J. Wetter. London. Improvements in controlling devices for the motor circuits of electrically-propelled vehicles. (The Elektricitäts Aktien-Gesellschaft vormals Schuckert and Co., Germany.)
768. The Davy Electrical Construction Co. (Ltd.) and J. L. E. Daniel. London. Improvements in or connected with electric arc lamps.

January 13, 1900.

814. B. G. Lamme. London. Improved method of and installation for operating two-phase electric motors. (Date applied for under Patents, &c., Act, 1883, sec. 103, June 14, 1899, being date of application in United States.)
837. H. H. Lake. London. Improvements in or relating to incandescence electric lamps. (T. Shearman, United States.)*
838. H. H. Lake. London. Improvements in or relating to incandescence electric lamps. (T. Shearman, United States.)*
839. H. H. Lake. London. Improvements in or relating to incandescence electric lamps. (T. Shearman, United States.)*
840. H. H. Lake. London. Improvements in or relating to incandescence electric lamps. (T. Shearman, United States.)*

SPECIFICATIONS PUBLISHED.

Note.—All Specifications can now be obtained at the uniform price of 8d. each.

1898.

19,876. Steinhart, Vogel and Fry. Electrolytic separation of zinc from zinc oxide.
26,723. Burnand. Device for indicating the frequency of an electric current or currents, the said device being applicable for signalling and indicating speeds and the like.
26,769. Anderson. Electrically operated clocks.

1899.

214. Ferreira and Pryce. Apparatus for electrically interlocking the block and mechanical signals on railways.
216. Lorrain (Esmond). Electric railways of the sectional conductor type.
1,188. Jones. Guards for overhead electric conductors such as trolley wire, and the like.
1,483. Jolin. Apparatus for heating by electricity.
1,673. Blackwell and Blackwell. Portable telephones, applicable also for testing purposes.
1,844. Champagne. Manufacture of plates for secondary batteries.
1,866. Orling and Braunerhjelm. Receiver for waves of light heat, or electricity. (Date applied for under International Convention, October 27, 1898.)
1,698. Orling and Braunerhjelm. Device for regulating the distance between objects hermetically enclosed applicable to receivers for waves of heat, light, or electricity. (Date applied for under International Convention, October 27, 1898.)
1,867. Orling and Braunerhjelm. Apparatus for regulating the sensitivity of receivers for waves of light, heat, or electricity. (Date applied for under International Convention, October 27 1898.)
2,906. Cox. Switchboards.
3,648. Chalandre Colas and Gérard. Electrolysis of salts in solution and apparatus therefor.
20,290. Timar. Appliances for imparting electricity and heat to the body.
20,471. Boult (Delafon). Electric batteries.
20,507. Von Arnswaldt. Electric igniter for gas.
20,743. Tourtel (Rissler and Bauer). Electricity meters.
20,789. Johnson. Gramophones and like machines for recording and reproducing sound.
20,862. Addenbrooke. Method and apparatus used in electrostatically measuring electric currents in a working circuit, and calibrating the measuring instruments so employed.
20,882. Weidlich and Nies. Sliding contact for telescopic or similar adjustable electroliers.
21,084. Mandt. Magnetically-operated locks suitable for safety lamps or other purposes.
21,232. Jacobson. Ear trumpets, applicable also to telephone receivers and the like.
21,311. Boult (Dalziel). Apparatus for exhibiting electric signals, advertisements, and the like.
21,413. Sachs. Safety fuses for electric circuits.
21,659. The British Thomson-Houston Co. (Ltd.) (Johnston). Circuit breakers for alternating electric currents.
21,663. The British Thomson-Houston Co. (Ltd.). (Fleming.) Electric arc lamps.
21,664. The British Thomson-Houston Co. (Ltd.). (Hartham and Stevens.) Electric arc lamps.
21,668. British Thomson-Houston Co. (Ltd.). (Pratt). Alternating electric current meters.
21,707. Casper and Peirce. Electric massage instruments.
22,533. British Thomson-Houston Co. (Ltd.) (Steinmetz). Systems of electrical distribution.
22,536. British Thomson-Houston Co. (Ltd.) (Oxley). Electric circuit changers.
22,615. Atterberg. Safety device for starting-switches of electric motors.
22,666 Anderson. Chemical generator of electricity.
22,857. Cunow. Medicinal light-curative apparatus for the production of complete or partial baths of chemical and electrical rays of light.
23,040. Boult (Störmer). Apparatus for the electrolysis of alkali chloride solutions.
23,055. Siemens Bros. and Co. (Ltd.). (Siemens and Halske Aktien-Gesellschaft). Current-collecting apparatus for the underground conductors of electric railways and tramways.

COMPANIES' MEETINGS AND REPORTS.

Direct United States Cable Co. (Ltd.).

The forty-fifth ordinary general meeting of this company was held at Winchester House, Old Broad-street, on Tuesday, under the presidency of Mr. E. M. Underdown, Q.C.

The GENERAL MANAGER and SECRETARY (Mr. T. Finnis) having read the notice calling the meeting, and other formal business having been disposed of,

The CHAIRMAN said: Gentlemen, the revenue for the six months to Dec. 31 last, after deducting outpayments, amounted, in round figures, to £56,800, while the working and other expenses, including income tax, but excluding the cost of cable repairs, absorbed £20,416, leaving a balance of £36,384 as net profit, making, with £3,176 brought forward from the previous half-year, a total of £39,560, which has been appropriated as follows: Interim dividend of 3s. per share to September 30, £9,105. 10s.; interim dividend of 3s. to December 31, £9,106s. 10s.; set aside to reserve fund, £15,000; carried forward, £6,347; making a total, as mentioned, of £39,560. It is satisfactory to be able to say that the revenue has continued to improve, and shows the not unsatisfactory increase of £2,434 as compared with that for the corresponding period of 1898. The expenses, on the other hand, show a reduction of £1 205, this reduction being owing chiefly to a less outlay on the maintenance and renewal of instruments, some special expenditure having been necessary under this head in the corresponding period. Beyond that reduction there is one of £249 in the London salaries. The usual particulars, of course, are set out in the abstracts accompanying the report. With respect to the cable repairs, I may say that they have only cost £1,989. 16s., which has been charged, as usual, to the reserve fund. I will say something further about these repairs later on. On the other hand, the reserve account has been credited with £6,317. 12s. 8d. interest on the investments, and with the £15,000 set aside out of revenue, bringing the balance of this fund up to £401.693. 16s. 2d. at cost. The investments have been increased during the half-year by £14,319, and they now stand at a total cost of £380,601. Their present market value is about £410,600, or £30,000 above their cost, and this notwithstanding the great fall in market prices even of all first-class investments. I have already said that the repairs amounted to a sum under £2,000 this half-year. Of course, that is exceedingly satisfactory, and if we could count upon a continuance of that we should be in a different position from most cable companies. It is very fortunate that we have been able to keep our cables in order at so small an expenditure. It is also well to say that the cable is working satisfactorily with duplex, and that has been very useful in our contributions to the pool, because, although we have been free from serious breakages, that of course cannot always be the case with the large number of cables which cross the Atlantic. With respect to the principal item in this statement, which is the placing to the reserve fund of so large an amount as £15,000, I have only received one comment from a shareholder, who would have liked to have a larger dividend; but if we look more closely into the affairs of the company, we must remember this—that while every half-year we are increasing our reserve fund by making an expenditure for investments, the history of the last year or two has been unfavourable even to the best class of investments, and the market value of our investments, although it is still far above their cost, does not exceed the cost to anything like the extent it did on a former occasion. In point of fact, therefore, we are making, up to a certain extent, some lee-way in that respect. As I have frequently explained here, it is also necessary to take note that while our investments are not increasing in value, the materials which would be required, should we have to bring our reserve fund into play, are increasing in cost. I think that these considerations are enough, without anything else, to warrant us in being extremely careful to keep up our reserve fund. Moreover, this is only a question of an interim dividend, and, as you are aware, the board has always done everything that is possible and prudent at the end of the year, when we know what the total expenditure has been, to make up the dividend as far as we can by way of bonus; and we trust to be able to do so this year. If we had to consider only our own affairs, we should be very comfortable and happy, but we know that steps are being taken by other nations to establish telegraphic communication across the Atlantic. A powerful German company has been established, and no doubt within a not very distant period a cable will be laid from Germany to the Azores, and from the Azores to the United States. As to that, we can of course say nothing. Direct communications are of course quite naturally adopted by foreign and important countries. What we did object to was our country being made, as it were, a stepping stone for these communications, to the prejudice of British interests; and I may say that no exertion has been spared on the part of our allied company, the Anglo, and of our own board, to put these matters forcibly before Her Majesty's Government, who, I am glad to say, have, as far as we can judge, thoroughly entered into the spirit in which these representations have been made, and I think that they will do all that they can to protect British interests. There is another point to bear in mind, which Mr. Newton mentioned at our last meeting: that is, with respect to an all-British Pacific cable. That also has been carefully looked after, and I think that I may go so far as to say that Her Majesty's Government have shown the strongest disposition to protect the interests of this company and of the allied company in this respect. Of course we must remember that while the interests of other companies perhaps are somewhat imperilled by Pacific cables of every kind, yet our own interests, as communicating between the British Isles and the American continent, are likely

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directly or indirectly, to benefit by Pacific communications. W do not generally say very much about the famous French suit, which, as far as I know, has at the present time beaten the longest procedure I have been connected with, which is the Delagoa Bay arbitration—in length of time; but this we know—that the suit appears to have made a step forward, the verdict of the Rouen tribunal being now subject, as far as the amount of it is concerned, to the opinion of experts, who are to decide how much of that amount is payable as damages, subject to deduction for any services which were rendered by the French company during the period that their adherence to the pool lasted. I do not wish to put too high a value on the result of that, but at the same time, so far, we are making some progress in this matter. I mentioned the establishment of a German company, and I must add that, as I have often mentioned here, the arrangement between the Anglo company and the German Government came to an end at the termination of last year. It has not, however, actually been stopped, and is at present proceeding provisionally, subject, as we hope, to some reasonable arrangement being come to. We are joining with our sister company—the Anglo—in endeavouring to keep that matter as straight as we can. You will notice that Mr. Finnis, our secretary during a great number of years, who is fully master of all the details of this business, has been named by us the general manager as well as the secretary, his duties with respect to the accounts being handed over to another officer. We think that this arrangement is extremely satisfactory, and I have no doubt that you will approve of this step having been taken. I do not think that there is any other point to which I need refer. I believe I have mentioned everything that is of importance, and I will now conclude by moving—

"*That the report of the directors dated January 16, 1900, together with the statement of accounts to December 31, 1899, annexed thereto, be and the same are hereby received and adopted.*"

Sir JAMES PENDER, Bart., M.P., seconded the resolution.

The CHAIRMAN expressed his readiness to hear any remarks or to answer any questions, but no shareholder rising to address the meeting, he put the resolution in the usual way, and it was carried unanimously.

Mr. J. B. MARMONT then proposed a cordial vote of thanks to the chairman, the directors, and the staff for their able conduct of the company's affairs during the past half-year.

Mr. JOHN NEWTON seconded the motion, which was carried unanimously.

The CHAIRMAN, in reply, said the shareholders might be quite sure that, in the somewhat difficult position in which the directors found themselves, their energies would be devoted to protecting the company's interests.

The proceedings then terminated.

Smithfield Markets Electric Supply Co. (Ltd.).

The directors' report for the 15 months ended Dec. 31 states that the gross revenue amounts to £12,083. 6s., against £6,501. 5s. 2d. for the year to Sept. 30, 1898, while the gross profit on trading has been £3,475. 0s. 9d., against £759. 3s. 1d. for the same period. This result would have been even better but for the difficulty which the company has experienced, in common with all other electric lighting companies, in obtaining the best quality steam coal, and the consequent largely increased consumption. Nevertheless, further reductions have been effected in the costs per unit generated and sold. The net profit for the 15 months, after paying debenture interest and other charges, is £564. 18s. 2d., reducing the deficit to £210. 2s. 8d. This amount will, it is anticipated, have been more than wiped off by Jan. 31, 1900.

The conviction expressed by the directors in their last report, that the use of electricity in the Central Markets was likely to become more popular, has been borne out by results. During the 15 months under review 78 new installations have been obtained, and the increase in the number of lamps connected has been 7,237, or 74 per cent. As about one-half of these lamps were connected during the last three months of the year the full effect on the revenue will only be apparent in the current year's accounts, which should show a further substantial increase. New customers are constantly being obtained, and several are at present waiting to be connected.

The plant and machinery has worked satisfactorily throughout, no interruption of any kind having occurred in supply. The storage battery has been in use since October last with economical results. The value of this battery in the saving of coal and wages will be considerably enhanced during the summer months as it will enable the plant to be shut down for several hours per day, as well as ensuring against failure in the supply at all times.

The directors regret that their application for a provisional order to enable them to supply current in the City of London was unsuccessful. The cost of the application will be spread over a period of five years.

Mr. H. S. Leon has been appointed a director to fill the vacancy caused by the retirement of Mr. G. H. Brougham Glasier.

City and South London Railway Co.

The report of the directors for the half-year to Dec. 31 announces that the receipts from all sources amounted to £27,506. 1s. 3d., and the cost of working £15,968. 4s. 6d., leaving a profit of £11,537. 16s. 9d. Inclusive of the balance brought forward, the net revenue account shows an aggregate total of £15,538. 4s. 8d. After making provision for the debenture stock interest, a balance remains available for dividend of £11,429. 19s. 6d. Out of this it is recommended that the full dividend of 5 per cent. per annum be paid on the preference shares, and a dividend at the rate of 1½ per cent. per annum upon the consolidated ordinary stock, leaving £1,267. 9s. 6d. to be carried forward. The directors regret the diminution in the dividend, arising from increased cost of materials and from the fact that the ordinary stock ranking for dividend has been increased by £225,000, expended on lines not yet open for traffic.

Moorgate Street Extension.—Owing to the delay on the part of the several contractors, it was found impossible to open the line at the date anticipated. Every possible pressure has been put upon the contractors, and the works are now so far completed that it is hoped the sanction of the Board of Trade for the opening for public traffic will be obtained within the next two or three weeks. The delay has been a source of great disappointment, as the capital expended on the construction and equipment of the extension has consequently been unproductive in place of earning an adequate return.

Clapham Extension.—The works on this extension are rapidly approaching completion; the surface stations are well advanced, and there is every prospect of its being ready for public traffic within the next three months.

Islington Extension.—The sites for the stations on this extension have been acquired and are in the hands of the contractors. Good progress has been made with the tunnelling; 579 yards on the up line and 550 yards on the down line have been driven.

The subway at London Bridge to connect this company's station at the corner of Denman-street with that of the London, Brighton and South Coast Railway will be commenced as soon as some preliminary boring operations have been completed.

Of the ten locomotives referred to in the last report as under contract, eight have been delivered and are giving satisfaction.

Generating Station.—The principal works necessary for running the trains to Moorgate-street are now completed, and the further power required for the extension to Clapham is expected to be ready early in March. A large new carriage shed is in course of erection.

Parliamentary.—A bill is to be submitted to Parliament seeking sanction to substitute a tunnel of 30ft. in diameter for two of 21½ft. at the station at the Islington terminus, whereby greater convenience will result in the working of the traffic and a saving in the cost of construction.

Negotiations are in progress with the Great Northern and City Railway Co. for the construction of a joint station at the corner of Old-street for the exchange of traffic between the two companies; and a bill has been deposited in Parliament by the Baker-street and Waterloo Electric Railway Co., now in course of construction, for the extension of that line from Waterloo to join this company's railway at the Elephant and Castle station.

Waterloo and City Railway Co.

The directors' report for the half-year ended Dec. 31, shows that the capital account amounted to £573,656. 9s. 9d., and that the further estimated expenditure of £40,000 is amply provided for; the revenue account shows that the gross receipts, less Government duty, amounted to £34,348. 19s. 4d. From this the London and South Western Co. have retained £4,824. 4s. in respect to working expenses, leaving £8,524. 15s. 4d. payable by them, in order to provide for a dividend at the rate of 3 per cent. per annum on the Company's ordinary and borrowed capital. This dividend is payable on Feb. 13.

The number of passengers carried during the six months was 1 769,731, exclusive of season-ticket holders (776). The railway was opened on Aug. 8, 1898, and the number of passengers carried between that date and Dec. 31, 1898, was 1,442,855, the number of season-ticket holders then being 454.

On Jan. 8, three additional entrances were opened to the City station in connection with the public subways, which are being constructed at the Mansion House by the Central London Railway at the joint expense of the two Companies; and when the whole of the subways are completed there will be two other entrances at the Royal Exchange.

Liverpool Overhead Railway Co.

The report of the directors for the half-year ended Dec. 31, 1899 states that the gross revenue receipts amounted to £42,928. 11s. 9d., and the working expenses to £25.007. 5s. 5d. The number of passengers carried during the last four half-years is as follows:—

	June 30, 1898.	Dec. 31, 1898.	June 30, 1899.	Dec. 31, 1899.
First Class...	637,547	663,177	594,669	676,768
Second Class	2,686,651	2,962.827	2,445,572	2,941,392
Workmen ...	1,148,743	1,268,917	1,435,038	1,596,797
Totals...	4,472,941	4,894,921	4,475,279	5,214,957

An increase of 320,036, and in receipts of £1.940.

The works of the Waterloo and Great Crosby tramways are proceeding, and it is hoped they will be opened for traffic during the current half-year. The directors are promoting a bill in Parliament for a short extension northwards, to join the Seaforth station of the Lancashire and Yorkshire Railway, and southwards for a short line beyond the Herculaneum station, and for widening the line at Pierhead station.

There is available for distribution £18.841. 14s. 7d., out of which the directors recommend dividends at the following rates (less tax), payable Feb. 16: 5 per cent. per annum on preference (£3,000), and 5 per cent. per annum on ordinary shares (£11,250), leaving £4,591. 14s. 7d. to be carried forward.

Deutsch-Atlantische Telegrafen Gesellschaft.

The first report of the Directors of this Company deals with the progress of the scheme for the establishment of an independent cable from Borkum, viâ the Azores, to New York. The Company, which was formed in Feb., 1899, entered into an agreement in May last with Messrs. Felten and Guilleaume and the German Government. The concession granted by the German Government for the establishment of the cable is for forty years from the

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commencement of working, and the laying of the cable is to be finished by Oct. 1, 1900. In case the cable is found to be inadequate for dealing with the traffic, the undertakers will be justified in laying a second cable for the duration of the concession. The German Postal authorities will operate the cable from the German terminal point, whilst the undertakers are to work and maintain the line at the Azores and on the North American side. The cable is in the first instance intended to deal with the telegraphic service between Germany or its Hinterlands and America and *vice versâ*, but Peru, Brazil and the other South American States are excluded from its sphere of activity. The German Government will pay to the Company a guarantee of £70,000 per annum until the expiration of the concession, and will receive in return the revenue from messages sent in both directions between Germany and America to the extent of £85,000 per annum. When the receipts exceed £85,000 the German Government will, under certain conditions, participate in the excess at the rate of 25 centimes per word. The undertakers are pledged to take over the cable line of the Deutsche See Telegrafen Gesellschaft from Borkum to Vigo not later than by the end of 1904. The company has obtained permission to land the cable in the United States, whilst a landing position at Fayal, in the Azores, has been secured through the intermediary of the Europe and Azores Telegraph Co, Ltd. which will receive £2,500 for affording the necessary facilities. As soon as the working of the cable yields a dividend exceeding 8 per cent. the company undertakes to lay a cable between Fayal and Santa Maria, Azores. A further condition for the laying of the cable at the Azores was that the cable should be ordered from the Telegraph Construction and Maintenance Company of London. The cost of making and laying this cable—which will be 4,366 knots in length—amounts to £935,000. It is estimated that the cable, which is expected to deal with 8,000,000 words per annum, will be completed before October. Arrangements have been made with the Commercial Cable Co., whereby the latter places its network in the United States at the disposal of the company for the despatch of telegrams by the new cable to Germany, and provision has been made for the transmission of messages by other routes in case of any interruption in the working of the new cable. The capital of the company is £1,200,000, and £700,000 has been already paid up.

BLACKPOOL AND FLEETWOOD TRAMROAD CO.—The report of the directors states that the balance of profit, including the sum brought forward after providing for debenture interest, is £10,027. 17s. 3d., and a dividend at the rate of 10 per cent. per annum is recommended. This will absorb £7,247. 10s. 8d.; sums of £521 and £500 are to be written off the cost of application to Parliament for further powers under Act, 1898, from preliminary expenses, leaving £1,759. 6s. 7d. to be carried forward. The number of passengers carried during the half-year was 1,161,786. The gross receipts amounted to £20,476. 0s. 2d.

DOUGLAS SOUTHERN ELECTRIC TRAWAYS (LTD).—A general meeting of this company was held at Manchester on Friday. The directors' report stated that the daily service of the electric tramways had been most efficiently maintained. The miles run were 37,593, passengers carried 100,769, gross traffic £4,444. 5s. 5d. After paying tolls, the nett passenger and small sundry receips amounted to £3,719. 15s. 4d., against £3,457. 14s. last season. The total profit on the season's working was £1,455. 4s. 3d., making, with the amount brought forward, £1,806. 3s. 10d., and a dividend at the rate of 6 per cent. per annum was declared on the 7 per cent. preference shares, £271 16s. 3d. being carried forward. At the meeting the chairman (Mr. T. J. Hutchinson) stated that they had been able to run the line, with its many peculiarities, without a single accident of any description throughout the season. Mr. Davenport, a director, said it was quite possible that at an early date there would be an electric tramway line from the bridge at Douglas to Douglas Head, which would favourably affect the Douglas Southern Co.'s prospects.

GREAT NORTHERN & CITY RAILWAY CO.—The third half-yearly meeting of this company was held yesterday, Sir Charles Scotter presiding. A report from the engineers, Sir Douglas Fox and partners, was read, showing that the construction of the line was being actively proceeded with. The chairman remarked that the Central London Railway was approaching completion, so that the board of this company would have the benefit of the experience gained in the working of that and other similar undertakings in the matter of electrical appliances. The Waterloo and City Railway, of which he was a director, adopted a system of traction at the outset which was thought to be the best at the time, but experience had shown that some alterations in the traction power were necessary. The London and South Western Co., who work that railway had, therefore, ordered new motors, and it was expected that, in the course of a few months, the working of the line would be greatly improved. The Great Northern and City Line would pass through one of the most densely populated districts of London, and he was sure that if they could provide a cheap mode of traction, and a frequent service, the success of the undertaking was practically assured.

METROPOLITAN RAILWAY CO.—At a shareholders' meeting last week the chairman, Mr. J. Bell, referred to the experiments in electric traction on the Metropolitan system between Earl's Court and High-street, Kensington. The directors, he said, felt disappointed that these experiments had not yet been completed. He pointed out that the experiments had been conducted after the traffic had ceased at night and on Sundays, which, in his opinion did not form a fair working test. The subject was receiving the board's careful attention, and in addition to the experiments above mentioned, others had taken place on a piece of the company's line at Wembley Park which, so far as they had gone, had given all concerned a large amount of valuable information which would assist them materially in solving the difficulties of applying electric traction to the working of the lines.

WESTERN UNION TELEGRAPH CO.—This company have issued their report for the quarter ended Dec. 31. The following statement exhibits the condition of the company at the close of the quarter ended Sept. 30, 1899:—

Surplus July 1, 1899, as per last quarterly report ...		$8,056,927 53
Net revenues, quarter ended Sept. 30, 1899		1,666,567 03
		$9,733,494 56
From which deducting for—		
Dividend of 1¼ per cent. paid Oct. 16 ...	$1,216,991 25	
Interest on bonded debt.....	224,120 15	
		$1,441,111 40
Left a surplus Oct. 1, 1899, of		$8,292,383 16
The net revenues of the quarter ending Dec. 31, based upon nearly completed returns for October, partial returns for November, and estimating the business for December, were about		1,600,000 00
		$9,892,383 16
From which appropriating for—		
Interest on bonds		224,120 15
		$9,668,263 01
It requires for a dividend of 1¼ per cent. on capital stock issued, about		1,216,992 00
Deducting which leaves a surplus, after paying dividend, of		$8,451,271 01

In view of the preceding statements, the committee recommend that a dividend of 1¼ per cent. on the capital stock of the company be declared payable on and after Jan. 15.

NEW COMPANIES, STATUTORY RETURNS, &c.

CHARLES S. MADAN & CO. (LTD.).—This company was registered on Jan 20 with a capital of £12,000 in £1 shares, to acquire the business carried on as Charles S. Madan & C., and to carry on the business of mechanical, electrical, consulting, and general engineers, iron and brass founders, &c. Messrs. C. S. Madan and W. H. A. Ord-Mackenzie are the first governing directors.

DUXBURY BROS. (LTD.)—This company was registered on Jan. 15, with a capital of £5,000 in £5 shares, to carry on the business of mechanical and electrical engineers, machinists, tool makers, &c. The first directors are J. K. Duxbury, A. Y. Duxbury, and K. Duxbury.

FIELD, MALLETT & CO. (LTD.).—This company was registered on Jan. 22, with a capital of £21,000 in £1 shares (2,000 "A" preference and 7,000 "B" preference), to take over the businesses of Howard Field and C. S. Mallett and Co., and to carry on the business of engine and motor car manufacturers, mechanical and electrical engineers. The first directors are H. Field, E. A. Head, L. N. Bamber, and C. S. Mallett.

FIREPROOF ELECTRIC SWITCHBOARD CO. (LTD.)—This company was registered on Jan. 17, with a capital of £1,000, in £1 shares (500 preference), to acquire and deal with any patents and to carry on the business of manufacturing electricians and manufacturers of fireproof switches and switchboards, &c. The subscribers are J. O. Dale, W. E. Godfrey, T. Newcombe, J. E. Carr, T. M. Hanson, J. W. Bennett, and J. E. Robinson. The first directors are J. O. Dale (chairman) and Percy H. Byrd (managing).

GENERAL TRAMWAYS CONSTRUCTION SYNDICATE (LTD).—This company was registered on Jan. 16, with a capital of £200,000 in £1 shares, to construct and maintain in Geneva, or elsewhere, tramways, railways, telephone and telegraph lines, &c. The subscribers are L. Neumann, A. Marc, A. Ries, T. H. Lovinsky, E. J. Hallerstadt, C. Schmidt and E. J. Burridge. The first directors are L. Neumann, A. Ries, H. A. Butters, Gen. N. Harris, and J. M. Lucach.

SMOKE PREVENTER AND FUEL ECONOMISER (LTD.)—This company was registered on Jan. 18, with a capital of £300,000 in £1 shares (100,000 preference and 200,000 ordinary), to acquire certain patents, patent rights, &c., relating to improvements in inventions for the prevention of smoke, economisers of fuel, or the production of increased heat in boilers or other furnaces, &c., and in particular to acquire from Mr. J. Alves, of Melbourne, the letters patent for Great Britain for improvements in and relating to fire bridges for steam boilers and other furnaces, &c. The first directors are Messrs. M. Guthrie, H. Macdonald, J. Alves, J. McLaren, and A. Anderson.

SOUTH WALES ELECTRICAL POWER DISTRIBUTION CO. (LTD.).—This company was registered on Jan. 16, with a capital of £30,000 in £10 shares, to carry on the business of electricians and electrical engineers in all its branches, and to produce, store, supply and sell electricity for light, power, heat, or other purposes. The subscribers are A. Hood, T. E. Brown, (civil engineer) Sir W. T. Lewis, Bart. (civil engineer), E. P. Martin (civil engineer), A. T. Walker (civil engineer), A. Kelly (each with 100 shares); and R. Forrest and E. Riffert (with 50 shares each). The management is vested in a committee of not less than four nor more than seven members.

AUTOMATIC ELECTRIC RAILWAY SIGNAL CO. (LTD.)—The annual return to Dec. 4, 1899, has been filed. The capital is £10,000, in £1 shares, of which 5,940 have been taken up. £1 has been called up on 1,640, and 4,300 shares are considered as fully paid.

BRIGHT'S LIGHT AND POWER (LTD.)—The annual return to De 26 has been filed. The capital is £200,000, in £1 shares (100,000 preferen e)

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All the ordinary shares have been taken up. 10s. has been called up on each of 66,660 and £1 on each of 7. £20,683. 10s. has been paid, leaving £12,653. 10s. in arrears. £33,333 is considered as paid.

CENTRAL ELECTRIC SUPPLY CO. (LTD.)—The annual return to Jan. 12 gives the capital as £100,000, in £5 shares, of which 307 have been taken up, and £1 per share has been called and paid on 300 of these.

ELECTRIC FUR MACHINING CO. (LTD.)—According to the annual return to Jan. 12, the capital is £3,600, in £1 shares, of which 566 have been taken up. £1 has been called up and paid on 16 shares, and 550 are considered as fully paid.

CITY NOTES.

MEMORANDA.—Bank rate 4 per cent. (since Jan. 25, 1900). Price o silver 27⅞d. per oz. (Feb. 1). Consols (2¾ per cent.) 100⅜—100⅝ for money, 100⅜—100⅝ for account; 2½ per cent. 98½—99 (Feb. 1). Stock Exchange Settling Days: Consols, Feb. 2; Stocks and Shares Continuation Days, Feb. 7 and 21; Ticket Days, Feb. 8 and 22; Pay Days, Feb. 9 and 23; Mining Share Carry-over Days, Feb. 6 and 20.

BRISTOL TRAMWAYS AND CARRIAGE CO.—The directors recommend the payment of a dividend at the rate of 8 per cent. per annum for the past half-year, and the reserve is increased from £80,832 to £90,314. The dividend at the corresponding period last year was 7 per cent. The number of passengers carried during the year was 25,330,806.

BRITISH ELECTRIC TRANSFORMER MANUFACTURING CO. (LTD.).—The directors of this company have declared an interim dividend at the rate of 6 per cent. per annum for the six months to Dec. 31 last. Dividend warrants will be posted on 9th inst.

STOCK EXCHANGE NOTICE.—The Stock Exchange committee has ordered the further issue of £230,255 sterling 4 per cent. 500 year debenture stock of the *Commercial Cable Co.* to be quoted. Application has also been made to the committee to appoint a special settling day in 6,360 ordinary (£5 fully paid) shares, 8,038 5 per cent. cumulative preference (£5 fully paid) shares, 5,433 vendors' ordinary (£5 fully paid) shares, and 9,862 vendors' (£5 fully paid) cumulative preference shares of the *Hampstead Electric Supply Co. (Ltd.).*

WESTMINSTER ELECTRIC SUPPLY CORPORATION (LTD.).—The directors recommend the payment of a dividend at the rate of 16 per cent. for the half-year ended Dec. 31 last, making, with the interim dividend, 13 per cent. for the year.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	'99–1900	£	£		£	£
*Birmingham Tramways.	Jan. 27	4,060	+ 371	4	16,004	+ 963
Blackpool Corporation...	„ 25	135	+ 9	43	21,221	+ 4,403
Blackpool and Fleetwood	„ 27	149	- 5	4	573	+ 9
Bradford Corporation ...	„ 28	339	+ 92	76	25,303	...
Brisbane Trams	Dec. 13	1,816	+ 570	11	24,810	+ 7,622
*Bristol Trams & Carriage	Jan. 26	2,697	+ 315	4	10,859	+ 835
*Buenos Ayres & Belgrano	Dec. 31	2,514	+ 676	52	114,020	+48,619
City & South London Ry.	Jan. 23	1,092	- 42	4	4,470	- 46
Dover Corporation	„ 29	151	+ 19	43	8,805	+ 1,020
Dublin United	„ 26	2,925	+ 310	4	10,869	+ 1131
Dublin Southern Dist....	„ 26	609	- 11	4	2,233	
*Glasgow Corporation ...	„ 27	8,333	+1,130	...	...	...
*Liverpool Corporation...	„ 20	6,622	+ 715	3	20,027	+ 2,220
Liverpool Overhead Rly.	„ 28	1,671	+ 313	4	6,026	+ 766
*Sheffield Tramways	„ 28	1,918	+ 755	4	7,341	+ 2,479
*South Staffs. Trams.....	„ 26	734	+ 191	4	2,349	+ 41

* Partly electrical.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Jan. 24.	Price Wednesday, Jan. 31.	Rate per Cent. Yielded. £ s. d.	Dividend Due.	Business Done During Week Ending Jan. 31. Highest	Lowest
			TELEGRAPHS.						
£110,900	100	4%	*African Direct Telegraph 4% Mort. Deb. (red.)	99 103	99 103	3 17 8	January and July.....	...	...
25,000	10	..	Amazon Telegraph.....	3 4	3 4	...	June and December ..	...	...
£125,000	100	5%	Do. 5 per Cent. Debentures	85 90	85 90	5 11 1	...	...	...
£875,520	Stock	15/0	Anglo-American	65 68	65 68	5 1 3	Feb., May, Aug., Nov.	65½	...
£3,062,240	Stock	30/0	Do. Preferred	115 116	115 116	5 3 4	„ „	115⅝	114⅝
£3,062,240	Stock	18/0	Do. Deferred.....	17¼ 17¾	17 17½	5 2 10	...	17⅝	16¾
$10,000,000	$100	$2½	Commercial Cable Capital Stock	165 175	165 175	...	Jan., Apr., July, Oct.	...	...
£1,563,078	Stock	4%	* Do. 4 per Cent. Debenture Stock	102 104	102 104	3 16 11	„ „	103¼	102¾
16,000	10	8/0	Cuba Submarine Ordinary	8½ 9½	8½ 9½	8 8 5	February and August	...	...
6,000	10	10,0	Do. Preference 10 per Cent.	19 20	19 20	5 0 0	„ „	...	...
12,931	5	2/0	Direct Spanish Ordinary.....	4 5	4 5	4 0 0	April and October.....	...	...
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference	9 10	9 10	5 0 0	„ „	...	...
£30,000	50	4½%	Do. 4½ per Cent. Debentures	101⅞ 105⅞	101⅞ 105⅞	4 5 9	January and July.....	...	...
60,710	20	3 0	Direct United States Cable.....xd	11¾ 12¼	11½ 12	5 16 8	Jan., Apr., July, Oct.	12	11
£120,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red.)	99 102	99 102	4 8 3	June and December ..	...	...
£4,000,000	Stock	5%	Eastern Ordinary	153 158	153 158	4 8 7	Jan., Apr., July, Oct.	158	153½
£1,795,000	Stock	3½%	Do. 3½ per Cent. Preference Stock	98 101	98 101	3 9 3	„ „	99	98⅛
£1,432,268	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.)	115 120	115 120	3 7 3	May and November ..	117	...
250,000	10	2/6	Eastern Extension	1½ 1⅝	1⅝ 1⅝	4 8 11	Jan., Apr., July, Oct.	1⅝	1 15/16
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	117 122	117 122	3 6 6	February and August	118	...
£16,200	100	5%	* Do. 5% (Austln. Gov. Sub.) Deb.,1900 (reg.) ..	99 103	99 103	4 17 1	January and July.....	...	...
£64,400	100	5%	Do. (Bearer)	100 103	100 103	4 17 1	„ „	...	...
£300,000	100	4%	*Eastern and S. African 4% Mort. Deb., 1909.....	101 104	101 104	3 16 11	February and August	...	...
£200,000	25	4%	Do. 4 per Cent. Mauritius Sub. Debs.(red.) ..	101⅞ 104⅞	101⅞ 104⅞	3 16 10	May and November ..	...	...
180,227	10	1/9	Globe Telegraph and Trust ..... xd	11 11½	11 11½	4 11 4	Jan., Apr., July, Oct.	11⅝	11¼
180,042	10	3 0	Do. 6 per Cent. Preference ..... xd	15 15½	15 15⅝	3 17 5	„ „	1⅝	15 7/8
150,000	10	5/0	Great Northern of Copenhagen	30 32	30 32	3 18 2	January and July.....	31	30⅝
£86,300	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb.(red.) ..	99 102	99 102	4 8 3	...	...	...
17,000	25	12/6	Indo-European	49 53	49 53	4 14 4	May and November ..	...	...
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904 ..	106 109	106 109	5 10 1	March and September	...	...
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.)	101 104	101 104	3 16 11	June and December ..	...	...
11,839	8	4/0	Reuter's	7 8	7 8	5 0 0	April and October.....	...	...
3,381	£100 Cert.	6%	Submarine Cables Trust	125 130	125 130	4 13 0	„ „	...	...
15,609	10	...	West African Telegraph	2½ 3½	2½ 3½	4 9 3	December and July ...	...	...
£200,000	100	5%	* Do. 5 per Cent. Debentures (red.)	99 102	98 101	4 18 9	March and September	98	...
30,008	2½	...	West Coast of America	½ 1	½ 1	...	...	...	...
£150,000	100	4%	* Do. 4 per Cent. Debentures	100 103	100 103	3 17 8	January and July.....	...	...
88,321	10	6d.	West India and Panama	¾ 1⅛	¾ 1⅛	...	May and November ..	...	...
34,563	10	6/0	Do. 6 per Cent. 1st Preference	9¼ 9¾	9¼ 9¾	6 3 1	„ „	...	...
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	7 8	7 8	7 10 0	„ „	...	...
£80,000	100	5%	* Do. 5 per Cent. Debentures	104 107	104 107	4 13 6	January and July.....	...	...
£389,731	Stock	4%	Western & Brazilian 4 per Cent. Debenture Stock ..	100 104	100 104	3 16 11	June and December ...	100	...
20),993	10	3/0	Western Telegraph (late Brazilian Submarine)	1¼ 1⅝	1¼ 1⅝	4 11 10	Mar., June, Oct., Dec.	1⅝	1 13/16
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1900)	106 109	106 109	4 11 9	June and December ...	...	...
£158,100	100	6%	Western Union 6 per Cent. Sterling Bonds (red.) .	98 103	98 103	5 16 6	March and September	...	...
			TELEPHONES.						
44,000	£5	3/0	Chili Telephone (fully paid)	2 3	2 3	6 13 4	August	...	...
224,850	10s.	0/1½	Consolidated Telephone Const. & Manufacturing ...	⅛ ¼	⅛ ¼	4 15 3	July	...	...
72,680	1	0/6	Monte Video Telephone Ordinary	⅜ ½	⅜ ½	5 0 0	October	...	...
86,492	1	1 0	Do. 5 per Cent. Preference	¾ 1	¾ 1	5 0 0	...	...	...
490,000	5	3/0	National	5⅛ 5¾	5⅛ 5⅜	5 4 4	February and August	5¼	5⅛
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Preference ...	14 15	14 15	4 0 0	„ „	14⅜	...
15,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference ...	14 15	14 15	4 0 0	„ „	...	...
250,000	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref. ...	5⅜ 5⅝	5⅜ 5⅝	4 8 11	„ „	5⅛	...
1,329,471	Stock	3½%	* Do. Debenture Stock 3½ per Cent. (red.)	98 100	98 100	3 10 0	June and December ...	98⅞	98
171,504	1	0/4	Oriental	¾ 1	¾ 1	5 0 0	April and October.....	...	...
58,000	5	2/6	United River Plate	4⅜ 5¼	4⅜ 5¼	7 2 10	July	...	...
16,639	5	1/4	Do. 5% Cumulative Preference	4¾ 5¼	4¾ 5¼	4 15 3	...	...	...
£179,947	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	103 105	103 106	4 14 4	June and December ...	...	...

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	NAME.	Previous Week's Price, Jan. 24.		Price Wednesday, Jan. 31.		Rate per Cent. Yield'd.	Dividend Due.	Business Done During Week Ending Jan. 31.	
								£ s. d.		Highest	Lowest
			ELECTRICITY SUPPLY COMPANIES.								
100,000	1	...	Bl'ckh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.)	⅞	1	⅞	1	...	...	...	...
6,000	10	7/9	Bournemouth and Poole Elec. Supply Ord.	12	13	12	13	3 0 0	...	...	...
6,000	10	4/6	Do. 4½ per Cent. Cumulative Pref.	10	11	10	11	4 1 10	...	...	...
19,661	5	2/6	Brompton & Kensington Electricity Supply Ord.	7	8	7	8	3 15 0	...	...	...
12,000	5	3/6	Do. 7 per Cent. Preference	8½	9½	8½	9½	3 13 8	March and September	...	...
20,000	5	...	Calcutta Elec. Supply Ordinary (fully paid)	6¼	6¾	6¼	6¾	...	...	...	...
30,000	5	4/0	Charing Cross & Strand Electricity Supply Corp.	10	11	10	11	4 1 10	February and August	...	...
20,000	5	...	Do. (Nos. 3,001 to 50,000)	9½	10½	9½	10½	...	...	...	...
20,000	5	2/3	Do. 4½ per Cent. Preference	5¾	6¼	5¾	6¼	3 12 0	,, ,,	...	...
34,000	5	2/6	Chelsea Electricity Supply Ordinary	7½	8½	7½	8½	3 10 7	March	...	
£100,000	Stock	4¼	* Do. 4½ per Cent. Debenture Stock (red.)	109	111	109	111	4 1 1	June and December	...	...
$1,200,000	$1,000	5	Chicago Edison 1st Mort. 5% 30 year Gold Bonds (red.)	100	110	100	110	4 10 11	April and October	...	...
60,000	10	7/0	City of London Electric Lighting Ordinary	10¾	11¼	10¾	11¼	5 4 4	February and August	11¼	11
40,000	10	6%	Do. 6 per Cent. Cumulative Preference	13	14	13	14	4 5 9	January and July	13¾	...
£400,000	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	122	127	122	127	3 19 9	June and December	...	...
40,000	10	...	County of London and Brush Prov. Ordinary	9¼	10¼	9¼	10¼	...	...	...	...
20,000	10	6/0	Do. 6 per Cent. Cumulative Preference	13	14	13¾	14¼	4 2 9	March and September	13	...
£200,000	Stock	4¼	Do. 4¼% Deb. Stock Certs. (all pd.) (red.)	108	111	108	111	4 1 3	...	109¼	...
15,000	5	10/	Kensington and Knightsbridge Ordinary	12	13	12	13	4 1 6	...	...	...
10,000	5	6%	Do. 6 per Cent. 1st Preference	7¼	7¾	7¼	7¾	3 17 5	January and July	...	...
110,000	3	...	London Electric Supply Ordinary	2	2¼	2	2¼	...	...	...	...
48,050	5	3/0	Do. 6 per Cent. Preference	5	5¼	5	5¼	5 9 1	...	5	...
£100,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures	101	103	101	103	3 18 1	Mar., June, Sept., Dec.	...	...
62,500	10	5/0	Metropolitan Elec. Supply Ord. (Nos. 1 to 62,500)	14½	15½	14½	15½	3 4 6	April and October	...	...
22,500	10	3/7½	Do. (Nos. 62,501 to 85,000)	14	15	14	15	3 5 8	...	...	...
£220,000	Stock	4½	Do. 4½ per Cent. Deb. Stock First Mortgage	115	117	115	117	3 16 11	June and December	...	...
£125,000	Stock	24/8	Do. 3½ per Cent. Mort. Deb. Stock (red.)	95	97	95	97	3 12 3	...	...	...
6,452	10	6/0	Notting Hill Electric Ordinary	15½	16½	15½	16½	3 15 0	March	...	...
10,000	5	5/0	Oxford Electric Ordinary	6¾	7¼	6¾	7¼	3 9 0	,,	...	...
300,000	1	8%	Rand Electric	⅞	1	⅞	1	10 13 4	...	...	...
£130,070	Stock	5%	River Plate El. Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb.	80	90	75	85	5 18 0	...	77	76
150,000	$100	$2	Royal Electric Company of Montreal Shares	150	170	150	170	4 14 2	...	...	...
£123,200	100	4½	* Do. 4½ per Cent. 1st Mortgage Debentures	104	106	104	106	4 5 6	April and October	...	...
31,980	5	5/0	St. James's and Pall Mall Electric Ordinary	15½	16½	15½	16½	4 8 1	February and August	16	...
20,000	5	3/6	Do. 7 per Cent. Preference	9	9½	9	9½	3 13 8	,, ,,	...	...
65,000	5	...	South London Electric Supply Ordinary (fully paid)	4	4¼	4	4¼	...	...	...	...
79,900	5	5/0	Westminster Electric Supply Ordinary	14½	15½	14½	15½	3 17 5	March and September	15½	14
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
125,000	1	7½d.	Aron Electricity Meter 6 per Cent. Cum. Pref.	⅜	½	⅜	½	6 17 2	...	...	...
45,000	1	...	British Electric Works Co. Ordinary	⅜	½	⅜	½	...	...	...	...
50,000	1	...	Do. 5 per Cent. Cumulative Preference	⅜	½	⅜	½	...	...	...	...
£50,000	100	...	Do. First Mortgage Debentures	97	99	97	99	4 5 8	...	...	...
40,000	5	5/0	British Insulated Wire Ordinary	11½	12½	13	14	3 11 5	...	...	...
27,500	5	3/0	Do. Preference	6	6½	6	6½	4 12 4	...	...	...
90,000	2	2/0	Brush Electrical Engineering	1¾	2	1¾	2	5 0 0	September	...	...
90,000	2	1/2½	Do. 6 per Cent. Pref. Non-Cumulative	2¼	2¾	2¼	2¾	5 1 1	,,	...	...
£125,000	Stock	4¼	Do. 4½ per Cent. Perpetual Deb. Stock	110	115	110	115	3 18 5	February and August	...	...
£50,000	Stock	4¼	* Do. 2nd Debenture Stock (red.)	102	105	103	105	4 5 9	June and December	...	...
20,000	5	5/0	Callender's Cable Construction Ordinary	13½	14½	13½	14½	5 3 5	,, ,,	...	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5½	6	5½	6	4 3 4	...	6⅛	5½
£90,000	Stock	4¼	Do. 4½ per Cent. 1st Mortgage Deb. (red.)	110	115	110	115	3 18 3	November and May	...	...
300,000	1	0/9½	Castner-Kellner Alkali Co. (fully paid)	1⅛	1⅜	1⅛	1⅜	5 16 5	...	...	...
60,000	1	0/7½	Chadburn's Ship Telegraph Ordinary	⅞	1⅛	⅞	1⅛	5 6 8	...	...	...
60,000	1	0/7½	Do. 6 per Cent. Cumulative Preference	⅞	1⅛	⅞	1⅛	5 6 8	...	...	...
32,098	3	1 0½	Crompton and Co. (Nos. 1 to 32,098)	3¾	4	3¾	4	4 10 9	January and July	3⅞	...
£100,000	100	5%	* Do. 5 per Cent. First Mortgage Deb. (red.)	98	101	98	101	4 19 0	,, ,,	...	...
60,000	1	0/3	Davis and Timmins 6 per Cent. Cum. Pref.	¼	1	¼	1	...	...	...	...
99,251	5	1/9½	Edison and Swan United ("A" Shares) (£3 paid)	2	2¼	2	2¼	7 3 9	February and August	...	...
17,139	5	2/9½	Do. (£5 paid)	3¼	4¼	3¼	4¼	6 13 4	,, ,,	...	...
£314,023	Stock	4%	Do. 4 per Cent. Mortgage Deb. Stock (red.)	92	94	93	95	4 4 3	June and December	94	...
26,100	5	5/11½	Edmundson's Electric Corporation Ord. (fully pd.)	4½	5½	4½	5½	5 14 3	Half-yearly	...	...
112,100	2	1/2½	Electric Construction Co. (Limited) xd	2	2½	2	2½	5 2 3	January and July	...	...
25,000	2	2/9½	Do. 7 per Cent. Cumulative Preference	2¾	3¼	2¾	3¼	4 6 2	July	...	...
182,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	103	106	103	106	3 15 6	January and July	...	...
30,000	5	...	Henley's Telegraph Works Ordinary	13	14	13	14	...	February and August	15⅞	13⅝
15,000	5	...	Do. 4½ per Cent. Preference	5½	6	5½	6	3 15 0	,, ,,	6¼	...
£50,000	Stock	4¼	Do. 4½ per Cent. Mortgage Deb. Stock (red.)	111	114	111	114	4 0 0	,, ,,	...	...
50,000	10	10/0	India Rubber, Gutta Percha, &c., Works	21	22	21	22	4 11 10	,, ,,	22	...
£300,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	100	104	100	104	3 16 11	March and September	...	...
37,350	12	12/0	Telegraph Construction and Maintenance	36	40	37	41	4 7 9	March and July	38	...
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909	103	105	103	105	3 16 2	...	...	...
20,000	5	3/0	Do. Manufacturing Ordinary	9	10	9	10	3 10 0	...	...	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5½	6	5½	6	4 3 4	...	...	...
30,000	5	5/0	Willans and Robinson Ordinary	9½	10½	9½	10½	4 5 9	April and October	9¾	...
30,000	5	3/0	Do. 6 per Cent. Cumulative Preference	7	7½	7	7½	4 0 0	,, ,,	...	...
£100,000	Stock	4¼	Do. 4½ per Cent. 1st Mortgage Debentures	104	106	104	106	4 0 2	May and November	...	...
			ELECTRIC RAILWAYS, TRAMWAYS, &c.								
12,000	10	6/0	Blackpool and Fleetwood Tramways	17	19	17½	18½	3 15 8	...	...	...
£167,900	100	5%	Brisbane Tramway 5 per Cent. Debentures	104	106	104	106	4 14 4	...	...	...
50,000	10	7%	Bristol Tramways and Carriage Ordinary	23	24	23	24	2 17 2	February and August	...	...
25,000	10	...	Do. Cumulative Preference (£6 paid)	6½	6¾	6½	6¾	...	...	...	...
£100,000	Stock	4%	Do. 4 per Cent. Debentures	117	118	117	118	3 7 3	...	...	...
30,000	10	9/0	British Electric Traction Ordinary (Nos. 1 to 30,000)	16	17	16	17	3 19 7	...	16¾	16
£15,000	10	...	Do. (Nos. 60,001 to 75,000)	15½	16½	15½	16½	...	...	...	...
30,000	10	6/0	Do. 6% Cum. Pref. (Nos. 30,001 to 60,000)	13¼	13¾	13¼	13¾	4 7 3	...	13⅛	13
£200,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures	125	128	125	128	3 18 6	...	...	...
40,000	5	1/9	Buenos Ayres & Belgrano 6% "A" Cum. Pref.	4¾	5¼	4¾	5¼	5 17 1	...	...	...
27,500	5	...	Do. "B"	4¾	5	4¾	5	...	...	...	...
265,585	Stock	5%	Do. 5 per Cent. Debentures	105	108	105	108	4 12 7	...	106¼	104
213,553	10	3/0	Central London Ordinary	8¾	10	9¼	10	3 0 0	June and December	10	9
£365,000	Stock	2¼	City and South London Railway Con. Ordinary	59	62	58	61	3 9 3	January and July	60	59
37,500	10	...	Do. (Nos. 22,501 to 60,000) (£5. 10s. paid)	4½	5½	4½	5½	...	...	...	...
£150,000	Stock	5%	Do. 5 per Cent. Perpetual Preference (1891)	143	148	143	148	3 8 0	January and July	...	...
£200,000	Stock	5%	Do. (1896)	135	140	135	140	3 11 11	...	...	...
£87,701	Stock	4%	Do. 4 per Cent. Perpetual Debenture	125	130	125	130	3 1 11	May and November	127½	...
20,000	10	7½	Imperial Tramways Ordinary	23	24	23	24	...	March and September	...	...
19,000	10	6%	† Do. 6 per Cent. Preference	15½	15¾	15¼	15¾	3 13 10	,, ,,	...	...
£200,000	Stock	4½%	† Do. 4½ per Cent. Debenture	113	115	113	115	3 17 11	January and July	...	...
30,000	10	1/3	Kidd'rm'nst'r & Dist. E.L. & Tr'ct'n 5% Pref. (£8 pd.)	8	8½	8		...	May and November	...	...
37,500	10	2½	Liverpool Overhead Railway Ordinary	9¼	9½	9⅜	9½	3 8 5	February and August	...	...
10,000	10	5%	Do. 5 per Cent. Preference	13	13½	13	13½	3 15 6	,, ,,	...	...
125,000	Stock	4%	Do. 4 per Cent. Debenture	105	107	105	107	3 14 9	January and July	...	...
24,000	5	...	New General Traction Ordinary	3½	4	3½	4	...	...	...	...
30,000	5	6/0	Do. 6 per Cent. Cumulative Preference	5	5½	5	5½	5 9 1	May	...	...
4,000	10	...	Oldham, Ashton and Hyde Elec. Tramway Ord.	18	19	...	...	...	February and August	...	...
4,000	10	5/0	Do. 5 per Cent. Preference	10½	10⅝	...	...	4 11 11	,, ,,	...	...
13,334	10	...	Potteries Electric Traction Ordinary	11⅛	12⅛	11⅛	12⅛	...	...	...	...
20,000	10	5/10	Do. 5 per Cent. Cumulative Preference	10	11	10	11	4 10 11	...	...	...
£510,000	Stock	3%	Waterloo and City Ordinary	101	104	101	104	2 18 4	June and December	...	...

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.
† The London Stock Exchange Committee refuses to quote these.

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THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,134. [No. 18. Vol. XLIV.] FRIDAY, FEBRUARY 9, 1900. PRICE SIXPENCE (by post, 6½d.), Abroad, 8d., or 15 cents. or 80/r., or 70pf.

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NOTES.

THE engineering laboratory at Cambridge University was the arena, on Friday afternoon last, of an event of unusual interest, when the "John Hopkinson Memorial Wing" was inaugurated and a commemorative portrait of the late Dr. HOPKINSON was unveiled. A large audience, including numerous distinguished scientists and university dons, assembled in a spacious and tastefully decorated lecture room forming a portion of the new wing. The inaugural address was delivered by Lord KELVIN, who spoke at considerable length with pleasing vivacity; and the portrait, which has been placed in a panel behind the chair, was unveiled by Dr. BUTLER, the Master of Trinity. At the close of the inaugural meeting, some account of which we give on another page, Prof. and Mrs. EWING held a reception in the adjoining laboratories, the drawing office being for the nonce turned into a drawing room for the dispensing of afternoon tea.

OUR readers are well acquainted with the history of the development of engineering teaching at Cambridge University. Prof. EWING was appointed professor of applied mechanics and mechanism in November, 1890. Early in 1891 a committee, styled the Mechanical Workshops Inquiry Syndicate, reported to the Senate on the proposal to establish an engineering laboratory. Prior to this, and as far back as 1878, Prof. J. STUART had established a little workshop in a shed close to the famous Cavendish Laboratory. Here students were drilled in the making of a scribing block, the peculiar design of which involved the use of every tool in the workshop. To return the "Syndicate" found that "the study of mechanics gains much in utility, and loses nothing in educational value, by being approached from the standpoint of the engineer"; and it recommended the formation of the laboratory.

FUNDS, however, amounting to some £20,000 would be required for the execution of the scheme on a complete scale; and even the partial completion at first carried into effect involved a large sum of money. Meanwhile, during the time that elapsed before the first batch of buildings was opened, a splendid impetus to the study of engineering at Cambridge was produced by the creation of a Mechanical Science Tripos. The report of the University syndicate recommending this examination was submitted to the Senate on May 23, 1892, and the grace creating the Tripos was voted in the Senate in the ensuing November. Subscriptions towards the laboratory steadily flowed in, and buildings were erected, the opening ceremony being performed by Lord KELVIN on May 15, 1894. This, the first portion and nucleus of the engineering laboratories, was erected at a cost of some £5,000, of which the University granted £1,000, the remainder being subscribed by private individuals.

EXCELLENT work was done by Prof. EWING with the aid of these laboratories, but it soon became clear that considerable extension of the buildings, as well as amplification of the teaching plant, would be necessary. It was while the laboratory was in this stage, and at a time when further development seemed imperative, that Profs. EWING and HOPKINSON, spending a summer vacation together in Switzerland, planned how the desired end could be attained by an appeal to the generosity of the engineering profession and its friends. Then swiftly came the tragic event which closed JOHN HOPKINSON'S brilliant career. It seemed then as though these plans, so cordially supported by him, were to be frustrated; but, with laudable generosity and public spirit, MRS. HOPKINSON and her son and daughter gave the sum of £5,000 for the execution of the scheme which her husband had projected. It was the completion of this scheme that formed the occasion of the interesting function last Friday.

WE cannot conclude our comments upon this important development of science teaching at one of our leading universities without once more insisting upon the great value of such an addition to the university curriculum. As Prof.

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Ewing pertinently observed, it not only makes the thoughtful people practical, but it makes the practical people thoughtful. There is no foolish effort to turn out ready-made engineers: Prof. Ewing would be the first to deprecate the suggestion that his engineering school renders the practical training of commercial workshops superfluous. Healthy practical thought, and resourcefulness of mind and hand, are the aims well attained in these admirably-equipped and no less admirably-managed laboratories.

The following circular-letter is being sent out by the Secretary to all members of the Institution of Electrical Engineers. In relates to the impending departure of the Electrical Engineers (R.E.) Volunteers for service in South Africa:—

Dear Sir: As you have probably seen by the electrical journals, it is proposed to give a "send-off" dinner in London to the South African contingent of the Electrical Engineers (R.E.) Volunteers. Particulars as to place and date cannot be definitely fixed until the War Office shall have announced the date of departure, but it is expected to be about the end of February. Meanwhile, it has been decided to invite members of all classes of the Institution of Electrical Engineers, who care to do so, to become hosts on the occasion of the dinner, each host subscribing two pounds (£2), which will be devoted to defraying the expense of the dinner both of the hosts and of the members of the volunteer contingent, the balance, if any to be applied to some fund connected with the corps.

Should you desire to become a host, please send, before February 20, a remittance of £2 to the honorary treasurer, Mr. Henry Edmunds, 2, Queen Anne's-gate, London, S.W., and also state whether you desire to be present at the dinner.

In order to save unnecessary correspondence and expense, a dinner ticket will be sent to each host, and it is requested that these tickets will be accepted in lieu of a formal receipt.—I am, dear sir, yours faithfully,

28, Victoria-street, S.W., February 6, 1900. W. G. McMillan, Hon. Sec. to the Dinner Committee.

We are asked to state that it is not intended to confine the dinner to members of the Institution, and that all who wish are cordially invited to become hosts and to send their remittances to the hon. treasurer. Lord Kelvin has promised to preside at the dinner, if the date to be selected renders it possible for him to do so. From another source we learn that Capt. F. L. Lloyd, R.E., chief instructor at the School of Submarine Mining at Plymouth, will have charge of the detachment of the corps. The detachment will be joined later by the commandant, Major R. E. B. Crompton. We also learn that Major G. A. Carr, R.E., instructor in electricity at the School of Military Engineering, has been directed to assist the committee in the purchase of equipment for the detachment.

A letter from Mr. Dane Sinclair, the engineer-in-chief of the National Telephone Co. (published in another column of this issue), throws a fresh light on the telephone controversy proceeding at Glasgow and elsewhere. The great point insisted on by municipal authorities and their telephone advisers in their attack on the National Telephone Co. has been that this company's system was technically inefficient. Yet, when the Postmaster-General wished to impose certain conditions on granting the Glasgow Corporation a licence, these conditions were complained of by Mr. Bennett, the Corporation's consulting telephone engineer. Mr. Bennett, it would appear, had based his estimate of the cost of a municipal telephone service on a certain thickness of wire, and the Postmaster-General had said that a thicker wire must be employed. Mr. Bennett, in his report on the Postmaster-General's specification, averred that the National Telephone Co. had employed wire of a smaller gauge; but now Mr. Sinclair distinctly states that the gauge indicated by the Post Office is precisely the one adopted as standard by the company, and that he has caused to be laid some 150,000 miles of this wire during the last few years. The negotiations between the Telephone Committee of the Glasgow Corporation and the engineering department of the Post Office with regard to this and other matters are practically concluded, and it would appear from the minutes published on p. 503 of our last issue that the department has given way to some extent in regard to this very question of size of wire. Have the Post Office engineers forgotten Mr. Preece's evidence before a recent Parliamentary committee with regard to the telephone wire employed in Guernsey, and the opinions expressed during Sheriff Jamieson's Glasgow inquiry, as to the quality of the material of the short-lived Mutual Telephone Co. of Manchester? Whether future telephone systems are to be maintained by companies, local authorities, or a Government department, we hope that good engineering with reliable and durable material will be placed before considerations of low tariffs and trade competition.

Tramway men will find a mass of valuable statistics in the recently issued Board of Trade return to the House of Commons of the street and road tramways of the United Kingdom, showing their development from 1878 to 1899, and giving particulars of the condition of each undertaking on June 30th last. A digest of the return reveals that, at the date stated, there were 1,122 miles of line open for traffic, of which 881 miles were in England and Wales, 106 miles in Scotland, and 135 miles in Ireland. The total paid-up capital represented by these lines was £18,052,773, of which about 8½ millions was share capital. The large proportion of loan capital is explained by the fact that 61 out of the total of 169 undertakings belong to local authorities. These represent about 519 out of the 1,122 miles, and £8,134,530 capital expended out of a total of £18,603,222 expended by all classes of undertakings. No less than 924,820,247 passengers were carried during the year ended June 30, a figure which compares instructively with 146,001,223 passengers for 1878, and with the 858,485,542 passengers for 1898. This large volume of traffic brought receipts aggregating £4,879,602, and involved working expenses amounting to £3,675,559. The net receipts, therefore, were £1,204,043. It will be seen, accordingly, that the tramway industry of the United Kingdom represents, taken as a whole, a net working profit of not quite 6½ per cent. upon the total capital expended.

Considering the heavy calls upon this profit before a balance for distribution to the shareholders or for relief of ratepayers can be arrived at, this percentage cannot be taken to indicate a flourishing condition in the tramway industry. Probably this is principally due to the expensive form of

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traction most generally in vogue; and when electric traction shall have more completely eliminated the horse from its place in tramway working a great improvement will certainly be realised. At present, while there are no less than 44,171 horses employed, there are only 584 motor-driven cars, counting all kinds of mechanical traction.

THE comparative study of electric supply works is one of the most effective methods of advancing our knowledge of electrical engineering, and one that we are sure a large number of our readers avail themselves of. To this end, we have been always careful to furnish our readers as promptly as possible with technical descriptions of new works. Towards the close of 1897 we approached the then chief engineer of the County of London and Brush Provincial Electric Lighting Co., with a view to secure facilities for preparing a series of descriptions of the stations controlled by that company; and we were promised special facilities. Delays occurred in the performance of this arrangement; and, to our surprise, the next we heard was that the company had consented to arrangements being made for simultaneous publication in the technical journals of descriptions of the St. Luke's and Wandsworth stations. Having re-entered upon preliminary negotiations on this basis, we were still more surprised when we were asked (1) to agree that two of our contemporaries should be granted priority of publication in point of date; and (2) that our own descriptions, and those of all the other journals, would have to pass the company's censorship before we would be allowed to publish anything. In these circumstances, and under such conditions, we have been compelled to decline to publish descriptions of the County of London Co.'s stations.

Cable Interruptions:—	Date of Interruption.
Latakia—Cyprus	June 21, 1899
Cayenne—Pinhieros	Oct. 11, 1899
Tangier—Tarifa	Jan. 3, 1900

Wireless Telegraphy in South Africa.—A Reuter's telegram announces that, after much difficulty, a high pole for the Marconi's wireless telegraph has now been erected at Modder River.

Erratum.—In our reprint of Mr. A. Roberts' Paper on "The Designing of Electrical Generating Stations," last week, on page 511, column 2, line 17, for "one of blue Lias lime, two of sand, and three of ashes," read "one of blue Lias lime, one of sand, and one of ashes."

The Royal Society.—Among the Papers down for reading yesterday were: "On Electrical Effects due to Evaporation of Sodium in Air and other Gases," by W. C. Henderson; and "On Electric *Touch* and the Molecular Changes produced in Matter by Electric Waves," by Prof. J. C. Bose.

Ingleton Water-Power Plant and the Recent Frosts.—We learn that, notwithstanding the severe frosts and snowfalls in the North of England recently, the water-power utilisation plant at the Ingleton electric supply works has not suffered in any way, supply having been maintained without interruption.

Australasian Association for the Advancement of Science.—The eighth session of this association was opened at the University of Melbourne, under the presidency of Mr. R. L. J. Ellery, C.M.G., F.R.S., on January 9th, when the presidential address was delivered. The sectional presidents' addresses were delivered on the following day, and Papers by various authors were read.

The American North-Western Electrical Association.—The eighth session of this Association was held at the Hotel Pfister, Milwaukee, Wis., on January 17th and 18th. There was a large attendance, and numerous Papers of considerable importance were read. Among these may be mentioned "Alternating-Current Phenomena," by Prof. Jackson; "Central Station Economics," by H. W. Frund; "Induction and Direct-Current Motors," by Ralph D. Mershon; "Relative Desirability and Efficiency of Various Types of Engines for Central Station Loads," by Prof. Richter.

Appointments.—Mr. G. W. Partridge, for some time past chief electrician to the London Electric Supply Corporation (Ltd), has been appointed chief engineer to the corporation, and Mr. C. J. Barley, late engineer to the Kensington and Knightsbridge Electric Lighting Co. (Ltd.), has been appointed superintending engineer at the Deptford station.

"Electrical" Fires in London.—In his report to the Fire Brigade Committee of the London County Council, the chief officer of the Metropolitan Fire Brigade states that nine fires occurred last year on the premises of electricians, five being caused by short-circuit of electric wires, one by overheat of boiler, one by hot ashes, and the causes of two unknown. There were ten fires at electric lighting works, caused as follows: Overheat of boiler, 1; short-circuit of electric wires, 5; spark from fire, 1; spontaneous ignition, 3; unknown, 2. Of the 3,846 fires in London in the year reported on, 18 were attributed to short-circuit of electric wires.

Standardisation of Traction Accounts.—The American *Street Railway Review* states that the Railroad Commissioners of Connecticut have issued instructions to the effect that the street railways of that state shall, after June 30, 1900, keep their accounts according to the "Standard System" devised by the Street Railway Accountants' Association of America and approved by the Convention of Railroad Commissioners. The intention of the Connecticut Commissioners to issue such instruction was announced at the Chicago convention of the Accountants' Association, but their formal action may be taken as the real beginning of that long-desired era when all such reports will be uniform.

Birmingham Association of Mechanical Engineers.—At the meeting of the above association held on Feb. 3 Mr. R. B. Hodgson read a Paper on the Meldrum furnace, with special reference to the econometer and refuse destruction. In connection with the latter portion of his subject, the author discussed in great detail the form a modern destructor should take. The Darwen electricity works refuse destructor was described, attention being called to the fact that this plant was being run entirely by refuse burned, without the assistance of any other fuel, 1·51b. of water being evaporated per lb. of refuse burned. The Darwen plant was described as one of the finest and most efficient in the kingdom.

"Science Abstracts."—We have just received a copy of the January number of *Science Abstracts*, in which, as the first number of Vol. III., are introduced several new and interesting features. There is included in it an entirely new section on Steam Plant, Gas and Oil Engines, and also abstracts dealing with motor cars of all kinds. The whole is printed in larger and clearer type. The considerable increase in the size of this production since its inauguration only two years ago bears ample evidence to its value and to the satisfactory manner in which it is edited. The present number contains no less than 49 pages dealing with electro-technical matters, not including electrochemical work.

Quantity Discharges of Electricity.—Prof. John Trowbridge describes, in the *Electrical Review* of New York, some experiments which he has made by charging a large coated surface from a storage battery of 20,000 volts pressure, and discharging either in air or in rarefied gases. In the case of a piece of iron wire, arranged as a shunt to the spark-gap, the spark is found to occur at the same time that the wire is deflagrated. He concludes therefore that in the case of large quantity discharges these might occur inside a metallic cage, the cage being considered as a shunt to a minute spark-gap inside the cage. In the case of lightning there is both high voltage and large quantity, and earlier experimenters perhaps overlooked the effects of quantity. A metallic cage might not therefore be a complete protection for a powder magazine.

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A New System of Night Signalling.—Our contemporary, *Electricity* of New York, states that a system of night signalling by means of flags held aloft by kites and illuminated by a suspended searchlight, on which Mr. William A. Eddy has been experimenting for some time, has just been given a practical trial at Bayonne, N.J. The searchlight was of about 100 c.p., and was suspended within a few feet of the flags. The light, which weighed 3lb. when loaded with carbide and water, was sent up at a quarter to seven o'clock, suspended 2ft. below the flags, each of which was 2ft. square. Both light and flags were supported by one 9ft. and two 7ft. kites. The flags were fastened to the kite cable by perpendicular staffs. To light the flags brightly, the searchlight was rigidly braced on the kite cable in such a position that it pointed straight skyward.

A Dowson Gas Generating Station.—In our issue of November 3rd last we published a description of the small Dowson gas electric supply works erected at Saltburn. Messrs Cox-Walkers now send us the following interesting results of three months' working. At the present time there are the equivalent of 1,300 lamps connected, and applications have been made for connection during the next three months of over 2,000 additional lamps. The revenue already exceeds the works cost of production, it being found that one Board of Trade unit is produced by the consumption of less than 3lbs. of coal, and this in spite of the fact that at present the great bulk of the current sold is supplied from the accumulators. Messrs. Cox-Walkers point out that an important advantage gained by the use of producer gas is the fact that there are no stand-by charges, as one or more engines can be started up at any time in about five minutes from the gas remaining in the holder, and in ten minutes new gas can be produced in any desired quantities: it is thus possible to work these engines either at full load or not at all, so obtaining great working economy. Further mains are now to be laid down, and a third engine and dynamo and second set of cells will be required within a few months, when the station will be capable of supplying 6,000 lamps.

The Institution of Junior Engineers.—At a meeting of this institution, held on February 2nd, at the Westminster Palace Hotel, Mr. H. G. Cotsworth read a Paper on "Arc Lamps and Arc Lighting." After a general description of the more important phenomena of the arc as worked on different systems, the author reviewed the means employed for working the striking and feeding mechanisms. A decided preference was evinced for the thermo-electric as against the electro-magnetic method. In an alternating-current system, for example, an alteration in the periodicity would have no effect on the regulation, as would be the case with an electro-magnetic control. He regretted that the thermo-electric system was not in more general use. Lamps made in America were nearly all controlled by a clutch, acting directly on the upper carbon guide-rod; on the Continent a clock mechanism found most favour; in England the prevailing type had a wheel controlled by a brake, which enabled a very sensitive and accurate feed being obtained. Referring to the working of the lamps, the author noted the necessity, in the case of series running of arcs, of an automatic cut-out, which, in the event of a lamp failing, would prevent the circuit from being broken. He thought, in street lighting, the best place for this cut-out was in the plinth of the lamp-post. Alternating arcs could be run in series across the primary mains, and if provided with a small choking coil across their terminals, the extinction of one lamp would not affect the others. In another arrangement means were provided for running alternating arcs in series with a constant current taken from constant potential mains. This was accomplished with the aid of a regulating transformer of special design. Alternating-current arcs did not give the same efficiency as continuous-current arcs, and the enclosed arc had any of its proved advantages more than counterbalanced by the increased first cost of the lamp owing to the necessity of two dense opaloid globes. In conclusion the author described an enclosed lamp working at 160 volts across the carbons, intended for running singly in parallel on 200 volt mains.

Trinity House and Wireless Telegraphy.—In connection with Mr. Marconi's Royal Institution discourse, printed in another part of this issue, the following letter in Saturday's *Times* is of interest:—

SIR: With reference to the statement in *The Times* of the 31st ult., under the heading "Science in 1899—Physics and Electrical Engineering," that evidence has recently been given that property to the value of £52,000 has been saved from loss by the establishment of wireless telegraphy between the East Goodwin lightship and the South Foreland, and that in spite of these facts the Brethren of the Trinity House move slowly in the matter, I am desired by the Elder Brethren of the Trinity House to inform you that they think it will be found that they were amongst the first in this country to move in the matter in the public interest.

The experiment at the South Foreland commenced at Christmas, 1898. The board afforded the necessary accommodation to the Wireless Telegraph Co. free of charge, and aided and encouraged them in every way, being from the outset favourably impressed by the advantages of the system. The Elder Brethren have, however, good grounds for stating that the alleged facts as to the saving of property of the value of £52,000 by means of this particular connection are incorrect; and, while they are of opinion that electrical communication with light vessels might, in certain circumstances, be the means of saving both life and property, they do not consider that any property which would otherwise have been lost has been so far saved through the agency of electrical communication of any description with light-vessels on the coast of England.

In considering the matter of the permanent adoption and extension of the wireless system, it is not only impossible to ignore the question of the expense involved, which would be considerable, but this question is not altogether within the control of the board as the general lighthouse authority.—I am, sir, your obedient servant, CHAS. A. KENT.

Trinity House, London, E.C., Feb. 3.

Major S Flood Page, managing director of the Wireless Telegraph and Signalling Co., replies at considerable length in Wednesday's *Times*. He says:—

I am not careful to argue the question as to whether £52,000, the value of the French ship, was saved by wireless telegraphy, but . . . the news of the disaster was conveyed to the authorities much more speedily than it would have been if this wireless telegraphy had not been established. It seems . . . to me difficult to deny that wireless telegraphy had, at any rate, some share in the saving of this considerable amount of money. . . . The Elder Brethren of the Trinity House . . . have given us the use of two rooms, they have permitted us to put up a pole and to install the system on the East Goodwin lightship and the South Foreland lighthouse, and other facilities. We have instructed some of their seamen in the working of the system, and undoubtedly the assistance we have received from them has enabled the experiments to be carried out at somewhat less cost to us than if we had established a station of our own. . . . But the cost of the experiments has been borne by the company, and has amounted to several hundreds of pounds. While these trials were of very great value at the outset, . . . we have nothing more to learn from a simple 12 miles experiment than we knew months ago. This being so, we determined to withdraw it, and on Dec. 20 last I called on Mr. Kent and told him so; and it was only at the request of one of the Elder Brethren, made personally to Mr. Marconi, that we have maintained it during this winter . . . . We supposed that the Elder Brethren were most anxious to have wireless telegraphy applied to all lighthouses and lightships, and that they were unanimously and strongly impressing this on the Board of Trade. . . . We must now realise that, having some doubts as to the value of electrical communication between the shore and lightship, they have not urged the necessity for such communication on the Government. . . . The most powerful steamship company on the Continent takes a very different view of this matter. On Monday next that company will, by permission of its Government, fit up, at their own expense, installations of Marconi wireless telegraphy on a lighthouse and lightship and on one of their steamers. They are under provisional contract with this company to place Marconi apparatus on every one of their very large fleet. It is manifest that Germany will take the lead in this, as in so many other branches of commerce and trade.

MEETINGS OF SCIENTIFIC AND ENGINEERING SOCIETIES, &c.

(TO-DAY) FRIDAY, February 9th.

PHYSICAL SOCIETY.

5 p.m. Annual General Meeting in the Rooms of the Chemical Society, Burlington House, W. Address by the President, Prof. O. J. Lodge, F.R.S.

SATURDAY, February 10th.

INSTITUTION OF ELECTRICAL ENGINEERS.

Students' Visit to Messrs. Siemens Bros. and Co.'s Works, Woolwich. Train leaves Charing Cross for Charlton at 9.20 a.m.

WEDNESDAY, February 14th.

INSTITUTION OF ELECTRICAL ENGINEERS.

7.30 p.m. Students' Meeting, when the subject of "Wireless Telegraphy" will be discussed.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. Paper to be read: "The Diffraction Process of Colour Photography," by Prof. R. W. Wood.

SATURDAY, February 17th.

INSTITUTION OF ELECTRICAL ENGINEERS.

11 a.m. Students' Visit to the Davies-street Station of the Westminster Electric Supply Co.

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CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

Heated Conductors.—The question as to what temperature is generated in an electrically-heated conductor is of great theoretical and practical interest. F. Kohlrausch investigates the condition of stationary temperature attained in such a conductor. The temperature attained would be infinite if no heat were lost by radiation or conduction, and if the conductivity were not impaired by heating, since the temperature would rise steadily with the continuation of the current. The author supposes the case of a conductor whose ends are kept at constant potential and constant temperature, and whose surface does not allow the passage of heat across it. Then the temperature is perfectly determined by the equipotential surfaces and by the ratio λ/κ of the two conductivities. The temperature is independent of the current strength; and the conductor may be composite, as long as the ratio λ/κ is the same for each constituent. The maximum temperature is

$$\theta_{max} = \tfrac{1}{8}\frac{E^2}{[\lambda/\kappa]}$$

if E, λ, and κ are expressed in a uniform system. The highest temperatures are furnished by the group of pure metals in which λ/κ is smallest. As it happens, the ratio is pretty much the same in all of them, and is equally influenced by change of temperature.

[Kohlrausch, *Ann. d. Physik*, No. 1, 1900.]

Conductivity of Amalgams.—The resistance of amalgams possesses a special interest, as shedding light upon the problem of metallic conduction without introducing the complications of structure inherent in solid metals. But even so, the amalgams must be dilute and of pretty high temperature if they are to give simple results. Weber, Matthiessen, Voigt, and Battelli only obtained consistent results with perfectly homogeneous amalgams. A. Larsen has done some work on the amalgams of lead, zinc, cadmium, tin, and bismuth at the ordinary temperatures of liquid water, and plotted curves showing, not the change of conductivity, but the change of conductivity as compared with that of pure mercury. The general result from the lead amalgams is that the relative conductivity increases in proportion to the temperature, and that increase again increases with the concentration of the amalgam, though not quite so rapidly as that. This rule applies up to the saturation of the amalgam, which occurs at a concentration of about 1·6 per cent. in lead amalgams, 2 per cent. in zinc amalgams, and about 5 per cent. in cadmium amalgams. All the results indicate that in the dilute amalgams the metal is dissociated, and this dissociation, as generally in solutions, increases with the temperature.

[A. Larsen, *Ann. d. Physik*, No. 1, 1900.]

Diffused Reflection.—Lambert's cosine law of diffused reflection, originally suggested by the flat aspect of the moon, has been shown to be nothing but a rough approximation, destitute both of theoretical justification and of experimental proof. The Lommel-Seeliger formula also fails to square with facts. The difficulties encountered are probably due to the imperfect dulness of the surfaces investigated, for even magnesium carbonate powder, the alleged ideal matt substance, falls somewhat short of the ideal. H. Wright describes some measurements made with plates of various substances and colours in a state of powder, and of such thickness as to be just opaque. He confirms Lommel's supposition that with a given size of grain the coefficient of diffusion is independent of the wavelength. This is the more remarkable, as a similar law does not apply to suspended particles such as give rise to the phenomenon of opalescence. An important result obtained is that the cosine law does not apply to a constant angle of emanation and a variable angle of incidence, but that, on the other hand, the amount of light reflected varies as the cosine of the angle of emanation when the angle of incidence remains constant, at least in perfectly dull powders. There is no law which is symmetrical both as regards i and e.

[H. Wright, *Ann. d. Physik*, No. 1, 1900.]

Magnetic Properties of the Elements.—The interesting work done by S. Meyer in endeavouring to find a general law of atomic magnetism must be regarded only as a rough preliminary survey. The main difficulty lies in the fact that the same metal, in two states of different valencies, may be diamagnetic in one state and paramagnetic in the other. J. Königsberger proves that cuprous compounds are diamagnetic, while cupric compounds are paramagnetic. He also considers it as definitely proved that a compound formed of two diamagnetic substances may be itself paramagnetic, and instances the cases of cuprous sulphide, selenide, and phosphide. As far as a connection between atomic magnetism and atomic volume can be traced, it appears that there is a definite and important connection which requires unravelling. But as regards this supposed connection, it is contradicted, or rather complicated, by the anomalous position of tin. The author regards the magnetic susceptibility of water as an open question even now, and thus throws a doubt on all data obtained from aqueous solutions. The mechanical treatment of wire-drawing produces a well-marked effect upon the magnetic susceptibility in certain directions.

[J. Königsberger, *Ann. d. Phys.*, No. 1, 1900.]

Thermo-Magnetic Effect in Bismuth.—When a plate of bismuth is traversed by a current of heat and at the same time exposed to a magnetic field at right angles to its plane, an E.M.F. is generated in the plate in a direction normal to the heat current. If a man were to stand in the magnetic lines of force so that they proceeded from his feet to his head, and were to look in the direction of the heat current, the E.M.F. would be directed towards his right hand. This effect has been termed the thermo-magnetic transverse effect by its discoverers, Ettinghausen and Nernst. Symbolically, the effect is approximately governed by the equation—

$$q = -\beta\frac{\delta t}{\delta z}\,HQ_t,$$

where q is the E.M.F., β the distance between the terminals of the circuit, and Q_t a function of the temperature. Putting $HQ_t = m$, it is found that m is nearly proportional to the increase of resistance experienced by bismuth in the magnetic field. E. Yamaguchi, in his experiments on this subject, finds that both these quantities increase very rapidly at the lowest temperatures, being doubled or trebled as the temperature falls from – 30deg. to – 120deg. For a full elucidation a better knowledge of the thermal conductivity of bismuth is essential.

[E. Yamaguchi, *Ann. d. Physik*, No. 1, 1900.]

Magnetic Twist in Nickel Tubes.—C. G. Knott further discusses the relations between Joule's discovery of the elongations accompanying magnetisation in iron and Wiedemann's discovery of the twist produced in an iron wire under the combined influence of longitudinal and circular magnetising forces. Following out a suggestion of Maxwell's as to the intimate connection between these two phenomena, the author expected to find both effects reversed in the case of nickel. This expectation was fully realised. It was also found that the circular magnetisation in a given field is greater than the longitudinal magnetisation in the same field, no doubt because the demagnetising factor is greater in the latter case. The shape in which the nickel was examined was that of a thin-walled, cylindrical tube, the only form which lends itself to theoretical treatment. There are still certain disagreements between theory and experiment, probably due to æolotropy in the specimen, either original or produced by magnetisation and hysteresis. However, it is clearly demonstrated that the Wiedemann and Joule effects are essentially the same. In other words, in striving to get an insight into the molecular changes that accompany magnetisation we are not warranted in considering the twist effect observed by Wiedemann as involving any factor that is not prominent in the production of the elongation effect observed by Joule.

[C. G. Knott, *Proc. Roy. Soc.*, Edinburgh, Dec., 1899.]

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THE JOHN HOPKINSON MEMORIAL WING OF THE CAMBRIDGE ENGINEERING LABORATORY.

On Friday afternoon last, the 2nd inst., the ceremony of inaugurating the new wing of the engineering laboratory at Cambridge University took place, the extensive new pile of buildings having been erected as a memorial to the late Dr. John Hopkinson. A gift of £5,000 by his widow, jointly with his son and daughter, has enabled this much-needed extension to be carried out. The wing is a block about 92ft. long and 40ft. wide, for the most part of three storeys, built alongside the original engineering laboratory, to the designs of Mr. W. C. Marshall. It includes a lecture theatre and supplementary lecture room, a large laboratory for testing the strength of materials and for experiments in hydraulics, a dynamo room, and several smaller rooms adapted to research. Towards the equipment of the laboratory a further sum of £1.200 was subscribed, chiefiy by engineers, and a number of important gifts of apparatus have been made. Among these is a testing machine, presented by past and present pupils of Prof. Ewing. A portrait of the late Dr. Hopkinson, painted by Mr. T. B. Kennington, and presented to the laboratory by subscribers, has been placed in one of the lecture rooms. This was unveiled by the Master of Trinity after the new building had been formally opened by the Vice-Chancellor and Lord Kelvin had delivered an inaugural address. Among those present were the Vice-Chancellor (Mr. W. Chawner, Master of Emmanuel College), Lord Kelvin, the Master of Trinity, Prof. Jebb, M.P., the Provost of King's, the President of Queens'; the Masters of Peterhouse, Trinity Hall. Christ's, Sidney, and Selwyn; Profs. Sir G. G. Stokes, Sir R. S. Ball, Allbutt, Sidgwick, Liveing, Moule, Forsyth, Ewing, Skeat, and Reid; the Public Orator, Sir Douglas Fox, Principal Hopkinson, Mr. Bertram Hopkinson, and many others.

The VICE-CHANCELLOR said it was a remarkable testimony to the importance attached by public opinion in England to the application of the highest scientific and mathematical knowledge in all practical studies that the engineering department should have received such large encouragement and so many donations from friends outside. Of the total cost, £12 500, no less than £11,000 had been contributed by donors. It was a happy thought to commemorate the name of Dr. Hopkinson in a building which would be associated with the studies to which he devoted his life. They could remember with pleasure his remarkable abilities, his brilliant academic career at two universities, and the unusual mathematical powers which he applied to scientific purposes. It might be some consolation that as long as the bricks and mortar and stone of that building remained there would be a memorial of his name and services. The Vice-Chancellor trusted that John Hopkinson's name would be enrolled among their list of benefactors

Lord KELVIN said the opening of the John Hopkinson memorial wing of the engineering laboratory was an event of the deepest interest, and of manifestly high importance in the history of the University of Cambridge. The Senior Wrangler of 1871 by the 27 years of his post-graduate life had largely added lustre to the long roll of distinguished men who had won the highest honour with which this mathematical university annually crowned the career of one of its undergraduates. John Hopkinson showed to quite an exceptional degree the rare power of grasping a high scientific truth, and applying it practically to mechanical art for the use of mankind. This was splendidly illustrated in the work which he did in improving the dynamo. The limits of time forbade description of his scientific and engineering work. John Hopkinson devoted himself enthusiastically to the work of civil engineering, and for fully 25 years of his life he gave great assistance in a large number of directions. Hopkinson's group-flashing light, a splendid application of scientific optics, was now in use in lighthouses and lightships all over the world. Everything that was for the good of the engineering profession Hopkinson had at heart. Not many years ago he founded a volunteer corps of electrical engineers, and he (Lord Kelvin) was made honorary colonel. A section of that corps were now under orders to proceed to South Africa, and all would wish them success. When Hopkinson was an undergraduate at Cambridge there was no physical laboratory, and probably he saw no experiments, except in the lecture room of Sir George Stokes. Lord Kelvin was sure that Sir George was proud of his pupil's having turned his instruction to such good account. The Cavendish Laboratory, founded by the late Duke of Devonshire, Chancellor of the University, with its first professor, Clerk Maxwell, had added greatly to the fame of Cambridge as a place of research. Since then great things had been done for physical science in that school by Lord Rayleigh and Prof. J. J. Thomson. But still there was something wanting—the application of physical science to the wants of mankind, and that had now been supplied by the engineering laboratory. John Hopkinson was keenly interested in this school of engineering. He gave support and advice to its promoters in its very beginning. Good work had been achieved under its present distinguished chief, Prof. Ewing. Excellent work had been done by students in the laboratory in virtue of the inspiration of the chief and under his guidance. Three of the exhibition scholars had chosen this engineering laboratory for their post-graduate work. The laboratory had grown largely, and there were now 150 students. Hopkinson always followed its progress with the utmost interest. In August, 1898, he was in Switzerland with Mrs. Hopkinson and their family. Then and there it was arranged with Prof. Ewing to make a systematic effort to raise funds for the extension of the laboratory. In October of the same year Mrs. Hopkinson said she wished the thing to be done. Well, it had been done—by Mrs. Hopkinson, her son, and daughter. In conclusion, Lord Kelvin said he had been deputed by the board of directors of the Linotype Co. to offer for the acceptance of the university a bust of Dr. Hopkinson.

Prof. EWING proposed a vote of thanks to Lord Kelvin, and spoke personally of his lordship's inspiration and example. He thanked Mrs. Hopkinson and her son and daughter for what they had done, and also spoke of the many other gifts that had been received. Only that day he had by telegram received the promise of a model illustrating polyphase transmission from the Westinghouse Co., of America.

Principal HOPKINSON, of Owens College, Manchester, seconded, and said he was pleased to hear the kind words of appreciation of the memorial of his brother.

The MASTER of TRINITY then unveiled the portrait, and said it was a very great pleasure to Trinity men to know that this great compliment had been paid to one of whom they were proud. It was pleasing to know that a replica of the picture had been offered to and accepted by Mrs. Hopkinson.

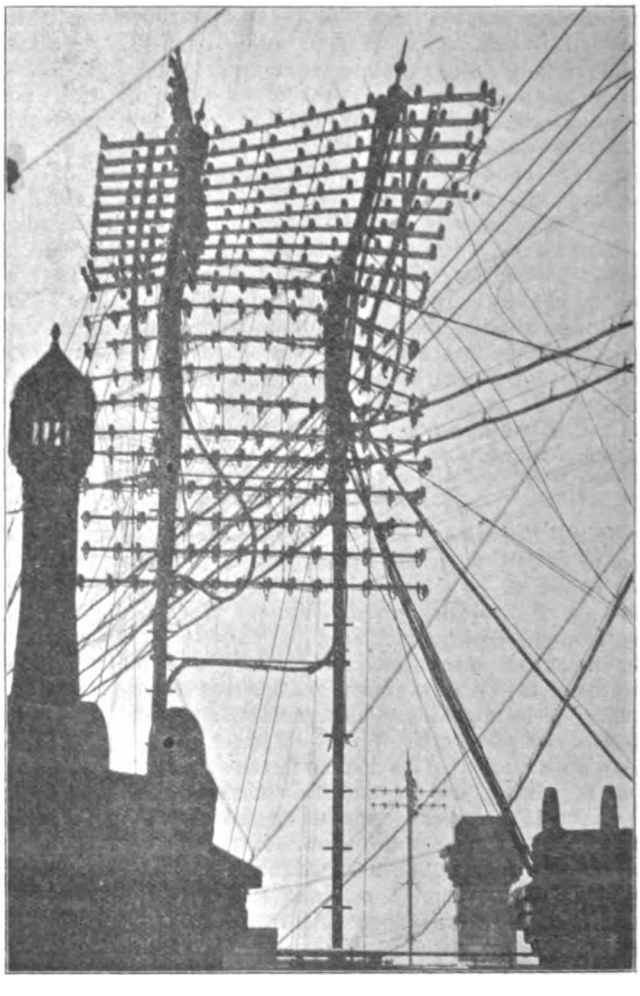
Mr. BERTRAM HOPKINSON, son of the late Dr. Hopkinson, having thanked the donors of the portrait,

Sir DOUGLAS FOX, President of the Institution of Civil Engineers, moved a vote of thanks to the Master of Trinity, and the proceedings terminated.

Professor and Mrs. Ewing afterwards held an "At Home" in the laboratories, which was largely attended.

TELEPHONE WIRES IN LONDON.

The snowfall on Friday night and Saturday caused great damage to the telephone wires in London, actually doing more



harm in this respect in the metropolis than any snowstorm since the great one of 1886. It appears that a thick damp snow of the quality that fell on Friday and Saturday clings to the wires much more than what falls during a long-

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continued snowstorm during a hard frost or keen wind. A number of standards and derricks were affected, and on Saturday over 4,000 lines were interrupted. Seven hundred men were immediately employed by the company to put matters right, and although they have been working during all the daylight hours (including Sunday), things have not yet been quite restored to their normal condition. The company has issued the following circular to subscribers:—

SNOWSTORM.

The company regrets to have to inform its metropolitan subscribers that the snowstorm yesterday has caused a partial dislocation of the London telephone service. No effort is being spared to get the service restored, but as it will take some little time before this can be fully accomplished, the company trusts that its subscribers will accord to it as much forbearance as possible. During the past four years the company has been using its utmost endeavours, but without success, to induce the London County Council to consent to the wires being put underground. Had the County Council done so, the present trouble would not have occurred.

WM. E. L. GAINE, General Manager.

The illustration, on the opposite page, of a disabled standard above the Mansion House Railway station is from a photograph kindly lent us by the General Electric Co. The standard in question was quite doubled over, but it had been partly restored when the photograph was taken.

NOVELTIES IN ACCUMULATORS FOR TRACTION PURPOSES.

Under the above title Herr Zacharias has an article in the first number of the *Centralblatt fur Accumulatoren und Elementenkunde*, dealing with the growth of the employment of accumulators for traction purposes. After referring to the early attempts which were made in 1881 by Julien in Brussels and Reckenzaun in London, to introduce accumulators for the propulsion of tramcars, Herr Zacharias points out that the early failures prejudiced the tramway companies and others against the employment of accumulators, and so the manufacturers of the latter were forced to obtain the necessary experience by laying down short tramlines at their own cost. The foremost firms in this field of work were the Aktiengesellschaft, Hagen, and the Wattaccumulatorenwerke, who about 1896 made extended trials in Berlin. But the cast-ribbed pattern of Planté plate first adopted by the Hagen Co. and the narrow mesh grid plate of the Watt Co. were both found unsuitable, and have been since superseded. The cast-ribbed plates were not only heavy, but they were less durable than had been expected, chiefly because it was impossible to cast the plate thick enough to give strength and to be at the same time homogeneous. The "Watt" plate, on the other hand, lacked rigidity, and the carbon dust or carbonised filament diaphragm which was inserted between the plates interfered with the free circulation of the electrolyte, so that the acid at the bottom of the cell became of much greater density than that at the top, with injurious results to the plates. Rólled lead has been substituted for the manufacture of Planté plates, but before this was introduced many other methods for making the plates more homogeneous had been tried. The plates had been forced between very finely-grooved rollers, so as to increase greatly the ribbed surface, or they had been pressed into moulds of various patterns which would give a large surface, but with no very satisfactory result, as such plates are always rather heavy.

Dr. Majert was the first to manufacture Planté plates from sheets of rolled lead, employing the process and the special form of plane which has already been described in these columns (Dec. 8, 1899, p. 218). Another method of manufacturing positive plates of the Planté type is the "Monobloc," which is employed by the Aktiengesellschaft l'Electrique in Brussels. The positive plate in each cell is formed of a compact block consisting of about 120 sheets of lead, each 0·5mm. thick, which are held together by a hard lead frame, and four corner pieces which are burnt on to the lead sheets. The plates are perforated according to their size, with from 20 to 30 holes 10mm. apart. The negative plates are composed of quadrangular tubes 0·5mm. thick, which are formed of lead hardened with a very little antimony. These tubes are filled with highly porous and spongy lead, and are provided with numerous longitudinal openings. This construction enables a battery having a large effective surface area to be enclosed within a very small space, and after more than a year's experience has been obtained of their working in various places, it has been found that they give satisfactory results; on the Belgian State lines it has been ascertained that the cells used for running the street cars only require cleaning after 20,000 kilometres had been run, so that the company is now in a position to guarantee the cost of running per kilometre. As the results of experience gained in working, the method of construction of the plates has undergone modifications and improvements, which will be referred to later on, when the patent rights have been secured.

In the Blot accumulator rolled lead is also employed for the positive plates, but in this case it is used in the form of long strips which are rolled up so as to fit into receptacles in the plate, but this system does not allow of much expansion and contraction taking place during charge and discharge.

The chief drawback to plates of the Planté type is no longer their weight, which has been largely reduced by improved methods of construction, but consists in the time required for their formation. To hasten this, an electrolyte is usually employed which will attack the lead, such as some salt containing chlorine; but when the formation has been completed it is most important that the plate should be freed from every trace of chlorine, for practical experience has shown that it is most injurious, about 0·00004 per cent. being the largest amount permissible. This fact and the necessary tests and treatment of the plates are now generally understood, so that it is possible to avoid undue injury from the effects of chlorine.

The use of accumulators for traction purposes will be greatly extended in the future, when the cost of their maintenance has been decreased, which will be the case when the plates can be turned out in large quantities in factories by machinery, instead of being made by hand; and the factory in Brussels has already made a beginning in this direction.

AN ELECTROLYTIC CENTRIFUGAL PROCESS FOR THE PRODUCTION OF COPPER TUBES.*

BY SHEBARD COWPER-COLES.

INTRODUCTION.

The electro-deposition of copper is now carried on in many large engineering works for the coating of hydraulic rams, barrels of guns, shell and shot, and is extensively employed in the manufacture of tubes and sheets, and for the production of large copper vessels. Most of the copper used by electrical engineers and over one-third of the total copper output of the world is now electrolytically refined. It is difficult to obtain exact figures, as the copper returns for various countries do not distinguish between raw and electrolytic copper, but it is estimated that one-half of the copper produced in the United States in 1897 was electrolytically refined, and in 1898 the proportion was slightly over that amount. The demand for electrolytic copper is on the increase, and the capacity of most of the electrolytic refining works has or is being increased.

PROGRESS AND EXTENT OF THE ELECTROLYTIC COPPER REFINING INDUSTRY.

The following figures published in *Industries and Iron* show the rapid growth of electrolytic refineries. The world's total output of electrolytic copper 15 to 20 years ago did not exceed 10 to 15 tons a week. In 1881 to 1882 this amount was probably increased to about 60 tons as the result of the refineries erected in Swansea. During the next four or five years several of the American refineries got to work, and by this time, say 1888 to 1890, the world's total production was probably not more than 280 to 300 tons per week. Since that date, up to the present time, many refineries of gigantic size have come into existence, not only in America, but in England, France, Germany, and even Japan; and it is quite safe to estimate the world's production at the present moment at no less than 500 tons per day, or about 180,000 tons of electrolytic copper per annum; and during the refining of this quantity of metal there are not less than 20,000,000 ounces of silver and 100,000 ounces of gold recovered.

* Paper read before the Institution of Electrical Engineers, Jan. 25.

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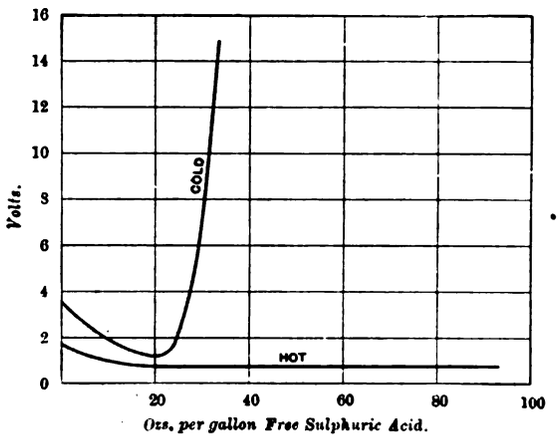
When these weights are converted into money value, the following astonishing figures are obtained :—

Annual copper value	£9,000,000
Ditto silver ditto	2,500,000
Ditto gold ditto	400,000

or, in round numbers, a total value of £12,000,000 sterling. This startling result has been achieved in a maximum of 25 to 30 years ; this industry has had a growth probably unparalleled in the history of commercial enterprise.

Increase of Current Density in Copper Refineries.

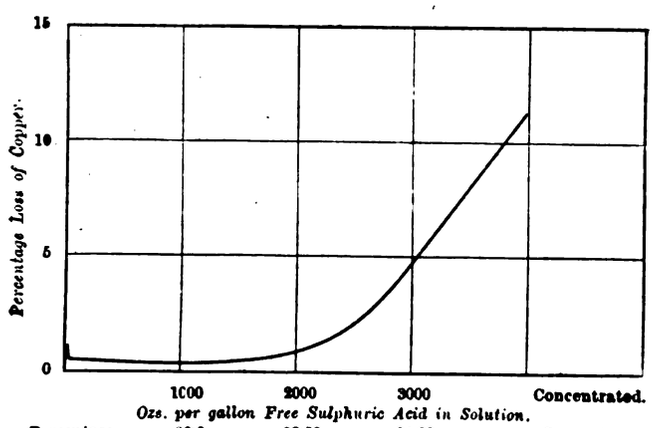
It has been the object of those engaged in the electrolytic refining of copper to increase the current density as much as possible, so as to



Curve 1.—Curves showing the Effect of Free Sulphuric Acid on the Voltage in Hot and Cold Solutions of Copper Sulphate.

get a larger output per vat. A considerable increase of current has been effected of late years by attention to details such as: (1) Proper circulation of the electrolyte ; (2) the purity of the electrolyte ; (3) the chemical composition of the electrolyte ; (4) the arrangement of the electrodes.

In a review of the position of the electro-copper refining industry by Mr. Titus Ulke, he mentions that it was not at all uncommon ten years ago for the copper refiners to stock their tanks with 75 to 100 times as much copper as was daily produced in everyday work. This enormous disparity has been gradually reduced, so that to-day only one-fourth to one-fifth of that amount is required on an average of 15 to 20 tons per ton of output. He attributes the cause of this

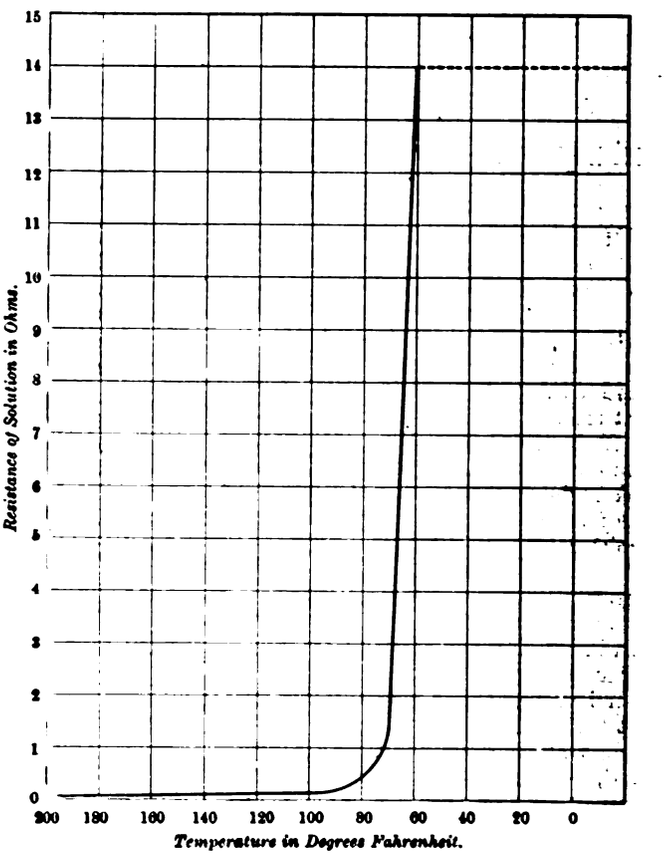

Percentage Loss of Copper.
Ozs. per gallon Free Sulphuric Acid in Solution.
Concentrated.
Percentage = 86·2 92·59 94·93 Concentrated.

Curve 2.—Curve showing the Solubility of Copper in Sulphuric Acid.

marked improvement to the method of handling the baths, and especially to the higher current densities now made practicable. Whereas formerly currents of only 2 to 4 amperes per square foot were thought permissible, to-day current densities of from 15 to 20 amperes are said to be employed in some establishments, and the end is not yet in sight. The conclusion arrived at by Mr. Ulke is that the average proportion between the total copper in process of treatment and the yearly capacity (measured by output) in our electrolytic copper works is now about 4 per cent. as against two or three times that amount formerly, and that the average proportion is likely to diminish still more within the next year or two.

Description of Various Methods for Improving the Physical Properties of Electro-Deposited Copper.

One of the best-known electrolytic processes for the manufacture of tubes is that in which an agate burnisher is used for consolidating the deposit during electro-deposition. This process has met with considerable success, the chief drawback being the tendency of the copper to laminate or exfoliate where the burnisher has been at work, the pressure on the burnisher requiring to be regulated to a great nicety. Elmore has sought to build up electro-deposited tubes equal to drawn ones by causing a burnisher to constantly traverse the length of the tubes backwards and forwards as they slowly rotate in the bath, and so obtain a copper possessing a high density. The current density originally employed for this process was about 16 amperes per square foot, but this the author believes has been considerably increased. Copper deposited by the Elmore process has stood a stress of 26·5 tons per square inch, with an extension of 16·5 per cent., the limit of elasticity being reached with a load of 23·3 tons per square inch, the specific gravity of the metal being as high as 9·2. Von Hübl has succeeded in producing, by simple deposition without the aid of a burnisher, a specimen of copper which broke at a stress of 23·6 tons : commercial cast copper breaks at about 8·4 tons per square inch. Another process, that is now being operated on a large commercial scale, substitutes a sheepskin burnisher for an agate one, smooth deposits being obtained by the application of an insulating



Curve 3.—Curve showing the Effect of Temperature on the Resistance of a Solution containing 1 gallon of water, 2lbs. of copper sulphate, and 60oz. of free sulphuric acid.

coating to the inequalities on the surface. The sheepskin impregnators, which move over the surface of the metal, coat all projecting parts with a thin film of animal fat, which hinders further deposition until the surrounding depressions have been raised to the common level. In later patents impregnators are mentioned composed of organic gelatinous or albuminous matter free from excess of grease, rendered insoluble by treatment with bichromate, or the softening of the albuminous or gelatinous constituents of the impregnators is prevented by soaking them with a solution of formic aldehyde (within the limits of 10 per cent. and 40 per cent.), after which it is washed in water to remove the aldehyde, or this substance is neutralised or decomposed by means of sulphuric acid. It is claimed for impregnators so treated that they may be employed with equal facility in a hot or cold bath. The current used is from 35 to 40 amperes per square foot of cathode area ; the voltage required is about 1·6 per vat. Tubes are deposited 12ft. in length and 16in. diameter and $\frac{1}{16}$in. thick, which are longitudinally cut and opened to form sheets. Several investigators have patented methods to improve the physical properties of electro-deposited copper by injecting the electrolyte on to the copper during deposition. Craydon Poore has devised a method for producing plates by projecting the electrolyte forcibly on to a cathode placed in a horizontal position.

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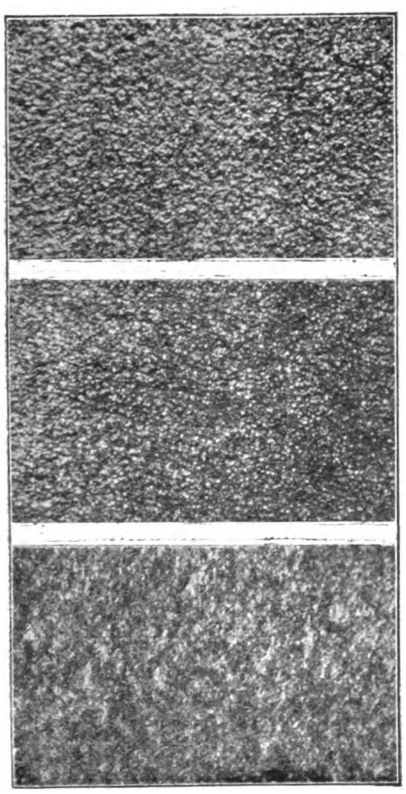
Centrifugal Copper Process.

The author has lately developed a centrifugal process, which is now being worked on a practical scale, for copper refining and the manufacture of copper tubes, sheet, and wire by electro-deposition, which does away with the troubles of lamination and enables a much higher current density to be used than has hitherto been the case, smooth tubes having been produced 12in. in diameter at the remarkably high current density of 200 amperes per square foot, the voltage being from 0·5 to 0·7. Solid-drawn copper tubes of such diameters cost about three times the price of tough copper cake. The centrifugal process is distinct from those already referred to, inasmuch as there are no burnishing tools employed, but the cathode on which the copper is deposited is revolved at a high rate of speed, the result being that the skin friction between the deposited metal and the electrolyte keeps the copper beautifully smooth and compact. Any gas bubbles evolved at the cathode, or impurities in mechanical suspension in the electrolyte which would have a tendency to settle on the cathode, are thrown off by centrifugal force. Mr. J. W. Swan has found that regularity and smoothness of deposit were almost entirely dependent on the absence of solid particles held in suspension in the electrolyte, and that excrescences could be entirely avoided by taking care

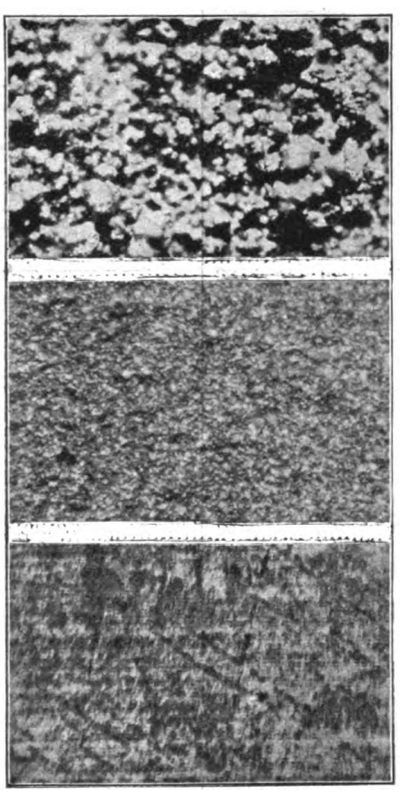
				Electrolyte.
Fig. 4.	100 amperes per sq. ft.,	revolving	.....	Hot.
Fig. 5.	150	ditto	ditto	do.
Fig. 6.	220	ditto	ditto	do.
Fig. 7.	40	ditto	ditto	Cold.
Fig. 8.	40	ditto	stationary	Hot.
Fig. 9.	100	ditto	ditto	do.
Fig. 10.	10	ditto	too much grease on mandrel	Cold.
Fig. 11.	10	ditto	no grease on mandrel	do.

Fig. 12. Copper crystals from a voltaic cell.

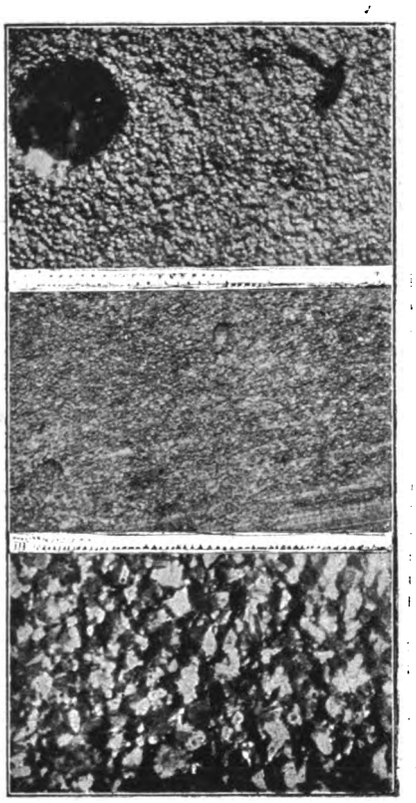
The apparatus employed for the centrifugal process consists of a wooden vat, A (Figs. 13 and 14), in which are placed anodes composed of crude copper. The cathode is a hollow mandrel, B, made of brass, which is supported on a revolving shaft, C. The shaft is brought through the bottom of the vat to the top of the cell, and is protected from the acid copper sulphate solution by a lead-cased wrought-iron column. The shaft is caused to revolve by gearing placed beneath the depositing cell, the speed varying with the size of the mandrel employed. The mandrel at one end is fitted with an eye-bolt, D, for lifting purposes, and a circular brass casting, E, against which the contact brushes F rub for collecting the negative current. The brushes are fitted to arm G, which are made to turn back to allow of the easy withdrawal and insertion of the mandrel. H is



Figs. 4, 5, 6.



Figs. 7, 8, 9.



Figs. 10, 11, 12.

Photo-micrographs of the Surface of Electro-Deposited Copper under Various Conditions. Fifty Diameters.

the electrolyte was free from solid floating particles. He observed that at the seat of each "nodule" was a speck of some foreign substance. Dr. G. Gore has given the matter some thought, and has observed that the greatest length of "nodule" is in the direction of the greatest intensity of current and amount of copper in solution.

A bath with a revolving cathode was then projected on the screen, and the gas bubbles were clearly seen being thrown off by centrifugal force. A number of specimens of tubes and sheets produced by this process were also exhibited. Some had been produced at a current density of 200 amperes per square foot, and they were deposited from solutions of approximately the following composition, the copper anodes containing about 30oz. of silver to the ton :—

	Oz. per gal.	Percentage.
Copper sulphate ($CuSO_45H_2O$)	22·44	10·95
Sulphuric acid (H_2SO_4)	22·34	10·90
Ferrous sulphate ($2FeSO_4$)	0·05	0·02
Water	160·00	78·13
		100·00

The series of photo-micrographs (Figs. 4 to 12) show the results obtained with rapidly revolving and stationary cathodes, all other conditions being the same.

a baffle plate made of an insulating material, placed at the bottom of the mandrel to prevent the formation of copper "trees" or "nodules." Figs. 15 and 16 show the "trees" and "nodules" which have a tendency to form if a baffle plate is not used. The electrolyte is briskly circulated through the cells by means of an acid-proof pump or air pump, the solution being forced or pumped to a reservoir, where it passes through a filter to rid it of all impurities in suspension. When it is desired to obtain a sheet of copper, the tube, after being removed from the mandrel is cut, flattened out, and annealed; when a wire, a piece of insulating material, is wound round the mandrel in the form of a spiral, and copper deposited between the threads until the thickness of copper is equal to the distance between the threads: the spiral is then removed, and after annealing is drawn out in the usual manner. The mandrel is given a small taper, and is slightly greased to facilitate the removal of the tubes. Figs. 17 and 18 show a modified arrangement for driving the mandrel above instead of from below. Another interesting feature of the centrifugal process is that it enables a hot and more acid solution to be used than is generally employed.

Slides were then shown giving photographic views of two copper deposits. All the conditions were similar, with the exception that the mandrels revolved at different speeds. In one case it was revolved at about 30 revs. per min., in the other at 1,000. In

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the first case copper had come down as a loose mud, and could not be removed from the mandrel. In the second case the copper had come down smooth and bright, and was expanded off the mandrel as a perfect tube. The current density was 170 amperes per square foot, and the temperature 160°F. The electrolyte was of the following composition :—

	Ozs. per gal.	Percentage.
Copper sulphate	30	12
Sulphuric acid	60	24
Water	1 gal.	64
		100

The amount of free acid has a very marked effect upon the voltage required, but a very small effect upon the actual weight of copper obtained, compared with the theoretical weight, as shown by Table I. and Curve No. 1 ; the amount of copper sulphate was 32oz. per gallon of water = 16·66 per cent.

Table I.

No.	Solution cold. Current density.	Voltage.	Oz. of H_2SO_4 per gallon by weight.	Percentage of free acid by weight.	Peripheral speed. Feet per minute.
1	100	3·5	0	0·0	471
2	100	2·5	6	3·03	471
3	100	2·0	8	4·00	523
4	100	1·8	10	4·95	471
5	100	2·2	25	11·52	523
6	100	8·0	30	13·51	523
7	100	12·0	40	17·24	471
8	100	14·0	60	23·81	523
9	100	20·0	100	34·24	628

The solution was circulated at such a rate that it was renewed in the depositing cell every five minutes. The above table shows the advantage of increasing the acidity of the solution up to a certain point, and the disadvantage of increasing it beyond that point ; the critical point seems to be about 15oz. of free sulphuric acid per gallon = 14·71 per cent. The rise of voltage in a cold solution is explained by the fact that the addition of sulphuric acid to a copper sulphate solution causes the copper sulphate to crystallise out ; this takes place on the electrodes, and largely increases the resistance. It has been shown that a saturated copper sulphate solution is the best conductor, and that a 25 per cent. solution of sulphuric acid offers the best resistance. With too much acid the polarisation ensues from its own decomposition by the action of the current. The latter trouble is said to set in when the copper sulphate solution has reached an acidity of about 13 per cent. : these remarks apply to stationary anodes.

Table II. and Curve No. 1 give the voltage required when depositing at 100 amperes per square foot from a solution containing 32oz. copper sulphate per gallon = 16·66 per cent., the temperature being 160°F., various amounts of free acid being used, with anodes of commercial copper.

Table II.

No.	Current density	Voltage.	Oz. of H_2SO_4 per gallon by weight.	Percentage of free acid by weight.	Peripheral speed. Feet per minute.
1	100	3·5	0	0·0	500
2	100	1·3	10	4·95	500
3	100	0·9	20	9·43	500
4	100	0·8	30	13·51	500
5	100	0·75	40	17·24	500
6	100	0·75	50	20·66	500
7	100	0·7	60	23·81	500
8	100	0·7	100	34·24	500

The solution in this experiment was not circulated. Comparing this table with No. 1, the advantage of using a hot solution is shown, also the advantage of increasing the acidity.

Table III. gives the variation of current and voltage due to increasing the temperature of the electrolyte.

Table III.

Amperes.	Volts.	Temperature of solution.	Ampere.	Volts.	Temperature of solution.
0·55	8·0	60°F.	16·00	0·85	100°F.
4·00	7·0	70°F.	16·00	0·80	120°F.
8·00	5·0	75°F.	16·00	0·75	140°F.
10·00	4·0	78°F.	16·00	0·70	180°F.
14·00	2·0	82°F.	16·00	0·70	200°F.
16·00	1·0	90°F.			

This table shows how a hot solution allows a heavier current to pass at a much lower voltage ; 150°F. is probably the most economical temperature to work at. The curve on the diagram was arrived at by dividing the E.M.F. by the current, giving the resistance in ohms.

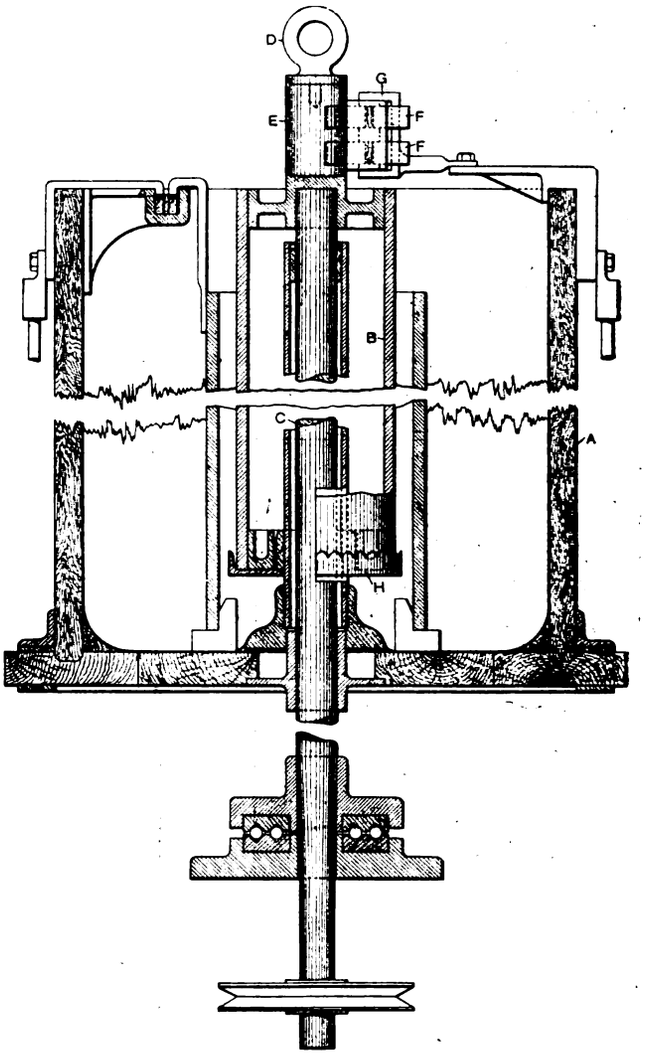

Fig. 13.

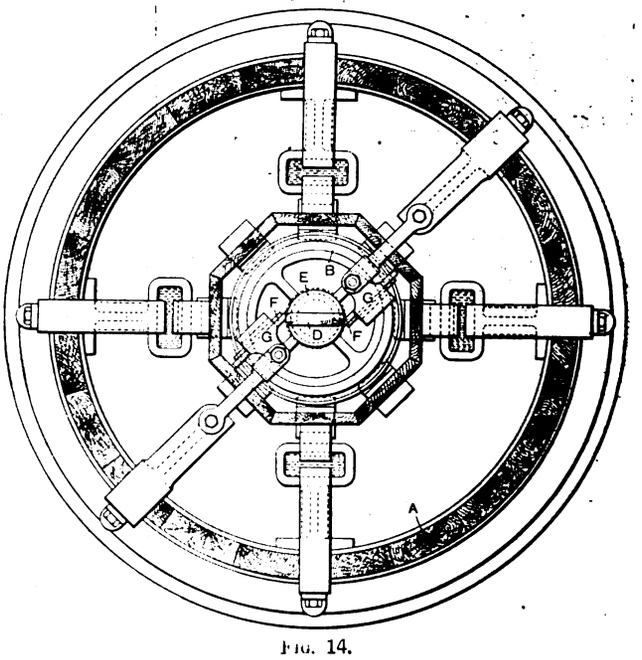

Fig. 14.

It is well known that from a neutral or slightly basic solution copper comes down in a coarse-grained, brittle condition, whereas the amount of free acid has a very marked effect on the voltage, as is shown by Table II. This may be due to the production of

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a small amount of cuprous acid from a neutral or basic solution, or to the influence of a large percentage of free acid on the mode of crystallisation of the metal.

Von Hübl has observed that the dark-coloured sponge deposits produced by too high a current density occur the more readily the poorer the electrolyte round the cathode is in copper. According to the same authority, this dark deposit is not due to the presence of cuprous oxide, but to the formation of a hydride. Hydrogen may under certain circumstances be occluded by electrolytic copper, which has been proved by the the analyses which have been made of the gas pumped out of various specimens of the metal. Thus, a certain sample gave up 4·4 times its volume of gas, consisting of 77·3 per cent. of hydrogen, 8·4 per cent. of carbon monoxide, 11·1 per cent. of carbon dioxide, and 3·2 per cent. of water vapour. Foerster and Liedel have studied the influence of temperature on the character of copper deposited from acid solutions. The experiments were not very conclusive, but they tend to show that tougher copper is

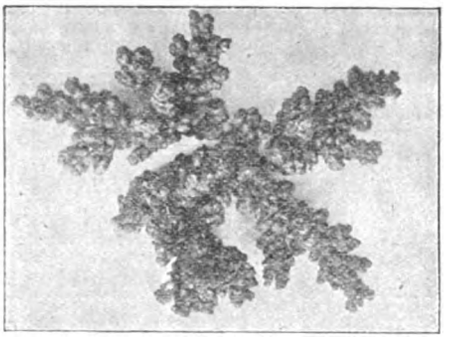


Fig. 15.

obtained with hot solutions than with cold. The experiments of Foerster and Liedel also show that the precipitation of brownish-red powdery copper is connected with a certain low concentration of the copper ions in solution. Owing to the rapid revolving of the cathode in the centrifugal process, the solution is kept well mixed, so the difficulty of having the solution poor in metal round the cathode is overcome.

The experiments on the loss of copper by corrosion with a revolving mandrel are not very reliable, but there is no apparent reason why the loss should differ from that with a stationary mandrel. If the solution is kept thoroughly saturated with copper sulphate, the corrosion ought not to be more than a very small per-

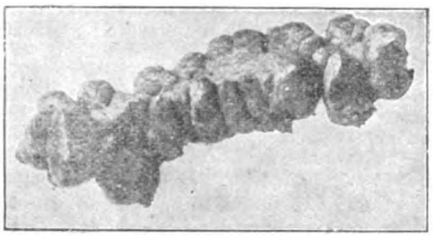


Fig. 16.

centage of the total copper deposited. This loss might be reduced by using a higher current density; for instance, if the current is doubled the percentage loss will be halved.

On the Loss of Copper by Corrosion.

Table IV.

No.	Current density.	Oz. of free H_2SO_4 by weight.	Per cent. of H_2SO_4 by weight.	Loss on cathode per cent.	Loss on anode per cent.
1	25	10	4·95	3·0	7·5
2	25	20	9·43	2·7	8·1
3	25	30	13·51	2·8	7·1
4	25	40	17·24	2·2	6·7
5	25	60	23·81	1·8	5·1
6	25	100	34·24	2·5	6·7

In these experiments (run in series) the time, temperature (160°F.), and current were kept the same. The greater loss at the anode is accounted for by the fact that the anodes were all much larger than the cathodes, therefore a greater surface was exposed to the action of the hot acid.

Table V. and Curve 2 show the solubility of copper foil in sulphuric acid:—

Table V.

No.	Percentage of H_2SO_4 per gallon by weight.	Loss per cent. hot solution.	No.	Percentage of H_2SO_4 per gallon by weight	Loss per cent. hot solution.
1	0·0	0·0	5	75·75	0·4
2	3·03	0·9	6	86 20	0·27
3	5·88	0 5	7	92·59	0·7
4	34·44	0·49	8	Concentrated acid	10·7

From this table the solubility of the copper in dilute sulphuric appears to be greatest at 3 per cent., and gradually falls to about 90 per cent., a greater increase taking place when concentrated acid is used.

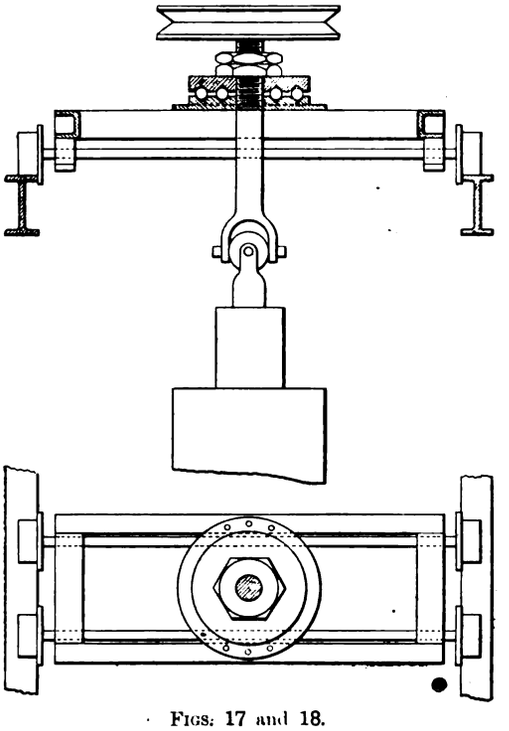
The following table shows a steady decrease in the solubility of copper in sulphuric acid from 10 per cent. to 50 per cent., the copper foil being immersed in the hot for three hours and in the cold solution for fifteen hours.

Table VI.

No.	Ozs. of H_2SO_4 per gallon by weight.	Per cent. of H_2SO_4 by weight.	Loss per cent. hot solution, three hours.	Loss per cent. cold solution, fifteen hours.
1	10	5·88	1·27	0·218
2	20	11·11	1·17	0·180
3	30	15·79	1·14	0·145
4	40	20·00	0 85	0·145
5	60	27·27	0·74	0·11
6	100	38·46	0·69	0·97

Anode Sludge.

As already mentioned, a very high current density can be used with the centrifugal process, and smooth deposits can be obtained



Figs. 17 and 18.

with a current density of even 200 amperes per sq. ft. This is a matter of great importance, as in copper refining with high current densities less anode sludge is formed. It has been observed by Foerster and Liedel that when a high current density and a high temperature are used there is far less sludge formed on the anodes. With a current density of 0·3 ampere per sq. decimetre at the ordinary temperature, a weight of 0·5 kg. of anode copper consumed left 3·7 grms. of sludge, containing 60 to 70 per cent. of copper, partly as cuprous oxide. Under the same conditions, but working at 40°C., the sludge was only 1·2 grms., and was nearly free from copper. With a higher current density—viz., 1 ampere per sq. decimetre—the quantity of anode sludge was about the same, at 20°C. and 40°C.—viz., 2·5 grms. from 1 kg. of copper. These results, although far from exhaustive, go to show that the high current densities used in modern copper refining have the incidental advantage of reducing the quantity of anode sludge, and thus making the working up for silver and gold easier and more economical. A

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yet higher temperature—viz., 60°C.—increases the quantity of sludge: a good deal of the increase is due to the presence of metallic copper, which may be regarded as having been formed during the spontaneous resolution of cuprous sulphate momentarily produced at the anode, thus:—

$$Cu_2SO_4CuSO_4Cu.$$

Gold is not dissolved from the anode, and silver only to a small extent, and selenium and tellurium not to any appreciable extent when present in small quantities.

Arsenic is found to be most readily soluble, and bismuth the least soluble, amongst the impurities in the anodes. According to Dr. Börcher, the mud or slime deposited on the anode may contain, after drying, gold, platinum, silver, silver sulphide, cuprous oxide and sulphide, basic sulphates of bismuth, tin, and antimony, antimonic acid, arseniate of copper, arseniates and antimoniates, lead sulphate and slag constituents in which may be iron, lime, magnesia, and silica; and with these there will also be a certain amount of metallic copper in a pulverulent state. If the anode contains too high a percentage of impurity, it leads to several practical difficulties, such as the periodical scrubbing of the anodes. Some of the impurities found in electrolytic copper are electrolytically deposited from the electrolyte, and others are mechanically thrown down. Centrifugal action seems to prevent any matter in suspension settling on the rapidly revolving cathode. E. Koller has communicated some interesting figures to the *Journal* of the Chemical Society. He found that the average composition of the vat deposit obtained (i.) during a year's treatment of reverberatory, and (ii.) from three months' treatment of converted copper, are as follows, exclusive of oxygen and combined water:—

	(I.) Per cent.		(II.) Per cent.	
Ag.	53·894	[0·3064]	55·15	[0·3076]
Au.	0·296		0·198	
Cu.	11·01	[0·0093]	13·82	
Pb.	0·91	[0·0093]	2·07	
Bi.	3·93	[0·0320]	0·34	[0·0035]
Sb.	6·25	[0·0651]	2·44	[0·0510]
As.	2·11	[0·0586]	1·09	[0·0180]
Se.	0·39	[0·0098]	0·72	
Te.	1·17		0·89	
Fe.	—		0·80	
SO_4	5·27		10·68	
H_2O	2·36		2·60	

The numbers in square brackets represent the percentages of the various elements in the unrefined copper, and show, therefore, the nature and the extent of refining effected by electrolysis. From these numbers it may be found that the whole of the silver, gold, selenium, and tellurium remain in the residue; whilst of the other elements there are left in the slime, in the two cases respectively:—

Cu., 0·07, 0·08; Bi., 78·22, 60·71; Sb., 61·14, 29·90;
and As., 22·90, 37·84 per cent.

Physical Properties of Electro-Deposited Copper.

Copper prepared by electrolysis may have as low a density as 8·00; the figure for normal copper is 8·9. Hard rolling, cold hammering, and hard drawing increase the tensile strength and limit the elasticity of copper considerably. The extensibility of annealed copper becomes less at high temperatures, and that of mechanically worked copper becomes higher. Some copper sheet (not annealed) deposited by the centrifugal process, 0·0245 of an inch in thickness, broke at 433lb., which is equal to 22·1 tons per square inch. Hard-drawn wire made by this process has a tensile strength of 29 tons per square inch, annealed 20 tons, the electrical conductivity being 99 per cent. The author has obtained excellent tough deposits of copper with the theoretical yield from a solution composed of:—

	Oz. per gallon.	Percentage by weight.
Copper sulphate ($CuSO_4+5H_2O$)	32	14·87
Sulphuric acid (H_2SO_4)	12·6	10·77
Water	...	74·36
		100·00

S. Sheldon has carried out a number of experiments to determine the electric conductivity of copper when annealed at various temperatures. A sample of copper was drawn several times without annealing, so as to become very hard, and was then cut up into different lengths, which were separately annealed at different temperatures both in a vacuum and in hydrogen, and tested for conductivity. The effect of the different annealings on vacuum in relation to conductivity is shown by the following figures: the conductivities of the samples were calculated from measurements of resistance, length, weight, and specific gravity.

According to Dr. Kiliani, the back E.M.F. is 0·12 volt, which has to be overcome with each pair of electrodes in the electrolyte under normal conditions. This back E.M.F. is due to the polarisation at the surface of the anode, and increases with the impurity of the raw copper used.

Table VII.

Annealed in a Vacuum.		Annealed in Hydrogen.	
Annealing temperature.	Conductivity.	Annealing temperature.	Conductivity.
°C.	Per cent.	°C.	Per cent.
20	101·5	20	99·0
37	101·5	45	99·0
54	101·5	105	99·3
118	101·6	234	99·8
215	102·0	360	101·0
300	102·1	483	101·9
600	102·4	1,050	189·33
755	102·7	...	...
930	99·0	...	...

The following figures give the approximate cost of producing electrical energy on a large scale with condensing engines, the co per kilowatt hour working out to 0·3995, in which case the cost of the electrical energy required to deposit one ton of copper is 14s. 5d. A large installation of 10,000 H.P. is now being put up near Manchester, which will supply electricity at ½d. per kilowatt:—

Estimated Cost of Working a 2,100 kw. Plant, the price being based on that prevailing in England.

(Staff arranged in three shifts for continuous running of 150 hours per week.)

Stokers	6 at	£1	13	3	per week	£9	0	0
Trimmers	3 ,,	1	4	6	,,	3	13	6
Engine drivers	6 ,,	1	17	6	,,	11	5	0
Oilers	12 ,,	1	8	0	,,	16	16	0
Dynamo & switchboard hands	6 ,,	1	8	0	,,	8	8	0
Superintendent	1 ,,	4	0	0	,,	4	0	0
Total wages per week						£53	2	6

(At 150 hours = 7s. 1d. per hour.)

Per Kilowatt Hour.

Salaries and wages	0·0405d.
Coal, 2·4lb. at 16s. per ton	0·2050d.
Water, at 6d. per 1,000 gallons	0·0014d.
Oil and sundry stores, waste, &c.	0·0400d.
Standing charges, office expenses, rent, insurance, &c.	0·0300d.
Repairs	0·0100d.
Interest on capital £29,000 at 5 per cent.	0·0222d.*
Interest on buildings £5,000 at 5 per cent.	0·0038d.*
Depreciation on plant 10 per cent.	0·0443d.*
Depreciation on buildings 3 per cent.	0·0023d.*
Total cost per unit generated	0·3995d.

The Anaconda Mining Co. has recently made public the cost of electrolytic refining during the year 1897 to 1898 at its works at Anaconda, Montana; the figures given are as follows:—

Assay expenses and salaries	£3,062	7	8½
Electric light	475	11	11
Expenses	775	16	2
Labour	28,408	13	2
Legal expenses	426	7	1
Power house expenses, coal	27,589	0	8½
Ditto ditto labour	9,880	9	10
Do. do. machinery and repairs	4,020	19	7

Making a total of £42,812. 6s. 6d. for power, of which £1,250 was charged to silver mill, leaving a net expense of £41,562. 6s. 6d. for power for the electrolytic refinery.

For recasting scrap-anodes	£3,585	4	8
Regenerating plant expenses	2,460	5	9½
Salaries, including management	3,252	9	11½
Stable expenses	391	17	6
Sundry supplies	2,362	6	6
Switching product	181	5	0
Taxes	1,146	19	3
Repairs on buildings	1,076	8	5
Repairs on machinery	1,521	0	11
On refining tanks	1,659	2	1½
Making a total of	£92.398	7	11½

The output of electrolytic copper was 59,505,711lb., consequently the cost of production was 3s 1½d. per cwt, or £3. 2s. 6d. per ton.

In the above calculations the dollar was taken at 4s. 2d.

DISCUSSION.

Mr. HENRY WILDE sent a letter in which he pointed out that the process described in the Paper was identical with one patented by himself in 1875 (No. 4,515), and which had been successfully in operation in Manchester for more than 20 years. He enclosed extracts from the specification claims, and stated that a good description of the patent was to be found in A. Watt's "Electro-Deposition." Nevertheless he thought Mr. Cowper-Coles had rendered a real benefit to the electro-chemical industry by describing his own system.

* On basis of working 50 weeks in the year.

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Mr. W. M. MORDEY suggested that the author should, if he had time, insert in Table VII. the resistances as well as conductivities.

Mr. S. Z. de FERRANTI said that when he was in Paris some six or seven years ago he saw an almost identical process at work there. It was not being worked commercially, but in a laboratory for the purpose of demonstrating with a view to selling the patents. The process was specially arranged for deposition from thin plates at a very high current density, and gave a uniformly good result. The difference was that the mandrel was horizontal instead of vertical, and the cylinder was only half covered with the electrolyte. The cylinder was a fairly large one—about 2ft. 6in. to 3ft. in diameter—and was revolved very rapidly. The copper strip which was deposited upon the mandrel was beautifully smooth and regular when it was stripped off, and the current density was exceedingly high. Mr. R. B. Saunders, of Eastbourne, had also worked in this direction. This gentleman was, he believed, at one time a manager of one of the Elmore works. In his case he coiled wire spirally upon an insulated mandrel, and this mandrel, which was covered with the copper wire and three-parts immersed in the solution, was rotated at about 100 revolutions per minute. Mr. Saunders found he could work at a very high current density, and the most beautifully-deposited copper was produced upon the wire spiral. The depositing went on until the copper was in sufficient quantity to be taken off the mandrel by uncoiling. The wire was then drawn through a few dies, and produced the most beautiful results. He (Mr. Ferranti) thought very highly of that process. It had not, however, been applied commercially in this country, because of the prevailing idea that it was not possible to produce copper wire more cheaply by this method than by the old-fashioned method, which had been well worked out up to now.

Mr. G. L. ADDENBROOKE asked Mr. Cowper-Coles if he would kindly tell them in what particulars his process really differed from the process which Mr. Swan described some time ago at the Royal Institution. Mr. Coles referred to the fact that Mr. Swan had mentioned that the smoothness of the deposit depended on the absence of solid particles, but at Mr. Swan's lectures he had also shown very conclusively the effects of rapid motion. Certainly the motion in Mr. Swan's method was not centrifugal, but he had exhibited a number of plates in which the copper deposited was produced by moving them at a very rapid rate in the solution, and he had also shown how this motion produced a perfectly even deposit, and he also had been able to use very great current densities. It seemed to him that the two processes were the same, and although there might be a mechanical application of Mr. Cowper-Coles' system which might be very good, it would be useful to know where the difference really came in.

The PRESIDENT (Prof. S. P. Thompson) said that in Mr. Wilde's specification he noted that a rapid whirling motion was imparted to the solution, and thus the system seemed to be the converse to that described by the author of the Paper. Mr. Wilde whirled the solution round, whilst Mr. Cowper-Coles whirled the mandrel round and kept the solution still, or at any rate going at a slower rate. One thing that interested him exceedingly in Mr. Coles' description was that the difference between the rough and nodular deposit and the very smooth deposit which he had obtained, and of which pictures had been shown, was so great. They had been told that at a certain high speed it was possible to whirl the mandrel round at a slower speed without producing much effect, but they had not been told what this limit was. Could it be given as a surface speed of feet per second? Some deposits had been obtained with a peripheral speed of 500ft. per minute. With reference to the question of conductivity which had been raised, he said it might be known to some present that a committee of the Institution had been at work putting together the information that existed as to the conductivity of standard copper, with a view to establishing authoritatively what was the standard of purity of copper. They were supposed to be working nowadays to Matthiesson's standard of 1862, but he was afraid that none of the actual samples are exactly the same as Matthiesson's standard was, and in the report of this committee—which, by the way, would appear in full in the January number of the *Journal*—these facts were put before them and brought up to date. In this report the specific resistances of different coppers were given, and also their values were given in terms of conductivity, Matthiesson's standard being regarded as 100 per cent. In 1862 it was supposed that Matthiesson had absolutely purified his copper, and that this would have a conductivity of 100 per cent. Nowadays the standard seemed to have reached 102 per cent. as compared with the old standard. There was some reason for observing the standard in terms of conductivity, although he agreed that it would be an advantage to have the absolute resistance set down in ohms also by the side of the diameter. Perhaps Mr. Cowper-Coles could give them some further information as to what was the standard he took in giving the conductivity. Did he mean that this was equal to Matthiesson's standard?

Mr. COWPER-COLES, replying, stated that, with reference to Mr. Wilde's letter, he did not claim anything new for revolving the cathode. This had been done for a great number of years—he himself had done so for 10 years. All he claimed to have found out was that centrifugal force had a great effect upon the deposit of copper when using high current densities. He was well acquainted with Mr. Wilde's patent, and from this patent it was evident that he had not appreciated the advantages of revolving the mandrel and utilising centrifugal force, because it was particularly mentioned in this patent that instead of revolving the cathode he used a propeller or some means of circulating the electrolyte rapidly. If this was the alternative method, it showed that Mr. Wilde had not realised that centrifugal force could not be brought into play, and thus get a smooth and pure deposit of copper. He had never read Mr. Swan's Paper, but had often talked with him about his process. Mr. Swan's experiments, he understood, were made with horizontal cathodes, and not perpendicular, and that he had got good rough deposits which however, showed the lines of rotation, and this of course spoiled the copper deposit. The limit of speed, mentioned by the President, apparently should not be less than 1,000ft. per minute. He had shown on the screen some copper tubes that were produced at 60 revolutions per minute, where the deposit was quite loose. With reference to Mr. Mordey's suggestion, he said this would no doubt be an advantage, and if he were allowed, he would add another column giving the resistances in ohms when the Paper was published in the *Journal*. He thought there was a good deal of difference between the processes described by Mr. Ferranti and his own. So far as he had been able to gather from the particulars M. Ferranti had given them, there had been no idea of using centrifugal force to throw off the impurities and gas bubbles) which were really the cause of getting bad deposits. The tubes he himself had shown them had not been touched mechanically at all.

The PRESIDENT, in proposing a hearty vote of thanks to Mr. Cowper-Coles, said they did not often have Papers on electrolytic processes, and when they did it was well that they should recognise the importance of this branch of the electrical industry, and he hoped they would have other Papers on electro-metallurgical subjects as time went on. Anything that would produce a purer and cheaper copper, or a pure copper which was more mechanically good than they had had before, was very much to the goodo f the electrical industry as a whole.

The vote of thanks having been passed by acclamation, the meeting adjourned.

ALUMINIUM FEEDERS FOR ELECTRIC RAILWAYS.*

The use of aluminium for electrical purposes is making considerable advances in America, and is tending apparently towards eliminating copper from its long-timed electrical monopoly. The latest success of the new metal is recorded in connection with the Chicago North-Western Elevated Railroad, where aluminium feeders have been adopted for the whole of its extensive electrical system. Over 24 miles of single track are being equipped for heavy traffic by means of electrical motors, something like 70 tons of aluminium having been purchased for the purpose. A considerable portion of the new metal has been put into place, so that it is now possible to observe the methods used for handling the wire, and the manner in which some of the difficulties in its use are being overcome.

Briefly, the North-Western Elevated Railroad consists of 5½ miles of four-track elevated structure and one mile of double-track structure. Throughout the four-track structures an express and local service will be maintained. The express service will be fast, with stops a mile apart; the local service will be slower, with stations every 500 yards. The well-known third-rail system has been installed throughout. Equipment consisting of heavy motor cars and lighter trail cars will be employed, of a general appearance closely resembling the equipment in use on the Metropolitan and Lake-street elevated roads in Chicago. The power house for the line is located at between 1,000 and 1,300 yards from the structure.

As may be well guessed, the reason why aluminium was decided on for the feeder system of the North-Western Elevated Railroad over copper was its greater cheapness with equal degree of efficiency. In March, 1899, when the question came up, it was shown that 48lb. of aluminium of the conductivity offered to the road was equal in current-carrying power to 100lb. of copper of the ordinary 98 per cent. conductivity. As copper at that time was quoted in the market at 18 cents a pound, this was equal to 36½ cents a pound for aluminium, whereas the actual market price for aluminium was then only 30 cents. As a matter of fact, something over $8,000 was saved by this decision.

The aluminium bought for the North-Western Elevated Railroad is entirely for the feeder system, and is confined to the elevated portion of the line. From the power house to the line the current is transmitted by lead-covered copper cables, which run along in vitrified clay conduits. Over 2·48 sq. in. copper section in copper cables are carried in the conduit. The 40 ducts of the conduits also carry eight 0·79 sq. in. tinned bare copper return cables, which connect the line with the negative side of the switchboard. At the junction of Dunning-street and the North-Western Elevated line six manholes are located, out of each of which six 3in. wrought-iron pipes run up pillars of the line. The 36 pipes carry the lead-covered copper up to its point of junction with the aluminium, and also bring back the return cables attached to the ironwork of the structure. In this connection it may be noted that the entire structure is used as a return, each rail of the track being bonded to the ironwork with a flexible bond, no bonds being used at joints except in the case of the trolley rails.

The aluminium feeders run from the point of junction with the underground system to the taps for the trolley rails on all parts of the structure. They consist of bare stranded cables of three sizes, 0·92, 0·80, and 0·69 sq. in. total sectional area of conductor, though there is but little of the last size used. The largest size is, roughly speaking, about 1½in. in diameter. It is "cable laid," consisting of 49 separate strands, and is astonishingly strong for its weight. The wire is handled in large spools of the size used for large copper cables. The spools, however, instead of weighing 3,800lb. to 4,600lb., as in the case of copper, only weigh about 1,600lb. The advantages in ease and cheapness of handling are evident.

* Abstract from the *American Electrician*.

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These bare aluminium cables are laid in a feeder box built of pine, along the centre of the structure. There are in all about 4½ miles of the boxing, of varying width, according to the number of cables carried. The largest number of cables in the boxing is eight, and the smallest two. The track is divided into five sections, each getting its quota of cables. Besides the aluminium feeders, the boxing also carries a 30-pair telephone cable for communication with the stations, and a 0·46 sq. in. insulated copper cable for lighting purposes.

The aluminium cables are laid in the feeder box on vitrified clay insulators placed on cross ties every 9ft. Every twentieth set of supports consists of Anderson split-spool insulators, which are clamped tight to the wire and give the needed strain. On the curves the vitrified clay supports and the iron chairs alternate. After the wires are put in place in the boxing the latter is covered over and forms a footway in the centre of the structure. Loose covers or lids are left at each insulator for access in case of repairs or changes. It is evident that this method places practically no reliance on the tensile strength of the aluminium cables, since they are supported every 9ft. and anchored every 180ft. Questions of insulation for the cables are also avoided.

The ends of the aluminium cables are anchored in a singular and highly effective manner. To the cable are soldered large copper connectors, which in turn are attached to Brooklyn strain insulators made for the purpose. These latter are held by heavy bare iron wires attached to eye-bolts in wooden cross-pieces. The copper connectors have another opening for copper wire of a carrying capacity equal to the aluminium. This arrangement is used where the underground wires connect with the aluminium feeders on the structure, and also at all special work and points where the path of the feeder boxing is interrupted. In such cases as the latter the ends of the aluminium cables are anchored, and insulated copper wire is run down under the tracks and past the obstruction, being connected with the ends of the aluminium cables again beyond.

This scheme for anchoring the ends of the cables also exemplifies how the cables are spliced. For the successful carrying out of all splicing operations, which have always been considered one of the most difficult points in the electrical use of aluminium, a remarkably simple method has been adopted. A plain copper connector of the ordinary type receives the two ends of the wire, which are then soldered fast into the connector. The only difficult point is the question of solder. This has been successfully solved by a machinist who works for the North-Western Elevated Railroad. After considerable experimentation, he has found a composition of metals which will not only successfully solder aluminium to copper, but also aluminium to aluminium.

Connectors are also used in making taps from the aluminium feeder cables to the trolley rail. This trolley rail is raised up on double petticoated insulators above a wooden string piece, the joints being well bonded by flexible bonds. Taps run from the feeder cables to it every 1,500ft. to 2,000ft. Either one or two strands of 0000 insulated copper cables are used for the taps, except at the ends of the feeders, where a tap of practically the same carrying capacity as the cable is used. These taps are soldered to copper clamps, which are tinned and then screwed tight around the feeder cables. The clamps are not soldered to the aluminium, pressure alone being relied on for a good contact. The junctions with the cables are covered with tar or pitch paint. At the other end the taps are soldered to copper plates, which are riveted to the trolley rails.

ELECTRICITY WORKS ACCOUNTS.

Croydon Municipal Electric Supply Works.

Although electric supply at Croydon was commenced in November, 1896, the works were run by the British Thomson-Houston Co.—the contractors—up to March 25, 1898, when the concern was taken over by the Corporation. In our table we give our analysis of the accounts covering the two years ended March 25 last, thus including one year of company and one of municipal control.

It is a pleasure to be able to record such results as the costs figures in our table indicate. These figures—even those of the first year of working—would have been none other than satisfactory as the results of a much older concern blessed with a cheaper coal supply than it is evident obtains at Croydon.

During the year ended at March 25 last the equivalent lamp connections have made the large increase of from 17,514 to 31,432 8 c p. lamps, an advance of nearly 80 per cent., with 201 new consumers. Similar progress is betrayed in the output, which shows an increase of 77 per cent. The load factor in both years stood at a very average figure—viz., 10·6 per cent. and 10·9 per cent. respectively.

Reverting to a consideration of the costs, the fuel item in both years attracts attention as being above the average. Oil, waste, &c., at 0·16d. per unit in the first year, was but slightly in excess of the average, while in the second year this item had fallen to a value far below the normal. Both wages and repairs at the station showed figures in both years which are abnormally low at the output. Finally, it is highly creditable that in the first year the aggregate works costs should come out at a very fair average at the output, while in the second year they, together with the total costs in both years, are considerably below the normal in similar conditions of output and load factor.

The working profits secured are no exception to the generally satisfactory aspect of the accounts, while, with the moderate total revenue secured in both years, the figures 61·2 and 43·2, representing the per cent. ratio of the costs to the revenue, are exceedingly satisfactory results.

It is to be hoped it will be found possible to maintain the excellent economic position which characterises the opening two years of the existence of this undertaking.

Bath Municipal Electric Supply Works.

Started in the end of 1889 under the *ægis* of the City of Bath Electric Lighting and Engineering Co. (Ltd), this undertaking was, about seven years later, acquired by the Corporation of Bath. The two years' accounts presented in our table are therefore those of the eighth and ninth completed years of working, or the first and second years under municipal control.

On the whole, the costs of 1898 indicate material improvement over those of 1897, but there was, and there is still, room for considerably better results than those shown in our table, considering how long the works have existed and the comparatively favourable load factor which prevails. In 1897 this factor was 11·4 per cent., and in 1898 12·3 per cent.—values both above the average. It is evident that it is the fuel item which constitutes *the* burden of the concern. The expenditure on this score was no less than double the average in municipal stations at the output of the Bath station, and were it not for this abnormal item the aggregate costs would stand at a reasonable figure.

Owing to a diminished revenue, the gross profit has fallen. Moreover, in consequence of the greatly increased expenditure on capital account, the interest and sinking fund charges are much increased, resulting in a loss for the year of £771, out of which £645 has been met by the credit balance brought forward from 1897.

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

Aberdeen (Municipal)	Jan.	12, 1900	Lancaster (Municipal)	Jan.	19, 1900
Ayr (Municipal)	Sept.	22, 1899	Leeds (Municipal)	Dec.	1, 1899
Bedford (Municipal)	May	19, ,,	Leicester (Municipal)	Jan.	26, 1900
Belfast (Municipal)	Sept.	15, ,,	Leyton (Municipal)	Sept.	8, 1899
Birmingham (Company)	Sept.	15, ,,	Liverpool (Municipal)	June	9, ,,
Blackburn (Municipal)	Jan.	19, 1900	Manchester (Municipal)	Aug.	11, ,,
Blackpool (Municipal)	Sept.	29, 1899	Newcastle and District (Co.)	Oct.	6, ,,
Bournemouth (Company)	April	29, ,,	Newcastle-upon-Tyne (Co.)	April	14, ,,
Bolton (Municipal)	Nov.	24, ,,	Newport (Mon.) (Municipal)	Dec.	15, ,,
Bradford (Municipal)	April	14, ,,	Northampton (Company)	Oct.	20, ,,
Brighton (Municipal)	May	12, ,,	Norwich (Company)	Nov.	17, ,,
Bristol (Municipal)	July	14, ,,	Notting Hill (Company)	Mar.	17, ,,
Burnley (Municipal)	Aug.	25, ,,	Nottingham (Municipal)	July	21, ,,
Burton-upon-Trent (Mun.)	April	21, ,,	Oldham (Municipal)	Dec.	1, ,,
Bury (Municipal)	Sept.	22, ,,	Oxford (Company)	May	19, ,,
Cambridge (Company)	Mar.	10, ,,	Pontypool (Company)	May	5, ,,
Cardiff (Municipal)	Dec.	15, ,,	Portsmouth (Municipal)	July	14, ,,
Charing Cross (Company)	Mar.	17, ,,	Prescot (Company)	Dec.	8, ,,
Chelsea (Company)	Mar.	31, ,,	Preston (Company)	Sept.	29, ,,
Cheltenham (Municipal)	Nov.	10, ,,	Reading (Company)	Oct.	13, ,,
Chester (Municipal)	June	23, ,,	Richmond (Company)	Oct.	13, ,,
City of London (Company)	May	12, ,,	Scarborough (Company)	Nov.	3, ,,
Clerkenwell (Company)	Aug.	18, ,,	St. Helens (Municipal)	Dec.	8, ,,
Derby (Municipal)	Jan.	26, 1900	St. James' & Pall Mall (Co.)	Feb.	24, ,,
Dewsbury (Municipal)	Nov.	24, 1899	St. Pancras (Vestry)	May	26, ,,
Dover (Company)	June	2, ,,	Sheffield (Municipal)	Dec.	29, ,,
Dundee (Municipal)	Jan.	12, 1900	Shoreditch (Vestry)	Oct.	27, ,,
Eastbourne (Company)	Feb.	2, ,,	Southampton (Municipal)	Nov.	10, ,,
Edinburgh (Municipal)	Nov.	17, 1899	Southport (Municipal)	July	7, ,,
Exeter (Municipal)	Aug.	5, 1898	South Shields (Municipal)	July	7, ,,
Glasgow (Municipal)	Sept.	1, 1899	Stafford (Municipal)	Dec.	29, ,,
Guildford (Company)	May	5, ,,	Sunderland (Municipal)	July	28, ,,
Halifax (Municipal)	July	21, ,,	Taunton (Municipal)	June	16, ,,
Hammersmith (Vestry)	May	26, ,,	Tunbridge Wells (Mun.)	Sept.	1, ,,
Hampstead (Vestry)	Aug.	25, ,,	Wakefield (Municipal)	Dec.	1, ,,
Hanley (Municipal)	April	28, ,,	Walsall (Municipal)	June	23, ,,
Harrogate (Municipal)	Oct.	20, ,,	Wandsworth (Company)	Aug.	19, ,,
Harrow (Company)	June	16, ,,	Westminster (Company)	Feb.	24, ,,
Hast'gs & St. Leonards (Co.)	Feb.	2, 1900	Whitehaven (Municipal)	July	28, ,,
H'use-to-H'useCo. (K'ns'gt'n)	Mar.	31, 1899	Windsor (Company)	Dec.	22, ,,
Hove (Company)	Mar.	10, ,,	Woking (Company)	Dec.	22, ,,
Huddersfield (Municipal)	Oct.	6, ,,	Wolverhampton (Municipal)	June	30, ,,
Islington (Vestry)	Oct.	27, ,,	Woolwich (Company)	Jan.	12, ,,
Kens'gton & Knightsbr' (Co.)	Mar.	3, ,,	Worcester (Municipal)	April	7, ,,
Kingston-upon-Hull (Mun.)	June	9, ,,	Yarmouth (Municipal)	Nov.	3, ,,
Kingston-on-Thames (Mun.)	April	21, ,,			

	BATH.		CROYDON.	
Undertaking Worked by	Bath Corporation.		Croydon Corporation.	
Date of Commencement of Supply	December, 1889.		November, 1896.[a]	
System of Supply	Alt.-current trans.	[house transformers.	Alternate-current sub-stations, two-wire.	
Chief Engineer	G. F. Metzger.		T. Herbert Minshall.	
YEAR ENDED	DEC. 31, **1897.**	DEC. 31, **1898.**	MAR. 25, **1898.**	MAR. 25, **1899.**
QUANTITIES—				
Units generated	514,224	537,052	374,609	619,849
„ SOLD (TOTAL)	314,720	356,700	255,309	451,664
„ sold to consumers	176,520	187,315	174,889	340,717
„ sold for public lighting, &c.	138,200	169,385	80,420	110,947
„ used on works	17,375	19,800	89,302	102,193
UNITS SOLD PER 8 C.P. LAMP CAPACITY	33·55	11·4	20·9	16·2
Maximum supply demanded	315	330	275 kilowatts	472·5 kilowatts
Number of public lamps	84 arc	88 arc, 21 (16 c.p.) glow	47 arc	75 arc, 4 (32 c.p.) glow
Number of consumers	185[a]	221[b]	214	415
Connections to mains in 8-c.p. lamps	14,153	17,802	17,514	31,432
CAPACITY OF PLANT IN 8-C.P. LAMPS	9,380	31,240	12,190	27,800
CAPACITY OF PLANT IN KILOWATTS	300	1,000	390	890
CAPITAL—	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.
AUTHORISED (TOTAL)	£50,378 / £168	£50,823 / £50·8	£47,900 / £123	£84,984 / £95·4
Share	— / —	— / —	— / —	— / —
Loan (including Debenture charges)	50,378 / 168	50,823 / 50·8	47,900 / 123	84,984 / 95·4
RECEIVED (TOTAL)	32,834[c] / 109	50,823 / 50·8	37,400 / 95·9	37,400 / 42·0
Share	— / —	— / —	— / —	— / —
Loan (including Debenture charges)	nil / —	50,823 / 50·8	37,400 / 95·9	37,400 / 42·0
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	— / —	nil / —	10,500 / 26·9	47,584 / 53·5
Share (unissued)	— / —	— / —	— / —	— / —
Share (uncalled)	— / —	— / —	— / —	— / —
Loan (including Debentures)	— / —	nil / —	10,500 / 26·9	47,584 / 53·5
REPAID (TOTAL)	— / —	— / —	— / —	— / —
RESERVE OR SINKING FUND	600 / 2·00	1,347 / 1·35	— / —	— / —
DEPRECIATION FUND	— / —	— / —	— / —	— / —
EXPENDED (TOTAL)	32,938 / 110	51,562 / 51·6	43,230 / 111	88,561 / 99·6
Lands and buildings	7,445 / 24·8	11,958 / 12·0	9,266 / 23·7	15,511 / 17·4
Plant	14,830 / 49·4	25,112 / 25·1	17,834[b] / 45·7	36,089[e] / 40·6
Mains	9,820 / 32·7	12,553 / 12·6	16,130 / 41·4	34,825 / 39·1
Miscellaneous	844 / 2·81	1,941 / 1·94	— / —	2,136[f] / 2·40
BALANCE OF CAPITAL ACCOUNT	−104[d] / −0·35	−739[d] / −0·74	−5,830[c] / −14·9	−51,161[c] / −57·5
REVENUE—	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.
TOTAL	£7,010 / 5·340d.	£7,113 / 4·780d.	£5,070 / 4·770d.	£9,394 / 4·993d.
Revenue from supply	4,182 / 3·190d.	4,374 / 2·940d.	4,169 / 3·910d.	7,980 / 4·240d.
„ meters, &c.	219 / 0·167d.	237 / 0·159d.	101 / —	203 / 0·108d.
„ public lighting	2,118 / 1·615d.	2,291 / 1·541d.	800 / 0·753d.	1,212 / 0·644d.
„ sale of lamps, &c.	395 / 0·301d.	123 / —	— / —	— / —
„ miscellaneous sources	95 / 0·072d.	83 / 0·059d.	— / —	— / —
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	£5,321 / 4·058d.	£5,635 / 3·789d.	£3,100 / 2·918d.	£4,053 / 2·153d.
WORKS COSTS	4,066 / 3·100d.	4,108 / 2·763d.	2,364 / 2·224d.	2,895 / 1·538d.
Generation of electricity	*3,215 / 2·450d.*	*3,552 / 2·389d.*	*2,117 / 1·992d.*	*2,632 / 1·346d.*
Fuel (including cartage, &c.)	1,871 / 1·426d.	2,107 / 1·418d.	1,351 / 1·271d.	1,721 / 0·915d.
Oil, waste, water, stores	386 / 0·294d.	432 / 0·291d.	168 / 0·158d.	170 / 0·090d.
Wages at station	611 / 0·466d.	675 / 0·454d.	473 / 0·445d.	544 / 0·289d.
Repairs and maintenance at station	334 / 0·255d.	275 / 0·185d.	125 / 0·118d.	97 / 0·052d.
Distribution of electricity	*343 / 0·261d.*	*113 / 0·076d.*	*46 / 0·043d.*	*114 / 0·061d.*
Wages, &c.	11 / 0·008d.	113 / 0·076d.	36 / 0·034d.	69 / 0·037d.
Repairs, renewals of mains, &c.	332 / 0·253d.		9 / 0·008d.	45 / 0·024d.
Public lighting	*508 / 0·387d.*	*443 / 0·298d.*	*201 / 0·189d.*	*249 / 0·132d.*
Attendance	503 / 0·387d.	443 / 0·298d.	107 / 0·101d.	116 / 0·062d.
Renewals			94 / 0·088d.	133 / 0·071d.
MANAGEMENT AND PROPERTY CHARGES	1,255 / 0·956d.	1,526 / 1·026d.	738 / 0·694d.	1,158 / 0·616d.
Royalties	— / —	— / —	— / —	— / —
Rent, rates, taxes	*181 / 0·138d.*	*137 / 0·092d.*	*118[d] / 0·111d.*	*160 / 0·085d.*
Management	*1,074 / 0·819d.*	*1,389 / 0·934d.*	*630 / 0·583d.*	*998 / 0·531d.*
Salaries	946 / 0·721d.	1,217 / 0·819d.	522 / 0·491d.	688 / 0·366d.
Stationery, &c.	48 / 0·037d.	40 / 0·027d.	98 / 0·092d.	112 / 0·060d.
Establishment charges	48 / 0·037d.	49 / 0·033d.		106 / 0·056d.
Law charges, &c.	32[e] / 0·024d.	83[e] / 0·056d.		92[g] / 0·049d.
FINANCIAL RESULTS—	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded
WORKING PROFIT FOR YEAR	£1,689 / 5·13%[g]	£1,478 / 3·50%	£1,970 / 4·56%[h]	£5,340 / 8·11%
Sum carried to Depreciation Fund	— / —	— / —	— / —	— / —
Sum carried to Reserve or Sinking Fund	600 / 1·82%[g]	747 / 1·77%	— / —	1,935 / 3·01%
Net interest on loans (incl. Debenture charges)	707 / 2·15%[g]	1,501 / 3·55%	— / —	2,108 / 3·20%
BALANCE FROM LAST ACCOUNT	— / —	645 / 1·53%	— / —	— / —
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	645[f] / 1·96%[g]	— / —	— / —	1,248 / 1·89%
Deficit	— / —	*126 / 0·298%*	— / —	— / —
ORDINARY DIVIDEND PAID	— / —	— / —	— / —	— / —
PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE	75·9%	79·3%	61·2%	43·2%
Expenditure per kilowatt capacity	£17. 14s. 7d.	£5. 12s. 8d.	£7. 18s. 0d.	£4. 11s. 1d.
REVENUE PER KILOWATT CAPACITY	£23. 7s. 0d.	£7. 2s. 3d.	£13. 0s. 0d.	£10. 11s. 2d.
Expenditure per 8-c. lamp capacity	10s. 10d.	3s. 7½d.	5s. 1d.	2s. 11d.
REVENUE PER 8-C.P. LAMP CAPACITY	14s. 11½d.	4s. 6½d.	10s. 4d.	6s. 9d.
REVENUE PER 8-C.P. LAMP CONNECTED	9s. 10⅞d.	8s. 0d.	5s. 9½d.	5s. 11⅞d.
Price charged for lighting, per unit	6d. to 4½d.	6d. to 4½d.	6d.	6d.
Price charged for power, per unit	3d. [ann.	3d. [ann.	3d.	3d.
Price charged for public lighting	£25. 17s. 6d. per arc per	£25. 17s. 6d. per arc per	2d.	2d.

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The Oldest Electrical Journal (established as a weekly Journal 1861—1878

Published every Friday, Price Sixpence; Post Free, Sixpence-Halfpenny

Editorial, Publishing and Printing Offices,

1, 2 & 3, SALISBURY COURT, FLEET ST., LONDON,

Telephone: 949 Holborn. *Telegrams:* "ELECTRICIAN NEWSPAPER LONDON."

All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher "THE ELECTRICIAN," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN" *Printing and Publishing Company, Limited, and be crossed* "*Coutts and Co.*"

All Editorial letters to be addressed to THE EDITOR.

All letters for insertion in "THE ELECTRICIAN," *or containing questions, must be accompanied by the name and address of the writer as evidence of good faith. No notice whatever is taken of anonymous communications.*

"THE ELECTRICIAN" *is published every Friday morning, in time for the morning mails. It is on sale at the railway bookstalls throughout the Kingdom on Friday morning, and can be obtained of all Booksellers and Newsvendors; or direct from the Publishing Offices, as above*

New Volumes of "THE ELECTRICIAN" *commence in April and October.*

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PROGRESS IN WIRELESS TELEGRAPHY.

The large hall at the Royal Institution was crowded last Friday by an audience anxious to hear what Mr. MARCONI had to say on the subject of wireless telegraphy. In spite of the severity of the weather, the seating accommodation was filled long before the time down for the commencement of the discourse, and by nine o'clock every available corner of "standing room" was also taken up. As usual, the assembly was a mixed one, from our neighbour who regretted he had not had time to read up the subject in the "Encyclopædia Britannica" beforehand, to the scientist who came with the hope of hearing the announcement of a new discovery. The audience included also a large proportion of the fairer sex, a number of whom were old *habituées*. As is necessary in the case of a Friday evening entertainment at the Royal Institution, a part of the lecture was devoted to elementary explanations; but as a whole Mr. MARCONI'S discourse was most interesting, and enabled an idea to be formed of the progress he, at any rate, had made since his Paper before the Institution of Electrical Engineers. What other workers have done recently still remains to be disclosed.

The first point that will strike the expert on reading the account of the lecture, given in another part of this issue, is the extreme diminution which the filings gap of the coherer has undergone. The width of filings between the two silver electrodes has now been reduced to one millimetre, and if a further reduction is made the tube will soon approximate to Dr. LODGE'S point coherer, with the exception that the gap is *in vacuo*. A far more important practical improvement, however, is in the introduction of a special form of induction coil in connection with the receiving instruments; for Mr. MARCONI states that, merely by adding this simple appliance to the apparatus employed during the naval manœuvres, and without otherwise altering the conditions in any way, the maximum possible signalling distance was increased from seven to 60 miles. Dr. LODGE and Prof. FESSENDEN have also been experimenting independently with transformers in the receiving circuit, but their published results tell nothing of such a great effect as this. But if the effect of the transformer is remarkable, still more remarkable is the difference

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in the result according to the manner in which the coil is wound. An ordinary step-up induction coil, connected in the same position with its primary between the vertical wire and earth and its secondary in circuit with the battery and coherer, actually proved detrimental. A fuller description of the various methods of winding, and also a table of dimensions, will be found in the patent specification which we recently published (*The Electrician*, Vol. XLIII., p. 848). As hitherto, Mr. MARCONI still apparently confines his attention to experimental work, and makes little attempt to explain his startling results theoretically. In this instance he merely throws out the vague suggestion that the operation of the particular form of winding shown is "to prevent the effects due to electromagnetic induction from being in opposition to the electrostatic induction at the ends of the primary." Now that his results have been made public, it is to be hoped that scientists will apply themselves to working out the reasons for these phenomena, and that this will enable a still greater advance to be made—perhaps in the direction of producing syntonous apparatus and eliminating the interference between independent sets of instruments and lines of signalling. In spite of the announcement, made some time ago, that Mr. MARCONI had succeeded in confining wireless telegraphic messages to the instruments destined for their reception, no word was said of this matter in his discourse. This was disappointing.

So much for the improvements made in the apparatus. The latter part of the lecture was devoted to an account of recent practical applications. The various trials made, which have been recorded from time to time in our columns, were recapitulated; but Mr. MARCONI forgot to mention the really permanent wireless telegraphic stations made by Lieut. TISSOT with DUCRETET apparatus between lighthouses on the coast of France. Wireless telegraphy is evidently far enough advanced to be extensively employed for such purposes, and for signalling to ships at sea, whether for peaceful or warlike purposes. No doubt also the time will soon come when lighthouses will be fitted with Hertzian-ray projectors for use in foggy weather. What is interesting the public mind most at the present moment, however, is the extent of the adaptability of this method of telegraphy to military operations on land. Without a doubt, had Kimberley and Ladysmith been provided with wireless telegraphic apparatus, signalling between the beleaguered garrisons and the relieving forces would have been greatly facilitated: it could have been conducted with absolute secrecy, and daily communication would have been possible much sooner. Yet the War Office can hardly be blamed seriously for not sending out induction coils, coherers, and accessories before the war began. Moreover, although we recognise the enterprise and bravery of Mr. BULLOCK and his staff of assistants, we cannot agree with Mr. MARCONI that the blame for the partial failure of their first efforts is wholly due to the much-maligned War Office. Criticisms of this department at the present time are prevalent enough elsewhere; they need not emanate from the lecture hall of the Royal Institution. Surely, if the Wireless Telegraph Co. is ordered to send out complete equipments, it should of its own accord have included in them the means of elevating their wires, which it knows to be as essential as the induction coil itself for long-distance signalling. And, finding these accessories omitted, should not the man in charge of this special signalling contingent remedy the omission on landing and before proceeding to the interior? The officers at the front, it might have been anticipated, had matters to attend to of more vital importance to the campaign than to make everything ready for the reception of the wireless signallers, who, it is allowed, arrived too late to be of material assistance. Much ingenuity was certainly shown in constructing kites for the purpose, but a few miniature balloons and a few cylinders of gas would no doubt have been more effective, and these might well have been included in the equipment brought from home. Failing these, suitable masts, or some other substitute, might no doubt have been obtained in Cape Town.

REVIEWS.

Copies of any of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price.)

Théorie de Potentiel Newtonien. By H. POINCARÉ. (Paris: MM. Carré et Naud.) 14fr.

M. Poincaré is always clear and interesting. His work is always original, not the reproduction of other writers by means of scissors and gum. He assimilates the work of others, no doubt, but he reproduces it in a form which is his own. This book contains the lectures delivered by M. Poincaré during 1894-5 at the Sorbonne, and very illuminating lectures they must have been to those who had the privilege of attending them. But nowadays it is not necessary, as it was when the University of Paris was founded, for M. Poincaré's disciples to attend his lectures in Paris; they can purchase and read his lectures at home. He can now lecture to all the world. It is the great duty of universities to produce knowledge for the whole world, and their produce can be distributed with a rapidity undreamt of in former times. It is to be hoped that they will rise to their responsibilities, and not confine their attention to those who can attend in their halls.

This work of M. Poincaré's is suited to those who intend to devote themselves to the mathematical aspect of gravitation, electricity, and magnetism. The law of a potential varying inversely as the distance covers an immense field of natural phenomena, maybe the whole field, but M. Poincaré's work does not enter into any particular applications of the theory. From the point of view of one who values mathematics for its ability to solve some special physical problem in which he takes an interest, those lectures are dreadfully dry. They are the dry bones of theory, with no glimpse of application to material problems. Did we write *no* glimpse?—well, once he actually descends to a dim vision of reality, and suggests that the reader shall imagine a quantity of electricity spread over a conducting surface, S. But dry bones are most interesting to the specialist. To the palæontologist dry bones are the source of his most elaborate theories, and he would be glad if he had no worse. In the mind of an anatomist a skull may excite the most unbounded enthusiasm, and in the mind of the mathematician the various ways of solving the problem of Dirichlet, as expounded by M. Poincaré, will seem like a well-ordered sonata with its theme worked out in various movements all conspiring to produce a harmonious whole.

Many readers of *The Electrician* will, we fear, hardly appreciate this view of M. Poincaré's lectures. They would like something more tangible than "the surface S" and "the region T." They will mostly be quite satisfied that M. Poincaré, and before him Green and Gauss and many others, have proved that this potential is continuous in passing through the "surface S," and that its differential coefficients are continuous within the "region T." Some people will no doubt think that it is hardly worth while collecting together, even in orderly arrangement, a number of different, or apparently different, solutions of the problem of determining the potential over a region when its value over certain surfaces is given. They will say that what is wanted is the solution of this problem in some particular cases, and not a more orderly presentation of the general problem and its solutions than has been available up till now. To such persons M. Poincaré's lectures will seem of little value. There are, however, many who are trying to make these general theorems clear and intelligible to students of mathematical ability, to whom clear ideas must be given about the

general theorems if they are to extend our knowledge in particular cases, and to all such teachers M. Poincaré's lectures will be a fruitful field of research, where they can learn how a master mind has ordered his own teaching so as to bring these intricate problems of an almost transcendental character clearly before his pupils.—G. F. F-G.

A Text-Book of Physics. By W. Watson, B.Sc. Lond. (London: Longmans, Green and Co.) 15s. 6d.

This is in every way an excellent and valuable work. It is a volume of 900 pages, comprising five parts, or "Books," dealing with the subjects of (i.) Mechanics and the Properties of Matter; (ii.) Heat; (iii.) Wave Motion and Sound; (iv.) Light; and (v.) Magnetism and Electricity. It is well printed, and contains nearly 600 admirable illustrations, the majority of which have been specially made for this work, and many of them illustrating matter which is quite new so far as text-books are concerned. The book is intended primarily for the use of students already acquainted with the elements of the subject, but it may be used with advantage by less advanced readers, since the more difficult paragraphs are marked by asterisks.

English scientists have shown very little desire to write text-books on physics. Good special treatises have been written dealing with parts of the subject only, but for a survey of the whole science students have had hitherto to rely on translations from the French and German. The excellent text-books of Deschanel and Ganot are now out of date, but are still largely used by students. The present work presents many advantages over these. It is a volume of about the same size as Ganot, but contains much more matter, and is admirably up to date. It is not written in such an elementary style as Deschanel, and is published in one volume instead of in four. No doubt there is a difference of opinion whether a text-book of physics, dealing with the subject as exhaustively as this one does, is better published in a single volume or in several. Our own opinion is that it would have been much better published in four or five volumes. The author could then have given fuller descriptions with advantage. In spite of the fact that this book takes up 900 pages, the number of subjects dealt with is so great that in no case is the written explanation longer than is sufficient. There is not enough of that disguised repetition so useful, and indeed so necessary, in all teaching, whether oral or by means of printed matter. The descriptions are in all cases simple and straightforward, and the mathematics employed are of the most elementary kind. The result is a book which will be of the greatest value to the student who has got over his first difficulties; but the elementary student would be better served with fewer subjects, each illustrated and explained in several different ways. The amount of labour and research necessary to gather together the matter for this book must have been enormous. Teachers will be grateful for the result. It is a pity that comparatively few references to original Papers are given, for such references would have greatly increased the value of the work to the advanced student without appreciably increasing the labour of the author.

There is much to praise and little to criticise in the work as a whole. The most important feature of it is that it offers in a most accessible form an account of a large amount of recent scientific work which can otherwise only be obtained after laborious search among scientific Papers and special treatises. It would be invidious to select any of these for special mention. But electricians will be interested in the excellent illustrated accounts of the subject of terrestrial magnetism, the researches of Dewar and Fleming on the resistance of metals at low temperatures, those of Fleming on thermoelectricity, the subject of platinum thermometry, the work of Drs. Hopkinson and Morris on the effect of temperature on magnetism, Ewing's molecular theory of magnetism, the chapters on electrolysis and contact E.M.F., the calculation of E.M.F. from thermo-chemical data and the Helmholtz corrections thereto, the passage of electricity through gases, the electromagnetic theory, electrical oscillations, and wireless telegraphy.

On the other hand, we may notice one or two minor blemishes. Iron-filing figures are, we think, worse than useless unless they are extremely well done, and in all cases the figures obtained by the needle method are more precise and instructive. These latter have not yet found their way into text-books, and it is a pity the present work did not set the example. Most of the iron filing figures here given are good, but we do not see much use in such illustrations as Figs. 407 and 408, found on pages 596 and 597.

Again, on page 587 it is stated, in connection with the subject of Ohm's law, that if an electromotive force E is driving a current C between two points A and B of a wire, "Ohm found *by experiment* that the ratio of E to C was constant so long as the physical state [temperature, &c.] of the wire between A and B was the same." Now, we are much mistaken if this is correct. Ohm did *not* find out his law by experiment. He deduced it as a mathematical consequence from certain assumptions he made, these assumptions being of quite a debateable kind. What Ohm was the first to grasp was a clear conception of the distinctive nature of the quantities, electromotive force, current, and resistance. He stated his law in a precise form, as became a mathematician, but the experimental fact that the resistance of a conductor was a constant quantity independent of the current passing was not proved till years after he stated the law. In fact, when Ohm gave out his law in 1827, the Wheatstone bridge was not invented, and the measuring instruments available were of the crudest kind. The wonderful accuracy of Ohm's law for metals has been abundantly established by the Wheatstone bridge since Ohm's time. But we do not know that there is any evidence to show that Ohm experimentally proved his law even to the degree of accuracy possible at the time.

In connection with the Wheatstone bridge, we are sorry to find on p. 696 the usual illustration of the student's form of wire bridge, with its confusing wealth of terminals, its highly-elevated scale, and its awkward top-heavy key. It is a melancholy fact that this illustration, or one having the same defect, is to be found in every text-book. No one used to testing would endure such a badly-designed key in practice. Why should it perpetually be put before the student?

Chapter XIV. of Book V., on "Electromagnetic Machines," is an illustration of the evil effects of too much contraction. This chapter is only 27 pages in length, yet it professes to deal with the following subjects: Barlow's wheel; induced currents produced by rotating a coil in a magnetic field; machines for the conversion of mechanical energy into electricity; dynamo-electric machines; series, shunt and compound machines; back E.M.F. in motors; alternating currents—transformers; the magnetic circuit; the electric telegraph; the telephone; the microphone; dimensions of electric and magnetic quantities; connection between the two sets of units; and the practical system of electromagnetic units. It would have been far better to have left out most of these than to deal with them so briefly. Moreover, it is difficult to see why a highly theoretical discussion on the dimensions of the electric and magnetic units, and their mutual relations, comes to be placed in a chapter professing to deal with the more technical side of electricity. This chapter is, in fact, the only one dealing with applied electricity, and it concludes oddly in a cloud of dimensional formulae.

Nevertheless, these criticisms are of minor importance, and there can be no doubt of the great value of Mr. Watson's work.

Kalender fur Elektrotechniker, 1900. Edited by F. Uppenborn (Munich and Leipzig: R. Oldenbourg, 1900.) 5 marks.

Herr Uppenborn's pocket book, almost indispensable to German electrical engineers, is now in its seventeenth year, and has undergone a thorough revision for the present edition. Among the additions is a short chapter on electricity meters, which would be still more useful if it were illustrated. In the preface the editor regrets the death of Herr W. Oesterreich, formerly of the German Post Office, who was responsible for some sections of the pocket book. We notice that the old German Telegraph Act of 1892 has not been superseded in the book by the new one which is now in force; but probably the latter was only finally passed after the book was already in the press.

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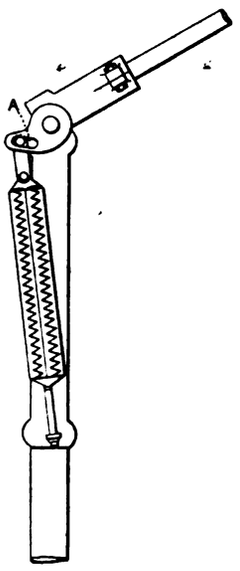
A TROLLEY SAFEGUARD.

The accompanying sketch illustrates an invention, styled a trolley safeguard, which has recently been brought out by Mr. R. Humphries, of Dublin. It is designed to prevent accident from "jumping the trolley." The inventor states that when the trolley jumps the wire, the catch which holds the springs in position at the far end of the slot A is lifted automatically by a releaser fixed to the back of the trolley stand. The springs (running on a steel roller) immediately close in to the end of the slot nearest the pivot, and the trolley falls 2ft. or 3ft. below the wire. All that is necessary to replace the trolley



in position is to push up the pole until the springs roll back into their original position, where they are caught and held automatically by the catch. The releaser (which is hinged) is then pushed up, and the car again started. The whole operation can be performed in two minutes.

RECENT PROGRESS IN WIRELESS TELEGRAPHY.*

BY G. MARCONI.

When Ampère threw out the suggestion that the theory of a universal ether possessed of merely mechanical properties might supply the means for explaining electrical facts, which view was upheld by Joseph Henry and Faraday, the veil of mystery which had enveloped electricity began to lift. When Maxwell published, in 1864, his splendid dynamical theory of the electromagnetic field, and worked out mathematically the theory of ether waves, and Hertz had proved experimentally the correctness of Maxwell's hypothesis, we obtained, if I may use the words of Prof. Fleming, "the greatest insight into the hidden mechanisms of Nature which has yet been made by the intellect of man." We cannot pay too high a tribute to the genius of Heinrich Hertz, who worked patiently and persistently in a new field of experimental physics, and made what has been called the greatest discovery in electrical science in the latter half of the nineteenth century. I cannot forbear saying one word as to the eminent electrician who was placed in his last home as recently as Saturday last, for it is manifest that several years ago Prof. Hughes was on the verge of a great discovery, and if he had persevered in his experiments it seems probable that his name would have been as closely connected with wireless telegraphy as it is with so many branches of electrical work in which he has gained so much renown and such great distinction.

The experimental proof by Hertz 13 years ago of the identity of light and electricity, and the knowledge of how to produce and how to detect these ether waves, the existence of which had been so far unknown, made possible true wireless telegraphy. I think I may be justified in saying that for several years the full importance of the discovery of Hertz was realised but by very few, and for this reason the early development of its practical application was slow. All of you know that the idea of communicating intelligence without visible means of connection is almost as old as mankind. Wireless telegraphy by means of Hertzian waves is, however, very young. I hope that if I pass over the story of the growth of this new art, as I have watched it, or do not attempt to prove the questions of priority, no one will take it for granted that nothing is to be said on these subjects, or that all that *has* been said is entirely correct.

The time allowed for this discourse is too short to permit me to recount all the steps that have led up to the practical applications of to-day. I believe it will probably interest you more to hear of the problems which have lately been solved, and the very interesting developments which have taken place during the last few months.

Mr. Marconi then gave a short explanatory description of his system and of the apparatus used, for the benefit of those of his audience who were unacquainted with the principles of wireless telegraphy by means of Hertzian waves. In describing the transmitter, he stated that, should it be necessary to direct a beam of rays in a given direction, the vertical wire and earth connection are omitted and the spheres placed in the focal line of a metal cylindrical parabolic reflector.

The form of coherer I have adopted is shown in Fig. 1, and I find that a great element of the success of wireless telegraphy has been dependent on using such a coherer.

It had been his experience and that of other workers that the coherer as previously constructed—that is, a tube several inches long partially filled with filings enclosed by corks—was far too unreliable to fulfil its purpose. He found, however, that if specially prepared filings were confined in a very small gap (about 1mm.) between flat plugs of silver, the coherer, if properly constructed, became absolutely reliable. In its normal condition the resistance of a good coherer was infinite, but when influenced by electric waves the coherer instantly became a conductor, its resistance falling to 100 or 300 ohms. This conductivity was maintained until the tube was shaken or tapped.

Having finished his description of the main features of the simple form of apparatus employed until recently, Mr. Marconi continued: Fig. 1 shows an improvement to the system of no slight importance. In it the aerial, or vertical, wire and the earth wire at the receiving station are not connected directly to the coherer, but to the primary

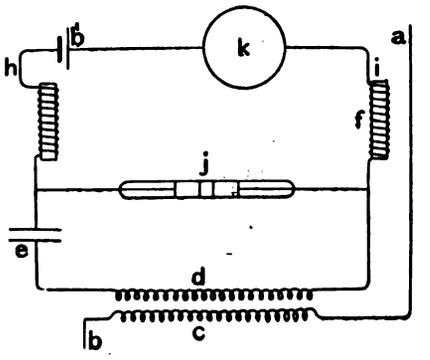


FIG. 1.

of a small induction coil or transformer, the secondary of which is connected to the ends of the coherer, one of the connections passing through a condenser. The object of this transformer is to increase the E.M.F. of the induced oscillations at the terminals of the coherer, and therefore causes it to break down with a weaker oscillation, and so be affected at a much greater distance than would be possible if it were connected directly to the vertical conductor. I had often noticed, during my early experiments, that a long thin wire at the receiving station would give very good results, while a shorter and thicker wire was not so advantageous. I thought that the reason of this was that the breaking down of the insulation of the tube was more dependent on the E.M.F. of the induced oscillation than on its quantity. In order to apply the necessary E.M.F. to the tube at great distances, we increase the E.M.F. of the oscillations induced in the wire or strip at the expense of the quantity.

I had formerly ascertained (Paper read before the Institution of Electrical Engineers, March, 1899*) that the distance over which it is possible to signal with a given amount of energy varies approximately with the square of the height of the vertical wire and with the square root of the capacity of a plate, drum, or other form of capacity area which may be placed at the top of the wires. The law governing the relation of height and distance has already been proved correct up to a distance of 85 miles. Many months ago it was found possible to communicate from the North Haven Poole to Alum Bay (Isle of Wight), with a height of 75ft., the distance being 18 miles. Later on two installations with vertical wires of double that length—*i.e.*, 150ft.—were erected at a distance of 85 miles apart, and signals were easily obtained between them. According to a rigorous application of the law, 72 miles ought to have been obtained instead of 85, but, as I have previously stated, the law has been proved only to be approximately correct, the tendency being always on what I might call the right side; thus, we obtain a greater distance than the

* Abstract of a Discourse delivered at the Royal Institution, Feb. 2.

* *See The Electrician*, Vol. XLII., p. 690.

application of the law would lead us to believe. There is a remarkable circumstance to be noted in the case of the 85 miles signalling. At the Alum Bay station the mast is on the cliff, and there is no curvature of the earth intervening between the two stations—that is to say, a straight line between the base of the Haven and Alum Bay stations would clear the surface of the sea. But in the case of the 85 miles the two stations were located on the sea level, and between them exists a hill of water, owing to the earth's curvature, amounting to over 1,000ft. If these waves travelled only in straight lines, or the effect was noticeable only across open space in a direct line, the signals would not have been received except with a vertical wire 1,000ft. high at both stations.

Leaving this interesting point for the present, I would like to say a few more words about the improvement shown in Figs. 1, 2, and 3. When I first mentioned it, I called it "an induction coil." It will probably interest you to know that it is not every induction coil that will work, but this transformer must be a very remarkably wound induction coil. While carrying out some experiments

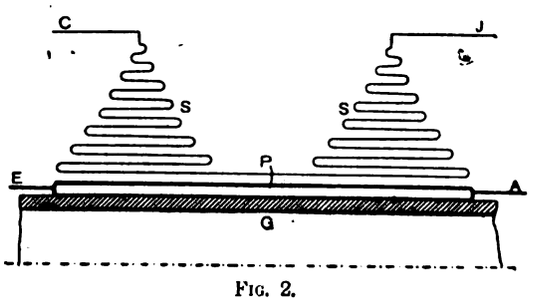


FIG. 2.

nearly three years ago at Salisbury, Captain Kennedy, R.E., and I tried numerous forms of induction coils wound in the ordinary way—that is, with a great number of turns of wire on the secondary circuit—with the object of increasing, if possible, the distance or range of transmission; but in every case we observed a very marked decrease in the distance obtainable with a given amount of energy and height. Similar results were obtained some months later, I am informed, in experiments carried out by the General Post Office engineers at Dover.

In all our above mentioned experiments the coils used were those in which the primary consisted of a smaller or larger number of turns of comparatively thick wire, and the secondary of several layers of thinner wire. I believe I am right in saying that hundreds of these coils were tried, the result always being that by their employment the possible distance of signalling was considerably diminished instead of being increased. We eventually found an entirely new form of induction coil that would work satisfactorily, and that began to increase the distance of signalling. This consisted of a coil, the primary of which was wound with fine wire contrary to usual custom, and the secondary with still finer wire.

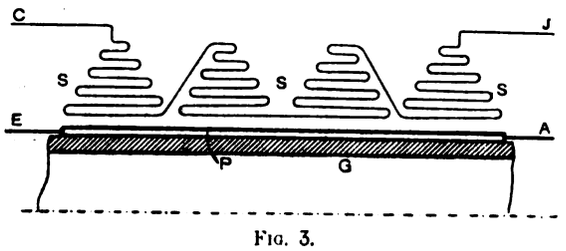


FIG. 3.

The peculiarity of this new coil or transformer was that, if the secondary circuit happened to be wound in more than one layer, no results were obtainable. This was considered to be a disadvantage, as it is impossible (owing to the thinness of the wire on the primary) to wind a secondary of much greater length over or under it, or of a much greater number of turns; and this is necessary in order to obtain a higher ratio of transformation between the primary and secondary than 1:1.

The next step in advance was a coil as shown in Fig. 2, in which the number of turns of the secondary is increased at the ends of the coil, the secondary forming at each end two sections or lumps, as shown in the figure.

This form of coil gave much better results than the previous one, and led to the construction of the coil shown in Fig 3. The diagrams are greatly enlarged half-longitudinal sections, but are not strictly to scale. In place also of showing the section of each coil or a layer of wire as a longitudinal row of dots or small circles, as it would actually appear, it is, for simplicity, shown as a single continuous longitudinal straight line. The secondary of this transformer is wound in several sections, but the peculiarity observed in this case is that the sections must be connected together in the way shown in the Figs. 2 and 3, and as the distance from the primary increases the number of turns in each section must diminish. If the sections are connected in another way it will not work. The operation of these particular modes of winding is, in my opinion, to prevent the effects due to electromagnetic induction from being in opposition with the electrostatic induction at the ends of the primary.

The results given by some of these induction coils have been remarkable. During the naval manœuvres I had an opportunity of testing how much they increased the range of signalling with a given amount of energy and height. When working between the cruisers "Juno" and "Europa" I ascertained that when the induction coil was omitted from the receiver the limit distance obtainable was seven miles, but with an induction coil similar to that shown in Fig. 3 a distance of over 60 miles could be obtained with certainty. This demonstrated that the coils used at that time increased the possible distance nearly tenfold. I have now adopted these induction coils or transformers at all our permanent stations.

A number of experiments have been carried out to test how far the Wehnelt break was applicable in substitution for the ordinary make and break induction coil at the transformer station; but, although some excellent results have been obtained over a distance of 40 miles of land, the amount of current used, and the liability of the break getting fatigued or out of order, have been obstacles which have so far prevented its general adoption.

As is probably known to most of you, the system has been in practical daily operation between the East Goodwin lightship and the South Foreland lighthouse since December 24, 1898, and I have good reason for believing that the officials of Trinity House are convinced of its great utility in connection with lightships and lighthouses. It may be interesting to you to know that, as specially arranged by the authorities of Trinity House, although we maintain a skilled assistant on the lightship, he is not allowed to work the telegraph. The work is invariably done by one of the seamen on the lightship, many of whom have been instructed in the use of the instruments by one of my assistants. On five occasions assistance has been called for by the men on board the ship and help obtained in time to avoid loss of life and property. Of these five calls for assistance, three were for vessels run ashore on the sands near the lightship, one because the lightship herself had been run into by a steamer, and one to call a boat to take off a member of the crew who was seriously ill.

In the case of a French steamer which went ashore on the Goodwins we have evidence given in the Admiralty Court that, by means of one short wireless message, property to the amount of £52,518 was saved; and of this amount, I am glad to say the owners and crews of the lifeboats and tugs received £3,000. This one saving alone is probably sufficient in amount to equip all the lightships round England with wireless telegraph apparatus more than ten times over. The system has also been in constant use for the official communication between the Trinity House and the ship, and is also used daily by the men for private communication with their families, &c.

At the end of March, 1899, by arrangement with the French Government, communication was established between the South Foreland lighthouse and Wimereux, near Boulogne, over a distance of 30 miles, and various interesting tests were made between these stations and French war-ships. The maximum distance obtained at that time, with a height of about 100ft. on the ships, was 42 miles.

The most interesting and complete tests of the system at sea were, however, made during the British naval manœuvres. Three ships of the "B" fleet were fitted up—the flagship "Alexandra" and the cruisers "Juno" and "Europa." I do not consider myself quite at liberty to describe all the various tests to which the system was put, but I believe that never before were Hertzian waves given a more difficult or responsible task. During these manœuvres I had the pleasure of being on board the "Juno," my friend, Captain Jackson, R.N., who had done some very good work on the subject of wireless telegraphy before I had the pleasure of meeting him, being in command. With the "Juno" there was usually a small squadron of cruisers, and all orders and communications were transmitted to the "Juno" from the flagship, the "Juno" repeating them to the ships around her. This enabled evolutions to be carried out even when the flagship was out of sight. This would have been impossible by means of flags or semaphores. The wireless installations on these battleships were kept going night and day, most important manœuvres being carried out and valuable information telegraphed to the admiral when necessary.

The greatest distance at which service messages were sent was 60 nautical miles between the "Europa" and the "Juno," and 45 miles between the "Juno" and the "Alexandra." This was not the maximum distance actually obtained, but the distance at which, under all circumstances and conditions, the system could be relied upon for certain and regular transmission of service messages. During tests messages were obtained at no less than 74 nautical miles (85 land miles).

As to the opinion which naval experts have arrived at concerning this new method of communication, I need only refer to the letters

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published by naval officers and experts in the columns of *The Times* during and after the period of the autumn manœuvres, and to the fact that the Admiralty are taking steps to introduce the system into general use in the navy. As you will probably remember, victory was gained by the "B" fleet; and perhaps I may venture to suggest that the facility which Admiral Sir Compton Domville had of using the wireless telegraph in all weathers, both by day and night, contributed to the success of his operations. Commander Statham, R.N., has published a very concise description of the results obtained in the *Army and Navy Illustrated*.

Mr. Marconi then read the extract from the article from this journal, published in *The Electrician*, Vol. XLIII, p. 663.

The most important results from a technical point of view obtained during the manœuvres were the proof of the great increase of distance obtainable by employing the transformer in the receiver as shown in Figs. 1, 2, and 3, and also that the curvature of the earth which intervened, however great the distance attained, was apparently no obstacle to the transmission. The maximum height of the top of the wire attached to the instruments above the water did not on any occasion exceed 170ft., but it would have been geometrically necessary to have had masts 700ft. high on each ship in order that a straight line between their tops should clear the curved surface of the sea when the ships were 60 nautical miles apart. This shows that the Hertzian waves had either to go over or round the dome of water 530ft. higher than the tops of the masts, or to pass through it, which latter course I believe would be impossible.

Some time after the naval manœuvres, with a view of showing the feasibility of communicating over considerable distances on land, it was decided to erect two stations, one at Chelmsford and another at Harwich, the distance between them being 40 miles. These installations have been working regularly since last September, and my experiments and improvements are continually being carried out at Chelmsford, Harwich, Alum Bay, and North Haven Poole. In the month of September last, during the meetings of the British Association in Dover, and of the Association Francaise pour l'Avancement de Science in Boulogne, messages were exchanged with ease between Wimereux, near Boulogne, and Dover Town Hall, a distance of 30 miles.

An interesting point was that it was demonstrated that the great masses of the Castle rock and South Foreland cliffs lying between the Town Hall, Dover, and the lighthouse did not in the least degree interfere with the transmission of signals. This result was, however, by no means new. It only confirmed the results of many previous experiments, all of them showing that rock masses of very considerable size intervening between two stations do not in the least affect the freedom of communication by ether-wave telegraphy (see *Journal* of the Institution of Electrical Engineers, April, 1899, p. 280).*

It was during these tests that it was found possible to communicate direct from Wimereux to Harwich or Chelmsford. This result was published in a letter from Professor Fleming addressed to *The Electrician* on September 29th. The distance from Wimereux to Harwich is approximately 85 miles, and from Wimereux to Chelmsford also 85 miles, of which 30 miles are over sea and 55 over land. The height of the poles at these stations was 150ft., but if it had been necessary for a line drawn between the tops of the masts to clear the curvature of the earth, they would have had to have been over 1,000ft. high

In America wireless telegraphy was used to report from the high seas the progress of the yachts in the international yacht race, over 4,000 words being transmitted in the space of less than five hours on several different days. Some tests were carried out for the United States navy; but, owing to insufficient apparatus, and to the fact that all the latest improvements had not been protected in the United States at that time, it was impossible to give the authorities there such a complete demonstration as was given to the British authorities during the naval manœuvres. Messages were transmitted between the battleships "Massachusetts" and the cruiser "New York" up to a distance of 36 miles.

A few days previous to my departure from America the war in South Africa broke out. Some of the officials of the American line suggested that, as a permanent installation existed at the Needles, Isle of Wight, it would be a great thing, if possible, to obtain the latest war news before our arrival on the St. Paul at Southampton. I readily consented to fit up my instruments on the St. Paul, and succeeded in calling up the Needles station at a distance of 66 nautical miles. All the important news was transmitted to the "St. Paul" while she was under way steaming 20 knots. The news was collected and printed in a small paper called the *Transatlantic Times*, several hours before our arrival at Southampton.

At the tardy request of the War Office, we sent out Mr. Bullock and five of our assistants to South Africa. It was the intention of the War Office that the wireless telegraph should only be used at the base and on the railways, but the officers on the spot realised that it could only be of any practical use at the front. They therefore asked Mr. Bullock whether he was willing to go to the front. As the whole of the assistants volunteered to go anywhere with Mr. Bullock, their services were accepted, and on the 11th of December they moved up to the camp at De Aar. But when they arrived at De Aar, they found that no arrangements had been made to supply poles, kites, or balloons, which, as you all know, are an essential part of the apparatus, and none could be obtained on the spot. To get over the difficulty they manufactured some kites, and in this they had the hearty assistance of two officers—viz., Major Baden Powell and Captain Kennedy, R.E., who have often helped me in my experiments in England. (Major Baden Powell, it will be remembered, is a brother of the gallant defender of Mafeking.)

The results which they obtained were not at first altogether satisfactory, but this is accounted for by the fact that the working was attempted without poles or proper kites, and afterwards with poles of insufficient height, while the use of the kites was very difficult, the kites being manufactured on the spot with very deficient material. The wind being so variable, it often happened that when a kite was flying at one station there was not enough wind to fly a kite at the other station with which they were attempting to communicate. It is therefore manifest that their partial failure was due to the lack of proper preparation on the part of the local military authorities, and has no bearing on the practicability and utility of the system when carried out under normal conditions.

It was reported that the difficulty of getting through from one station to another was due to the iron in the hills. If this had not been cabled from South Africa it would hardly be credible that anyone should have committed himself to such a very unscientific opinion. As a matter of fact, iron would have no greater destructive effect on these Hertzian waves than any other metal, the rays apparently getting very easily round or over such obstacles. A fleet of 30 ironclads did not affect the rays during the naval manœuvres, and during the yacht race I was able to transmit my messages with absolute success across the high buildings of New York, the upper storeys of which are iron.

However, on getting the kites up, they easily communicated from De Aar to Orange River, over a distance of some 70 miles. I am glad to say that from later information received they have been able to obtain poles, which, although not quite high enough for long distances are sufficiently useful. We have also sent a number of Major Baden Powell's kites, which are the only ones I have found to be of real service. Stations have been established at Modder River, Enslin, Belmont, Orange River, and De Aar, which work well and will be invaluable in case the field telegraph line connecting these positions should be cut by the enemy. It is also satisfactory to note that the military authorities have lately arranged to supply small balloons to my assistants for portable installations on service waggons.

While I admire the determination of Mr. Bullock and our assistants in their endeavour to do the very best they could with most imperfect local means, I think it only right to say that if I had been on the spot myself I should have refused to open any station until the officers had provided the means for elevating the wire, which, as you know, is essential to success.

Mr. Bullock, and another of our assistants in South Africa, has been transferred, with some of the apparatus, to Natal to join Gen. Buller's forces, and it is likely that before the campaign is ended wireless telegraphy will have proved its utility in actual warfare. Two of our assistants bravely volunteered to take an installation through the Boer lines into Kimberley, but the military authorities did not think fit to grant them permission, as it probably involved too great a risk. What the bearing on the campaign would have been if working installations had been established in Ladysmith, Kimberley, and Mafeking before they were besieged, I leave military strategists to state. I am sure you will agree with me that it is much to be regretted that the system could not be got into these towns prior to the commencement of hostilities.

I find it hard to believe that the Boers possess any workable instruments. Some instruments intended for them were seized by the authorities at Cape Town. These instruments turned out to have been manufactured in Germany. Our assistants, however, found that these instruments were not workable. I need hardly add that no apparatus has been supplied by us to anyone from whom the Boers could possibly have obtained any of our instruments.

I have spoken at great length about the things which have been accomplished. I do not like to dwell upon what may or what will be done in the immediate or more distant future, but there is one thing of which I am confident—viz., that the progress made this year will greatly surpass what has been accomplished during the last twelve months; and, speaking what I believe to be sober sense, I say that by means of the wireless telegraph telegrams will be as common and as much in daily use on the sea as at present on land.

* *The Electrician*, Vol. XLII., p. 692.

Calcium Carbide.—The output of calcium carbide from Sweden is rapidly increasing. The Trollhättan factory is being considerably extended, and new works are being erected at Alby, Mansbö, and Brattfons. The annual production will thus be raised from 1,000 to 6,000 tons.

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THE STANDARDISATION OF ELECTRICAL ENGINEERING PLANT.*

BY R. PERCY SELLON.

To the user of electrical engineering plant, not less than to the producer, the subject of its standardisation is one of great practical importance. By "standardisation" is meant the general acceptance, to a far greater extent than at present obtains in this country, of certain standards of output, quality, efficiency, or other characteristics of electrical engineering plant, to meet ordinary requirements of usage for light, traction, and power.

1. Of the four chief ingredients of successful competitive production—viz., (*a*) cheap labour, not to be confounded with low wages; (*b*) cheap materials; (*c*) efficient management; and (*d*) repetition manufacture—much has been said and written of the first three, but little of the last. And yet every manufacturer of experience knows that it is as influential a factor in determining not only his own profit, but decisive advantages to the user, as any of the factors of labour, materials, or supervision. In order to convince oneself of this, it is only necessary to consider the influence of repetition manufacture upon the price and reliability of any article of common use—say, in our own industry, incandescence lamps and their accessory fittings, in respect of which some measure of standardisation has been evolved—and to reflect what, on the other hand, the cost would be if many manufacturers or users adopted different standards.

In the early years of an industry, experiment and development by trial and error are desirable and inevitable, in order to ascertain the possibilities and limitations of the art. But as the stage of repetition public demand is reached, standardisation becomes increasingly possible and advantageous. Its advance is, however, liable to be retarded by a number of causes, notable among which are the folly of some producers, and the ignorance of many users. There are always some manufacturers who think that by supplying a special or unique type of apparatus to the buyer they will force him into placing his future orders with them. Hence they resist any tendency towards standardisation. There are also many buyers who allow themselves to be persuaded into the belief that in securing something new and different from previous usage they are doing well for themselves and giving evidence of superior intelligence; whereas the probability is that they are paying a higher price for a less reliable article. There is a third class who believe that standardisation is the business of the producer only; and that the user need not concern himself to assist in bringing about a condition of things for which every manufacturer who knows his business eagerly strives. This view is erroneous.

The intelligent producer is undoubtedly deeply concerned in the advent of standardisation, because it means for him the possibility of repetition manufacture—on the manifold advantages of which it is not necessary to dwell. But to the user, if he would only realise it, the fruits of standardisation are equally beneficial, for they involve for him the following advantages: (*a*) Less capital outlay; (*b*) prompt delivery; (*c*) immunity from the risks attendant on novel designs; (*d*) full manufacturer's guarantees.

2. Viewed from the "patriotic" standpoint, this subject acquires also special significance in these days of acute struggle between British, American, and Continental manufacturers for our own and the world's markets in electrical wares. The causes which underlie the ability of American and Continental producers to compete keenly and successfully with the British electrical manufacturer are several, and generally outside the scope of this Paper. But conspicuous among them is the fact that the former have (as anyone who has visited their leading workshops can testify) attained to a degree of repetition manufacture superior to the British producer. This fact is so noteworthy as to constitute in itself a telling argument in favour of increased standardisation among us, for the flood of American electrical engineering plant into Great Britain is swelling in spite of the fact that we have the advantage of lower wages (on the whole), cheaper materials, and a longer experience of factory organisation.

3. It therefore becomes important to endeavour to trace the cause of this preferential position held by our foreign rivals. The explanation would appear to lie in a difference of procedure. According to American and Continental practice, the producer determines, in a large measure, the character of the plant employed by the user; while, according to British custom, the buyer very generally imposes upon the manufacturer not merely a specification of the ends he wishes to attain, but the details of means by which he desires those ends to be achieved. This is due to the fact that under the American and Continental system producers largely secure outlets for their manufactures through the agency of powerful financial organisations created by and allied to their interests, who are concerned simply with commercial results, and are content to leave the technical means of attaining them to the manufacturing interests with whom they co-operate. In America these organisations take the form of colossal trusts or consolidations of competing interests, on the Continent that of industrial banks. In either case there is a close relation between producer and buyer. In Great Britain, on the other hand, the demand for electrical engineering plant in recent years has issued chiefly from local authorities, or from private users unconnected with any manufacturing interests; and these have very naturally had recourse to electrical engineers acting in a consulting capacity or passing permanently into their service, to guide them in the choice of plant to fulfil their requirements. That the practical operation of this system in the past has been primarily responsible for the relative absence of standardisation in this country, with its attendant evils alike to user and producer, appears certain. For the user's engineer has frequently been out of touch with manufacturers; and the temptation to strike out on new and "showy" lines, suggestive of individuality, ability, or foresight, has in the very nature of things been great. The result has been the issue of specifications too often calling for wanton divergences from previous practice or existing manufacturers' standards.

The source of the evil is traceable to the fact that the buyer's engineer has gradually overstepped the rational function of stating the ends or performance required by the buyer, and has proceeded to specify in minute detail the means or constructional methods by which the required results are to be achieved, without taking responsibility for the result. It is not necessary to adduce specific examples in illustration of this statement, because the author believes that it is one which no fair-minded electrical engineer acquainted with the facts will dispute. There is no difficulty in producing overwhelming evidence of its truth if such be required. To the same primary cause may probably be traced the variety in size and character of the power units in many of the central stations of Great Britain—another instance of "splendid isolation" in our methods; for foreign practice is at one in adopting fewer and larger units, uniform in size and character from the commencement. Whether advantages of temporarily reduced capital outlay and higher efficiency under our system are a sufficient compensation for loss of interchangeability and periodical relegation of plant to the old metal market, remains to be proved when the bills are presented later on and contrasted with one another. Meantime, it is interesting to note that one result of our procedure is the comparative unpreparedness of British manufacturers to compete with foreign producers in the common markets of the world as regards large units.

4. Whether British collectivism is on the whole a more healthy medium than American or Continental private enterprise for the progressive growth of the electrical engineering industry is a large question outside the scope of this Paper. We have here to accept it as a fact, and consider whether an evil which it has brought in its train is a necessary one; and if not, how it can be averted for the future. Assuming, then, that the buyer's engineer has come to stay, it would appear that a condition precedent to the standardisation of plant is the standardisation of the buyer's engineer. The fundamental fact requiring appreciation is that standardisation, to the greatest degree possible, is in the interest of the user at least as much as that of the manufacturer.

From this we may pass on to postulate that standardisation is primarily the function of the producer and not of the user or his engineer, because the former is in a better position to determine, experimentally and by his more intimate knowledge of the means of production, the direction and extent to which it is possible. Inasmuch as the manufacturer's success is dependent on the judgment with which he creates or responds to public demands, there exists always an efficient safeguard that he will not (consciously) standardise on unsuitable or inefficient lines. The user, on the other hand, is of course the proper judge as to the results he wishes to achieve. It would appear, therefore, that the initial obstacle to a greater measure of standardisation than at present obtains would be removed if the user or his engineer would confine himself to stating the ends he has in view, leaving it to the producer to furnish the means whereby they may be attained. If this procedure were adopted users would still retain full liberty of choice between the products of different manufacturers, while the latter would have an opportunity (which under the present system of detailed specifications they do not enjoy) of undertaking repetition manufacture, assuming that they have sufficient confidence in the substantial harmony between their designs and public requirements to take the risk of quantitative production. This system would have the incidental advantage that the producer could then be properly called upon to guarantee results, since the responsibility of selecting the means to attain them would rest exclusively with him. The present custom too often imposes upon the manufacturer a mass of fantastic detail emanating from the brain of the user or his engineer, for which he is called upon to take responsibility—an illogical system which can only be compared to the proposition that every man should be expected to father another man's child. It may be objected that the general adoption of the course suggested would lead to stagnation in development, and that the producer, relieved from the constant pressure of change now exerted by the user, would settle down to the perpetuation of antiquated

* Paper read before the Institution of Electrical Engineers, Feb. 8th.

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designs—to the disadvantage of the public and the fetich of Progress. The answer to this is: firstly, that much of the change hitherto demanded has been wanton and retrogressive; secondly, that competition within the ranks of manufacturers themselves must always prove a sufficient stimulus to keep abreast of public demand; and finally, that it is largely by the adoption of the system suggested that the American and Continental producers are snatching trade from the British manufacturer in his own market.

5. If, then, the principle be accepted that standardisation, with the qualification named, is for the advantage alike of producer and user, we may pass on to consider how far, and by what means, it is capable of beneficial extension. Standardisation presupposes such a substantial and sufficiently enduring demand for an article as to make it worth the while of manufacturers to incur the requisite outlay in time and money to achieve it. Hence, as already mentioned, in the early and experimental stages of an industry it is neither possible nor desirable. The period at which it becomes practicable is largely one for the judgment of producers. But from the preceding argument it is evident that the user plays an influential part in hastening or retarding its advent, as is proved by the fact that standardisation is much further advanced for the same character of products abroad than in Great Britain. This clearly indicates that it is the system in this country, and not the infancy of the industry, that is responsible for this condition of affairs. Standardisation, to be enduring, must proceed on lines which shall be beneficial alike to the producer and user. It follows that any attempt to stereotype detail of design or construction must ultimately fail in its object, because such a course will not be adapted to the varying manufacturing facilities of different producers, nor will be acceptable to the user, since it must prove restrictive of constructional improvement and involve the buyer in paying a higher price for an article which the producer will decline to effectively guarantee. In other words, enduring mutual advantage to producer and buyer will only result if standardisation be confined to ends or performance, and not to means or constructional detail.

Under the term "ends" or "performance" as opposed to "means" or "constructional detail" would fall the following: (*a*) Steam pressure, (*b*) electrical pressure of generation, (*c*) electrical pressure of distribution, (*d*) periodicity of alternate-current generation, (*e*) sizes of generating steam units—(say in convenient fractions or multiples of horse-power or kilowatts), (*f*) sizes of mains (say in convenient fractions or multiples of a sq. in. or other unit), (*g*) sizes of motors; and similarly as regards transformers, arc and incandescence lamps, and essential fittings and accessories. That much can be done in this direction is evidenced by the ease and rapidity with which, as regards electric traction, we have acquiesced in the standards of pressure, general construction and types of motors, trucks and accessories prevalent in America. There can be little doubt that had practical electric traction originated with us, instead of being an imported art from the United States, we would still be in the stage in which buyers' engineers would be creating different "standards" of their own composing, while every producer would be expected to manufacture and guarantee a corresponding variety of designs.

The author understands that most of the leading electric cable manufacturers in this country have already adopted, by agreement among themselves, certain standards in their own department of production. The question of standardisation has also for some time received attention at the hands of the Electrical Engineering Plant Manufacturers' Association. Again, the Municipal Electrical Association, a body thoroughly representative of the municipal users' interests, has given evidence of its readiness to co-operate with manufacturers in the direction of standardisation of the commercial conditions of contracts for electrical plant. Its representatives have met in conference representatives of the Electrical Engineering Plant Manufacturers' Association, and have agreed upon certain general conditions as a basis for specifications of plant required by local authorities; and the outcome has undoubtedly been beneficial. It is evident, therefore, that the whole subject is ripe for consideration on the broader basis of harmonising, by adequate representation and discussion, all sections of users' interests with those of producers.

6. It is not possible to enter in this Paper upon the consideration of the actual formulæ which might constitute standards for the future. This is a very large and important question demanding much careful thought and discussion. The machinery for this purpose already exists, at any rate as a nucleus, in the uniformity committee of this Institution, appointed shortly after the submission of a highly suggestive Paper on "Uniformity of Plant," by Mr. C. H. Wordingham, before the Municipal Electrical Association in the summer of 1898. But beyond a word of advice on the subject of standard periodicities, nothing has so far issued publicly from the deliberations of this committee extending over 18 months. At this rate we may become irretrievably committed to many steps which all may live to regret before effective results are obtained; for an unexampled expansion in every department of electrical engineering, notably those of electric traction and of power distribution over extensive areas, appears about to take place in this country.

The author ventures to suggest that additional weight and acceleration to the work of the committee of the Institution would be given if it were strengthened by the addition of representatives of all interests concerned—viz., those of the manufacturer, user, consulting engineer, and user's engineer. The Institution might also encourage the submission of Papers suggestive of standards for various classes of electrical engineering plant and accessories. These, together with the views which would be brought out in discussion, would serve as a valuable guide to a representative committee.

In conclusion, the propositions which the author has endeavoured to establish may be briefly recapitulated as follows: (*a*) Standardisation, to a greater degree than at present exists, is in the interest of the manufacturer, as a means of facilitating repetition production and of meeting the competition of standardised foreign manufactures. (*b*) Standardisation of "ends" or "performance," as distinct from "means" or "constructional details," is equally in the interest of the user, by securing for him low purchase cost, prompt delivery, freedom from the risks of experimental design, and full manufacturers' guarantees. (*c*) The relative absence of standardisation in Great Britain, in contrast with other countries, is mainly traceable to the prevailing system wherein the user's engineer specifies "means" or "constructional details," instead of confining himself to "ends" or "performance." (*d*) The determination of standards by organised effort, rather than by the slow and costly process of "trial and error," is desirable, and should be undertaken under the auspices of the Institution of Electrical Engineers, as representing the interests of both producer and user.

[The above Paper is accompanied by a table of central stations in Great Britain, with particulars of system, periodicity, generating pressure, and distributing pressure employed. These particulars being embodied, with numerous others, in the sheet supplement recently issued by *The Electrician*, the table is not here reproduced. —Ed. *E.*]

ELECTRICAL PROGRESS IN AMERICA DURING 1899.

The *Electrical Review* of New York for Jan. 3 contains an interesting article, from the pen of Mr. Charles T. Child, discussing the advances and progress made by the electrical industries in America during the past year. These, according to the writer, have proved in the highest degree satisfactory and encouraging to the electrical interests of America, and he states further that there has never been a time "when the outlook has been brighter or the promise of future prosperity larger than now."

The most striking feature of this advance is the development of the electromobile, which has already become a familiar object on American streets. Both the weight and the cost are, however, items which must be considerably reduced before it can cease to be anything but an expensive luxury. Large sums of money are being invested in numerous electric motor-car companies, and much money is also being spent in carrying out experiments on the reduction of the weights of the batteries and other improvements in the vehicles themselves.

The street railway systems of America have, it is claimed, reached a point in their development which is nearly perfection. The most notable features of this development are the extension of the conduit conductor systems and the formation of syndicate companies embodying in one large central concern numerous minor power companies. Cable and horse railways in New York and Washington and other places have now been replaced by electrical systems using underground conductors with an open slot conduit. We noticed in a long descriptive article in our last week's issue the very large installation of the Third Avenue Railway Co., the principal feature of which is the power station with a maximum capacity of 100,000 H.P. High-tension polyphase current is here generated, which is converted at the sub-stations to low-tension continuous current for use on the cars. Another large undertaking is that of the Manhattan Elevated Railroad Co. of New York, who have recently placed such enormous orders with the Westinghouse Co. for the entire electrical equipment. On this system also high-tension polyphase distribution, with converter sub-stations, will be used. The power station will have a capacity of 70,000 H.P., and the dynamos to be installed will be the largest in use—viz., 6,000 H.P. each. Electric traction is also being applied to existing steam railways with marked and continued success. Very long inter-urban lines have been opened up, many of these being worked from a single large power station on the polyphase transmission and converter sub station system. One such line is 40 miles long. In the construction of electric railways it is to be noted that direct-coupled generators have become general, while switchboards, line material, trucks, &c., are all of standard patterns, differing but little in various installations. The car equipments have likewise undergone no notable change, two four-pole enclosed, single reduction gear motors, operated by a modification of the series-parallel controller, with a magnetic blow-out extinguisher for the arcs formed during working, being the type in common use. There

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is also, in larger cities, a tendency towards double truck cars As a remarkable instance of the growth of inter-urban lines, it may be mentioned that a journey can now be made on electric cars between Paterson, N.J., and Portland, Me., *vid* New York and Boston, a total distance of 360 miles, with but three breaks aggregating 14 miles.

The electric lighting industry is in a no less active and flourishing condition. Here again consolidation of interests has been very marked, thus allowing of larger areas being supplied from one central station. The use of alternating currents for arc lighting is also increasing. In Brooklyn the area served from a single station embraces more than 100 square miles. In the two generating stations in that city three-phase current at 6,600 volts is produced at the dynamo, and fed by underground lines to sub-stations, where it is transformed to lower voltages for use either as alternating or direct current. In these large stations economies can be practised which would be inadmissible in smaller power houses. Among these are automatic methods of handling coal, stoking, removing ashes, &c. Experiments on rectifiers for arc lighting on a large scale are to be made at some of the larger stations. By means of the enclosed arc lamp, the problem of arc lighting with series lamps on alternating-current circuits has been solved. Several installations using such lamps under periodicity of about 60 ∿ have proved eminently satisfactory in their working. Single-phase current is generated by a constant potential dynamo, and is led through the primary of a transformer having high leakage. In the varying field of the primary the secondary coil is suspended by a system of levers and counterbalance weights, its position being determined by the repulsions between it, the core, and the primary coil. Excellent regulation for constant current in the secondary is thus obtained. The enclosed arc is now being nearly invariably used for indoor lighting where direct constant potential current is available. The alternating type of enclosed arcs is also increasing in favour. In street lighting from low-tension direct-current mains they have given every satisfaction.

There has been a falling off in the movement towards municipalisation of electric light stations in America. The experience of the municipal lighting plant of the city of Detroit has been far from encouraging to the advocates of public ownership of such large concerns.

In the electrical transmission of power over long distances there has been much development. The 43-mile line of the Mount Whitney Co. in California was opened in 1899. There has also been much extension in the power supply industry at Niagara Falls, the whole of the lighting of Buffalo being now operated from Niagara power. The use of aluminium in transmission lines is also increasing very rapidly. The fine transmission line of the Niagara Falls, which we described in our columns some little time ago, is built entirely of this metal, as also other lines. It is also being used for switchboard work, and for short lines of conductors carrying large currents.

There has been also a gratifying increase in the applications of electrical power from stationary motors, particularly in their application to printing presses, machine tools, &c. In the packing houses of Armour and Co., Chicago, the electrical installation represents an outlay of over a million dollars. The United States navy have also equipped electrically two large battleships, the "Kearsage" and the "Kentucky." Central power plants, forward of the main engine, furnish electrical power to all the auxiliaries of the vessels excepting the anchor winches, capstans, and steering gear. For ventilating, turning turrets, training guns, hoisting ammunition, working boat and coal hoists, &c., electric power is used throughout.

In its application to the chemical industries but one new process was introduced in 1899—that of making graphite. The reduction and refining of copper, the manufacture of calcium carbide, the production of alkali and bleach, have employed much electrical energy. The outputs of carborundum and aluminium have likewise shown a considerable increase.

The telephone industry has been in a most interesting and excited condition during the past year, owing to the formation of a powerful company with large capital and influential personnel, with the avowed purpose of competing with the Bell companies. In telephone engineering the principal features of the year's work have been the installation of the common-battery system in the exchanges of New York and Brooklyn, the growth of long-distance lines, and the building of toll lines from town to town. The common battery system is one in which the batteries furnishing energy to the transmitters are grouped at the exchange instead of being distributed at the individual stations. Quickness of operation and facility of inspection are among the special advantages claimed for this system.

In telegraphy very little has been done. The great business of the two large telegraph companies has increased, but has not felt the stimulus given it by the war in the summer of 1898. In ordinary telegraphy perhaps the most interesting developments were the experiments of a number of newspapers with a method of transmitting drawings by wire. This was a revival of the old method of Caselli and Bain, and was fairly successful so far as the reproduction of the pictures was concerned, but seems to have been abandoned on account of its slowness in working and consequent expense when working on leased wires. An experimental demonstration of the Pollak-Virág system of high-speed telegraphy was made late in the year, and it is stated that its successful operation was well shown.

During the latter half of the year the colliers "Brutus" and "Nero," of the U.S. navy, surveyed a route for a transpacific cable from San Francisco, by way of the Hawaiian Islands and Guam, to a point on the east coast of Luzon in the Philippines. It was believed that the route was practicable, though two obstacles, one a mountain rising from deep water to within a few fathoms of the surface, and the other an abyss of hitherto unsounded depth, were found on the great circle course followed, and would necessitate divergences.

In other departments of electrical work the advance has been steady and solid rather than rapid and spectacular. The new year finds the whole industry in a condition of prosperity, and with an almost unparalleled amount of work on hand. Much of this is for export.

During 1899 the export trade in electrical machinery and supplies grew in an amazing fashion. In Great Britain especially was found a market for large shipments of such goods, American firms having secured contracts for several important installations here. American trade with Mexico has also largely extended.

CORRESPONDENCE.

TELEPHONES AT GLASGOW.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: With reference to the notice appearing under the above heading on page 380 of your issue of the 5th ultimo, I shall be glad if you will kindly insert the following corrections:—

In the paragraph referred to it is stated, "The National Telephone Co. use wire weighing 12·54lb. to the mile for its underground cables," which is altogether misleading and incorrect. The weight of the wire used by the National Telephone Co. in all its underground work is 20lb. to the mile, and of this class of wire it has laid down during the last few years approximately 150,000 miles. It is, however, right to say that a few experimental lengths of the lighter and cheaper wire have been tried by the National Telephone Co., with the result that its use has not been approved. For overhead cables the weight of the wire used is 20lb. per mile, and for general distribution work it is 40lb. to the mile, the same weight as the Postmaster-General's specification laid down for Glasgow. For junction lines erected overhead the wire in general use is 100lb. to the mile. These weights of copper wires have been habitually used for telephone work for many years in this and other countries.—Yours, &c.,

DANE SINCLAIR,
Engineer-in-Chief of the National Telephone Co.

London, Feb. 5.

LEGAL INTELLIGENCE.

Turner and Sons v. Brinsmead.

This case was fully reported in *The Electrician* for Jan. 12 and 26. On Saturday Mr. Justice Matthew now intimated that he had received the report of the assessor (Prof. A. B. W. Kennedy).

Mr. ELDON BANKES said that the position of the case now appeared to him to be that if the report showed that the defendant was entitled to reject the lift the only question was one of damages. If, on the other hand, the defendant was not entitled to reject the lift, but that it was in some respects defective, evidence would be required to show what amount it would cost to make it according to contract.

His LORDSHIP said that the report was not wholly favourable to either side, and he strongly advised the parties to settle the matter.

Acting upon this suggestion, it was decided to let the case stand over so that the parties might come to an arrangement.

Wilson v. The Carbon (New) Syndicate, Ltd.

A debenture-holder's action came before Mr. Justice Cozens-Hardy, in the Chancery Division, on Saturday, for judgment in default of defence. The syndicate was formed in Dec., 1897, to manufacture carbon plates for electrical purposes, and had power to issue debentures. £5,000 were issued in Dec., 1898, and a further issue in April last. The principal moneys have now become due. The syndicate was not in liquidation, but reconstruction is contemplated. A receiver was appointed on Nov. 15 last.

His LORDSHIP gave the usual debenture-holders' judgment.

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COURT OF COMMON COUNCIL.

At yesterday's meeting, Mr. A. Hudson, chairman of the Streets committee, presented a report submitting letters from the Charing Cross and Strand Electricity Supply Corporation, on the subject of vesting the City of London Electric Lighting Order, 1899, in a new company, and recommending that the company be informed that, provided the sanction of the Board of Trade is obtained to the formation of a new company, the Corporation will offer no objection, on the understanding that it will in no way prejudice the Corporation or electric light consumers, and on an undertaking being given under the seal of the company that the expenses in connection with the formation and the carrying on of such new company shall form no part of the purchase-money in the event of the Corporation deciding to purchase the undertaking. Relative to a notice from the Charing Cross and Strand Corporation of their intention to lay mains in the western district of the City, the committee recommended that the company be permitted to lay such mains, under the direction and to the satisfaction of the engineer and electrical engineer. Relative to the proposed alteration by the City of London Electric Lighting Co. of the standard pressure of supply, a letter from the Board of Trade was submitted stating the conditions upon which the Board have decided that the standard pressure may be altered from 100 volts to 200 volts.

In the discussion upon these recommendations, Mr. A. C. MORTON moved an amendment permitting the Charing Cross Co. to charge the ordinary expenses of the management of the new company as part of the working of it. The City Corporation ought not, of course, in the event of purchase, to pay the expenses of the formation of the new company, nor the expenses of carrying on both companies, but surely they must pay the expenses of the one which was to supply the City.

Mr. WALLACE moved that the report be printed and circulated among the members, and that the debate be adjourned for that to be done. The report, he said, was the most important document the Court had had before it for some time. This was to be a new company for financial purposes, and the City was to be dragged into it again. The Corporation must have a proper opportunity of considering these bargains before they were entered into.

The motion was agreed to.

TRADE NOTES AND NOTICES.

[Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.]

NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers, or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London:—

READY TO-MORROW.

"The Electrician" Electrical Trades' Directory and Handbook for 1900 (corrected to January 31st, 1900).—In addition to the well-known features of this Directory and Handbook (all of which have been carefully revised and brought quite up to date), a large addition has been made to the Handbook Division, including a Digest of the Law of the Telegraph and Telephone, for the use of municipalities and companies contemplating applying to the Postmaster-General for a Telephone Licence. This section of the book now includes the new model form of Licence issued by the Postmaster-General in January, the Telegraph Acts and Orders passed by Parliament in 1899, and other information in connection with this the latest development of electrical enterprise. The huge sheet tables of Electric Light and Power and Electric Railway and Tramway undertakings of the United Kingdom have been made complete up to the 31st January. These sheets form a most complete record of electrical engineering progress in connection with electricity supply and power and traction applications. The Directory Division has been carefully extended and corrected up to Feb. 2. A number of additional interesting sketches of the careers of well-known electrical experts have been added to the Biographical Division, together with a number of new portraits. The new volume is, we claim, the most complete and correct book of its kind ever published in any language. An analytical digest of the contents of this volume is in preparation, and will be ready in a few days.

"Practical Notes for Electrical Students."—By Messrs. A. E. Kennelly and H. D. Wilkinson. Price 6s. 6d., post free. The authors give in a clear and concise manner a good summary of the general principles of electrical science.

"The Incandescent Lamp and its Manufacture."—By Gilbert S. Ram. Price 7s. 6d., post free. The principles underlying the manufacture of the incandescent lamp are carefully and fully dealt with in this volume.

"The Centenary of the Electric Current, 1799-1899."—By Dr. J. A. Fleming. Price, paper covers, 1s. net, post free 1s. 3d.; strong cloth, 2s. 6d., post free.

"Localisation of Faults in Electric Light Mains."—By F. C. Raphael. Price 5s., post free. The book deals with the important subject of localising faults in electric light and power cables; and the various methods of insulation testing are here collected and discussed.

"Motive Power and Gearing for Electrical Machinery."—By E. Tremlett Carter, C.E., M.I.E.E. Price 12s. 6d., post free. In this comprehensive work an account is given of the scientific principles and modern practice in the use of engines for dynamo driving, not only for isolated power plants, but also for public electric lighting and power stations. The various forms of gearing in the power station and for electric motors are also dealt with; and the book contains, in addition, numerous tables giving exact data of the equipment and working of electric power stations.

"The Manufacture of Carbons for all Electrical Purposes."—by Francis Jehl. 10s. 6d., post free. This is a practical handbook, giving a complete description of the art of making carbons for electric lighting, electrodes, &c., with particulars of the various gas generators and furnaces used in carbonising. The work also contains particulars of the cost, &c. of erecting and working carbon works, and plans of a model factory.

"Wireless Telegraphy: Signalling across Space without Wires by Electric Waves." A Review of the Work of Hertz and his Successors.—By Dr. O. J. Lodge, with a large number of illustrations. New and Enlarged Edition, 5s. nett. *Now ready.*

"Electromagnetic Theory."—By Oliver Heaviside. *Vol. I.*, 12s. 6d. *Vol. II.*, 12s. 6d.

"Electric Motive Power," by Albion T. Snell, contains the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. Price 10s. 6d., post free; abroad, 11s.

"Electrical Testing for Telegraph Engineers."—By J. Elton Young, M.I.E.E. The scope of the book aims at furnishing a fuller treatment of the subject, from the standpoint of the Telegraph Engineer, than it has hitherto received, whilst it endeavours to facilitate a thorough comprehension of the theory of testing as applied to electrical lines in general. Demy 8vo, fully illustrated. 10s. 6d., post free.

"Electric Lamps and Electric Lighting," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is handsomely bound, and full of original illustrations, designs, initials, &c. *New and Cheaper Edition now ready.* **6s., post free.**

"The Electrician" Primers.—In Two Volumes. Vol. I., Theory. Vol. II., Practice. Price, stout paper cover, 2s. 2d. each, post free; cloth, 2s. 9d. Single Primers, 8d. each, post free.

TENDERS INVITED.

The New Tramways committee of the *Newcastle-upon-Tyne* Corporation require tenders for the supply of 130 car bodies, trucks for same, and for electrical equipment. Further particulars are set out in an advertisement, and general particulars and conditions of contract may be obtained from the consulting engineer, Mr. Charles Hopkinson (Messrs. Hopkinsons and Talbot), 26, Victoria-street, London, S.W. Tenders must be lodged at the office of the town clerk (Mr. Hill Motum), Town Hall, Newcastle-upon-Tyne, not later than March 2.

The *Keighley* Corporation invite tenders for the supply and erection of the following plant at their electricity works: Switchboard and balancer, 10-ton overhead traveller, storage battery, mains, conduits, arc lamps and posts, ejector condensers, exhaust pipes and tanks, main, steam, and feed water pipes. An advertisement gives further particulars, and specifications, &c., may be obtained from the borough electrical engineer (Mr. J. M. Smyth). Tenders, addressed chairman of the Electricity committee, Bridge street, Keighley, to be in by 10 a.m. March 1.

The *Sunderland* Corporation require tenders for the supply of (*a*) steam exhaust, feed, and other pipes, and (*b*) two steam-driven induced draught fans and accessories. An advertisement gives further particulars, and specifications, &c., may be obtained from the borough electrical engineer (Mr. J. F. C. Snell), Dunning-street, Sunderland. (Tenders, addressed chairman of Lighting committee, Town Hall, Sunderland, to be delivered at the office of the town clerk (Mr. Fras. M. Bowey) by noon March 2.

The Vestry of *Shoreditch* (London) are open to receive proposals and to contract for articles and works for one year from March 26, 1900, to March 25, 1901, inclusive. The contracts for the electricity department include electric cables and sundries, engineers' stores, ironmongery, tools, &c., wiring and fittings materials. Samples of these requirements may be seen at the electric lighting station, Coronet-street, Old-street, E.C., and at the Town Hall, Old-street, E.C. Further particulars will be found in an advertisement elsewhere, and tenders have to be sent in to Dr. H. Mansfield Robinson, Shoreditch Town Hall, Old-street, London, E.C., before 3 p.m. of Tuesday, 27th inst.

The *Salford* Corporation invite tenders for the supply and erection of electrically-driven mechanical stokers, economisers and fittings, jet condensers and pumps with steam exhaust and water pipes, electrically-driven feed pumps and feed pipes, and travelling crane. Copies of specification, &c., can be obtained from the consulting engineers (Messrs. Lacey, Clirehugh and Sillar), 2, Queen Anne's-gate, Westminster, S.W., and 78, King-street, Manchester. Some further particulars are given in an advertisement, and tenders must be delivered to the town clerk (Mr. L. C. Evans) by 10 a.m. of 28th inst.

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The *Wigan* Electric Light and Tramway department invite tenders for the supply and delivery of 3,000ft. of 2in. and 3,000ft. of 1½in. gas barrel. Further particulars are given in an advertisement, and tenders must be addressed to the chief electrical engineer (Mr. H. Collings Bishop), Bradford-place, Wigan, by Saturday, 24th inst.

The Corporation of *Durban* (Natal) invite tenders for the supply and delivery at Durban of: 1,900 tons steel girder rails, 64 tons fish plates, the necessary fish bolts, nuts, tie bars, and electric bonds; 407 lots Australian hardwood stringers, with the necessary dog spikes. An advertisement contains further particulars, and specifications, &c., can be obtained on application to the agents to the Corporation (Messrs. Webster, Steel and Co.), 5, East India-avenue, Leadenhall-street, London, E.C. Sealed tenders (in duplicate) must be delivered to Messrs. Webster, Steel and Co., by Thursday, March 8, or to the town clerk, Durban, by mail delivery, on or about Monday, April 2.

The *Aberdeen* Tramways committee invite tenders for the supply of four electrically-equipped tramcars and other material. Specifications may be obtained from the city electrical engineer (Mr. J. Alex. Bell), electricity works, Cotton-street, Aberdeen, after 12th inst. Tenders to town clerk (Mr. W. Gordon), Town House, Aberdeen, by noon of 28th inst. An advertisement gives further particulars.

The *Gloucester* Corporation invite tenders for the wiring of the Guildhall, public baths, and electricity works, and for supplying the necessary fittings. Specifications can be obtained from the town clerk (Mr. G. Sheffield Blakeway), Guildhall, Gloucester, and tenders must be in by Feb. 27. An advertisement contains further particulars.

The *Portsmouth* Electric Lighting committee require a third assistant engineer. Applications to superintendent, Gun Wharf-road, by 14th inst. See advertisement.

The New Tramways committee of the *Newcastle upon-Tyne* Corporation invite tenders for copper bonds. Particulars and forms of tender may be obtained after 10th inst. from the consulting engineer, Mr. Charles Hopkinson, M.Inst.C.E. (Messrs. Hopkinsons and Talbot), 29, Princess-street, Manchester.

The Electric Light committee of the Vestry of *St. Mary, Newington* (London), require tenders for the supply and erection of two water-tube boilers, feed pump, and sundry extensions to the steam and water mains for the electricity works at Penrose-street. Tenders to clerk (Mr. L. J. Dunham), Vestry Hall, Walworth-road, London, S.E., by 20th inst.

The *York* Corporation invite tenders for the conversion of the wiring of the Guildhall and public library to suit the higher voltage of the mains. Tenders to Mr. C. A. Midgley by Feb. 15.

The *Rochdale* Corporation invite tenders for the supply and delivery of electricity meters. Tenders to town clerk (Mr. James Leach) by 26th inst.

The *Kingston-upon-Hull* Corporation invite tenders for the supply of 35 double motor equipments and 10 car bodies (double-decked) to seat about 51 passengers. Tenders, addressed chairman Works committee, must be in by Feb. 19.

The *Bootle* Corporation require tenders for supplying and laying underground electric cables. Tenders to Town Hall, Bootle, by Feb. 17.

The *Glasgow* Corporation invite tenders for the supply of (1) 200/300 motor car trucks, (2) 200/300 motors and equipments, (3) supply, delivery and erection of overhead trolley constructional work. Tenders to Sir J. D. Marwick, Glasgow, by Feb. 17.

The Corporation of *Hastings* require tenders for the supply and delivery of twelve 20 kw. alternating-current transformers and high and low-tension switch gear. Tenders to Mr. B. F. Meadows, Town Hall, Hastings, by noon of Feb. 12.

The *Bath* Corporation invite tenders for high and low-tension cables, arc lamps, transformers, switchboards, &c. Tenders by Feb. 12.

The *Postmaster-General* invites tenders for the work of laying underground conduits and pipes for telephone purposes in several parts of the Metropolis. Forms of tender from the Controller of Stores (Mr. Chas. E. Stuart), G.P.O. Tenders by noon, Feb. 15.

The Corporation of *Great Yarmouth* invite tenders for the supply and erection of two water-tube boilers and three 200 kw. continuous-current steam dynamos. Tenders by 10 a.m., Feb. 15.

The *Walthamstow* District Council invite tenders for plant for electric lighting of their Isolation Hospital at Chingford. Tenders to clerk by 23rd inst.

Tenders are required for the public lighting of *Bridlington* for twelve months. Tenders to clerk by 14th inst.

The *Islington* (London) Vestry require tenders for electrical stores for one year, from March 25. Tenders to Vestry Clerk by 22nd inst.

The *Hammersmith* (London) Vestry invite tenders for electrical stores for 12 months to March 25, 1901. Tenders by 6 p.m., Feb. 14.

The *Birkenhead* Corporation require tenders for feeder and distribution mains. Tenders by March 1.

Tenders are invited by the *Swedish* Telegraph Administration for the supply of 300,000 kg. of 4·5 mm. copper wire and 190,000 kg. of 3·0 mm. copper wire. Tenders by 15th inst.

TENDERS RECEIVED AND ACCEPTED.

The contractors for the supply of the electric generating plant for electric lighting of the Felsted School are as follows (Crompton dynamos, Babcock boiler, Western Electric cables, and Chloride accumulators are specified in the contract):—

Section 1.—Boiler, Two 27 kw. Steam Dynamos, Condenser and Pipe Work, &c.

Reavell & Co. (*accepted*)	£2,318	10	0	Brush Co.	£3,057	10	0
F. Nell	3,697	0	0	Clark and Aiton	2,991	0	0
Elec. Construction Co.	3,341	0	0	W. H. Allen, Son & Co.	2,982	0	0
T. Metcalfe (Ltd.)	3,335	0	0	G. Wailes and Co.	2,902	17	6
C. A. Parsons and Co.	3,159	0	0	Crompton and Co.	2,837	0	0
Foote and Milne	3,102	0	0	E. Scott and Mountain	2,767	0	0
Ditto	2,870	0	0	Johnson and Phillips	2,740	0	0
Christy Bros. and Middleton	3,101	16	0	Rooper and Robins	2,434	6	0

Section 2.—Accumulators.

*W. J. Fryer & Co. (Chloride cells)	£481	0	0	Elec. Power Storage Co.	£551	17	6
Ditto (P. & G. cells)	415	0	0	Christy Bros. & Middleton	519	6	0
R. D. Cassells and Co.	789	0	0	Tudor Accumulator Co.	546	0	0
Gudgeon and Co.	760	0	0	W. C. Horne and Co.	530	18	0
Ashmore, Benson, Pease and Co.	587	0	0	Chloride Elec. Storage Syndicate	483	0	0
Rooper and Robins	584	0	0	Hart Accumulator Co.	425	0	0
Foote and Milne	580	0	0	Pritchetts and Gold	422	0	0

Section 3.—Cables.

*W. J. Fryer and Co.	£354	18	11	Christy Bros. & Middleton	£600	7	8
W. T. Glover and Co.	845	0	5	Foote and Milne	482	10	0
Johnson and Phillips	790	0	0	British Insulated Wire Co. (Ltd.)	468	17	0
Gudgeon and Co.	782	3	9				
Western Electric Co.	690	0	0				

Section 4.—Switchboard.

*W. J. Fryer and Co.	£110	0	0	Christy Bros. & Middleton	£158	0	0
Elec. Construction Co.	250	0	0	Rooper and Robins	135	0	0
Edison and Swan Co.	250	0	0	Elec. Transmission Co.	130	0	0
R. D. Cassells and Co.	197	8	0	General Electric Co	126	0	0
Crompton and Co.	181	0	0	Middleton and Co.	125	0	0
Foote and Milne	175	0	0	Gudgeon and Co.	93	15	0
T. Scott Anderson & Co.	160	0	0				

* Accepted as sub-contractors of Reavell & Co.

The following tenders have been received by the Tunbridge Wells Town Council for the supply of additional plant for the electricity works:—

400 kw. Steam Alternator.

Electric Construction Co. (Willans engine)	£4,615
S. Z. de Ferranti (Ltd.) (Willans engine)	4,677
Ditto (Ferranti engine)	4,820
Frank Suter and Co. (Helios dynamo and Willans engine)	4,827
General Electric Co. (Oerlikon dynamo and Willans engine)	4,834
Crompton and Co. (Willans engine)	4,896
Brush Co. (Universal engine)	5,310
C. A. Parsons and Co. (turbo-alternator)	4,375

Condensing Plant.

W. H. Allen, Son and Co.	£4,505
Ditto (with centrifugal pump)	3,855
Wheeler Condenser and Engineering Co.	4,471
Klein Engineering Co.	4,621
Worthington and Co.	4,975
Ditto (own pump)	4,647
Ditto (Baths scheme)	4,167

Two Lancashire Boilers.

Tinkers (Ltd.)	£3,060	Yates and Thom	£3,236
E. Danks and Co.	3,070	Musgrave and Sons	3,413

The following tenders have been accepted by the Barking District Council for the supply of additional electrical plant:—

Babcock & Wilcox (water-tube boilers, with fittings, economiser, feed pump, &c.)	£1,704	0	
Babcock & Wilcox (pipe work, &c., in engine and boiler house)	506	0	
Thames Ironworks Co. (two 100 kw. steam dynamos, vertical enclosed high-speed Allen engines)	2,094	0	
General Electric Co. (main switchboard and connections)	606	10	

The Council have deferred the consideration of the tenders for sections E (motor and trailer cars, trucks, and electrical equipment), F (overhead line equipments, posts, &c.), and G (underground feeder cables, conduits, road work, &c.) until the tenders for the opening bridge and embankments are under consideration.

The Shoreditch (London) Vestry have received the following tenders for the supply of cable for service connections:—

W. T. Henley's Co. (*accepted*)	£899	6	1
British Insulated Wire Co.	924	6	7
W. T. Glover and Co.	922	19	0

The Manchester Corporation has accepted the tender of Messrs. S. Z. de Ferranti (Ltd.) for the supply of two 1,000 H.P. generating sets for the Dickinson-street station at £18,000.

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The Newcastle-upon-Tyne Corporation were recommended to accept the following tenders for their electric tramway undertaking. The matter was debated on Wednesday, when the minutes were referred back for further consideration :—

British Westinghouse Co. (one 2,000 H.P. generator, with engine by Wallsend Slipway Co.), at £16,230.

Ditto (two 1,000 H.P. generators, with engines by Victor Coates and Co.), at £16,450.

Thos. Beeley and Son (for three superheaters for boilers), at £710.

The contract for excavation and concreting foundations for chimney at the new power station has been let to Mr. D. N. Brims at £1,651. 13s. 11d.

Nine tenders have been received for laying the rails and constructing the permanent way, but these have not yet been analysed.

The Hull Tramways Committee have accepted the tender of the Electric Railway and Carriage Works Co. to convert the five trailer cars which were to have been supplied under their contract, into motor cars for £300 each. The tender of the British Westinghouse Co. to supply five electrical equipments for the cars at £281 5s. 0d. per car has also been accepted.

The Sheffield Electric Lighting committee have accepted the tender of the Tasker Engineering Co. for the supply of steam and exhaust pipes and an independent jet condenser for the electric lighting station, at £1,732.

The tender of Macartney, McElroy and Co. has been accepted by the Southampton Council for the electric lighting of the tramway depôt at Shirley, at £225. 10s.

The tender of Mr. S. Page has been accepted by the Croydon Corporation for the erection of electricity station building extensions at £4,713. Nine tenders, varying from £5,726 to that of the accepted tender, were submitted.

A contract has been placed with Messrs. Davey, Paxman and Co., through their South African representative (Mr. J. W. Logan), for the supply of four loco. boilers for the Cape Town electricity works.

APPOINTMENTS VACANT AND FILLED.

A first-class electrical engineer is required for the Glasgow Corporation tramways. Particulars are set out in an advertisement elsewhere, and applications must be addressed to the manager of the tramways department (Mr. John Young), 88, Renfield street, Glasgow, or or before Feb. 24.

The Manchester Tramways committee require an assistant permanent way engineer. An advertisement gives further particulars, and applications (addressed chairman of committee, Town Hall, Manchester) must be in by Feb. 24.

The Bradford Electricity committee recommend the appointment of Mr. R. A. Chattock, superintendent engineer of the City of London Electric Lighting Co., as borough electrical engineer, *vice* Mr. A. H. Gibbings, resigned. The total number of applicants (40) was first reduced to ten, and then to the following four: Messrs. R. A. Chattock; C. A. L. Prusmann, borough electrical engineer at Doncaster; John Christie, resident station engineer at Glasgow; and H. F. Street, borough electrical engineer at Halifax. In 1894 Mr. Chattock was assistant engineer to the Metropolitan Electric Supply Co., and at the end of that year was appointed electrical engineer to the Hampstead (London) Vestry. In 1895 he joined the City of London Co.

BUSINESS NOTICES.

The electrical engineering business formerly carried on by Messrs. Calvert and Co., of Manchester, has been taken over by Mr. J. Collier (late assistant engineer with Messrs. Lacey, Clirehugh and Sillar), and is being carried on under the style of John Collier and Co.

The Electric "Tested" Lamp Co. have retained Mr. Haydn T. Harrison, M.I.E.E., as superintendent of their general testing and inspection department.

Messrs. Cox-Walkers, Darlington, inform us that during the past year they have been placed on the War Office list of contractors, and that the extent of the orders received by the firm, especially in telephone, fire alarm, switchboard and tell-tale apparatus work, has necessitated considerable extensions to their manufacturing premises.

Messrs. C. T. Mason, T. H. Wathes, and S. R. Brown (trading as Mason, Wathes and Brown), electricians, 80, Rutland-street, Leicester, have dissolved partnership. Debts by Messrs. Mason and Brown, who continue.

Messrs. J. B. McMorine and G. E. Bryan (trading as Mack, Bryan and Co.), electrical engineers, &c., 21, Old Haymarket, Liverpool, have dissolved partnership.

From Feb. 12 the address of Messrs. O'Gorman and Cozens-Hardy will be 82 instead of 66, Victoria-street, Westminster, London, S.W.

BANKRUPTCIES, LIQUIDATIONS, &c.

It has been resolved to wind up voluntarily the Crowdus Accumulator Syndicate (Ltd.), and Mr. C. Scott, 32, Victoria-street, London, S.W., has been appointed liquidator.

A meeting of the Electrical Time Recording Co. (Ltd.) will be held at 31, Bedford-row, London, W.C., on March 7, to receive an account of the winding up.

Meetings of the Direct Electric Generator Syndicate (Ltd.) and of the Direct Electric Generator (Foreign Patents) Syndicate (Ltd.) will be held on March 5 at 64, Gresham-street, London, E.C., to receive an account of the winding up.

The trustee in the bankruptcy of J. H. Dewhurst and Geo. Longden (trading as John Dewhurst and Son), Electrical and Mechanical Engineers, Attercliffe-road, Sheffield, has been released.

The discharge of E. A. Max Winter, electrical engineer, Amberley House, Norfolk-street, London, W.C., has been suspended for two years. The accounts showed liabilities £984. 11s. 2d. and assets nil. Bankrupt traded as the Imperial Electric Light and Power Co.

The first meeting of creditors of Frederick King, electrical engineer, Stone Bridge, Bristol, took place on Wednesday. Gross liabilities £822. 17s. 11d., assets nil. The receiving order has been made on the petition of the debtor's late partner. The cause of insolvency is stated to be that debtor's share in the partnership business had been overdrawn.

Dividend.—Mr. A. Dodds Fairbairn, liquidator in the matter of G. R. Blot and Co. (Ltd.), has just declared a first and final dividend of 20s. in the £, which is payable to creditors any day, except Saturday, between 11 and 2.

Plant for Sale.—Messrs. Allbright and Wilson (Ltd.), Oldbury, near Birmingham, have for sale three Babcock-Wilcox boilers and a Crompton steam dynamo. See advertisement.

Personal.—On Friday last Mr. R. A. Dawbarn, late superintending engineer of the Brush Co., was presented, at the London offices of the company, with a token of esteem and goodwill (subscribed for jointly at the Falcon works and the London office) on the occasion of his leaving the company to join the ranks of consulting engineers. The presentation was made in happy terms by Mr. F. Percy Sellon, and was suitably acknowledged by Mr. Dawbarn.

Electrical Accessories List.—Messrs. C. L. Ford and Co. send a new price list and catalogue of pocket accumulators, electric cycle lamps, bells, and accessories.

Calendars.—A unique calendar for 1900 is sent out by Messrs. Sax, Slatter and Co. (Ltd.). This takes the form of a standing desk or table almanack, 4in. by 5½in., the calendar being very neatly printed on metal. The printing work is admirable, as the letterpress is well stamped into the metal.

"Engineering Magazine."—The contents of the February issue of this magazine include an article on "The Development of Wireless Telegraphy."

"Cassier's Magazine."—The articles in the February issue include: "British Tramway Development," "Labour Clauses in Public Contracts," "Modern Machine Shop Economies," and "The Manufacture of Structural Steel in the United States."

Gong List.—A new wholesale list of bell metal and nickel-plated stamped steel gongs for electric apparatus is issued by Messrs. Coxon, Schmahl and Burrell, of 18, Grainger-street, Newcastle-on-Tyne.

Motor Starting Switches.—Messrs. Wm. McGeoch and Co. forward an illustrated booklet describing a new patent automatic starting switch for electric motors.

Patent Amendment.—Mr. Henry Reason, 112, Glo'ster-road, and the Mutual Electric Trust (Ltd.), 111, Glo'ster-road, Brighton, have applied for leave to amend specification of letters patent No. 17,764 (1898) for "Improvements in or connected with electric meters." Particulars of the proposed amendment are set out in the *Illustrated Official Journal (Patents)* of the 31st ult., and notice of opposition must be given within one calendar month of that date.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Jan. 31 to Feb. 6, with the ports of destination :—

Africa—Cape Town, £221 (including £95 telegraph sundries); Chinde, £368 (telegraph material); Durban, £409; East London, £33; Port Said, £43; *Argentina*—Buenos Ayres, £848 (including £458 telegraph material). *Australasia*—Brisbane, £169; Launceston, £63; Melbourne, £601; Perth, £132; Rockhampton, £1,300; Sydney, £699. *Belgium*—Ostend, £206. *Ceylon*—Colombo, £76. *China*—Shanghai, £405; Tientsin, £90 (telegraph material). *Germany*—Hamburg, £971 (including £400 telegraph material). *Gibraltar*—£37. *Holland*—Amsterdam, £50. *Hong Kong*—£156. *India*—Calcutta, £2,427. *Japan*—Kobe, £71 (telegraph cable); Yokohama, £896. *Madeira*—£28. *Norway*—Christiania, £60 (telegraph wire). *Portugal*—Lisbon, 2 tons (telegraph wire). *Russia*—St. Petersburg, £220 (telegraph wire) and £377 (telegraph paper). *St. Vincent and Ascension*—£303,334 (telegraph cable). *Siam*—Bangkok, £141. *Straits Settlements*—Singapore, £64. Total £314,495, against £25,432 in the corresponding week last year (Feb. 1 to 7).

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MUNICIPAL, FOREIGN, AND GENERAL NOTES.

Accrington.—The Town Council have authorised application to be made for a loan for electric lighting.

Asylum Lighting.—The contract for the lighting of the North Riding (Yorks.) Lunatic Asylum has been placed with Messrs. Crompton & Co. The installation is being erected to the specification of the consulting engineer (Mr. A. A. Campbell Swinton).

Barnsley.—The municipal electric tramway scheme has been bandoned, and terms have been made with the British Electric Traction Co. for the construction of a system of electric tramways in Barnsley and adjacent districts.

Birmingham.—A proposal by the Markets and Fairs committee to considerably extend the vegetable market and to adopt a scheme of electric lighting for the whole of the market was approved at the last meeting of the Corporation.

Blackburn.—The Council have decided to borrow £220,000 for electric tramway extensions. The system is to be extended through the Audley district to Queen's Park. The borough electrical engineer (Mr. A. S. Childs) has also been authorised to electrically equip the Church, Darwen, and Cemetery sections.

Blackpool.—An inquiry was held on Tuesday into the application of the Corporation to borrow £42,515 for electric lighting. The town clerk (Mr. T. Loftos) stated that that was the fifth application for sanction to an electric lighting loan, and since 1893 £120,000 had been borrowed. Their undertaking had made steady progress, and consumers had increased from 112 to 900. It was, therefore, necessary, with a view to meeting the increasing demand for electric current for lighting and for providing electric energy for working the tramways, that certain extensions should be carried out. Particulars of the extension scheme were then given by the borough electrical engineer (Mr. R. C. Quin), and the application was also supported by the Chairman of the Electricity committeee Ald. Brodie. There was no opposition.

Bolton.—The Local Government Board have sanctioned the borrowing of £79,750, out of £100,000 applied for electric lighting extensions. The Board intimate that the question of sanctioning the balance is held over until the work is ready to be undertaken.

Bootle.—The Council on Wednesday approved the recommendation of the Highways committee to lay tramway rails in Derby-road and Rimrose-road, at an estimated cost of £6,500. The relaying of the existing setts in the latter road and the repaving of the former road are to be carried out at an estimated cost of £8,209. The work is to be finished by the time the Liverpool Corporation are prepared to run electric car service on the adjoining city lines. Application is to be made for sanction to the necessary expenditure.

Brighton.—Messrs. Page and Miles recently submitted a proposal for wiring and fitting premises in the district, and also for letting electric motors and other apparatus on hire. This proposal has been examined by the Lighting committee, who reported that, with slight modifications, the scheme was a practicable one, and that the electricity undertaking would derive sufficient benefit from it to justify the Council in undertaking, on behalf of the contractors, the collection of the charges made for the use of the wires and fittings. The committee therefore recommended that the Council offer all wiring contractors in the borough to collect on their behalf for seven years from the commencement of the collection the rents or charges agreed to be paid by the owner or occupier of premises in which wiring is actually installed or fittings supplied on the hire system upon the following terms:—

(1) The charges not to exceed 3s. per lamp per annum. The lamp to be 8, 16, or 25 c.p., as desired. Where additional lights are required on the same fitting or at the same "point," the rate shall not exceed 1s. per annum for each additional lamp; (2) the consumer shall have the right to purchase the installation at any time after completion on terms to be agreed previous to the execution of the agreement for the hiring of the wiring or fittings; (3) the Council will undertake the collection of the charges agreed to be paid by the consumer to the wiring contractor, and to account for the same less 2½ per cent. for cost of collection; (4) the collection to be quarterly, and all accounts of sums to be collected on behalf of the wiring contractor to be left at the rate office before the last day of each quarter; (5) the Corporation not to be required to make more than one demand in respect of any account, or to sue or take any steps to compel payment of the account if not paid, nor shall their collector be called upon to prove delivery of such account; (6) if the same sum or a less sum than the amount of the Corporation account for electricity is obtained from a consumer, the whole of the payment made to go in discharge of the Corporation account; (7) wiring contractors to furnish the Corporation with a copy of every agreement between themselves and any consumer in respect of which the Corporation are requested to collect hiring charges.

This report was presented and approved at the last meeting of the Council.

Burnley.—Notwithstanding that the Corporation's tramway bill is being opposed by the Nelson, Padiham, and Brierfield local authorities, the Corporation have decided to proceed with their scheme. Another effort is, however, to be made to come to terms with the local authorities named.

Bristol.—In the quarterly report of the gas examiner to the sanitary authority (Mr. B. Kitt) it is stated that the total number of gas lamps discontinued in the districts now lighted electrically is 599, and the total number of electric lamps installed is 306. The consumption of gas during the past quarter shows a decrease of 1,385,544 cubic feet compared with the corresponding quarter last year. This decrease is attributed to the extension of the electric light

Cardiff.—At the meeting of the Electric Lighting committee last week the town clerk presented a report upon the result of the action brought by the Corporation against Messrs. S. Z. de Ferranti (Ltd.). The judge having made a suggestion that a reasonable settlement might be effected, it was eventually agreed that the defendants should pay £2,000 and costs, the Corporation to pay the £325 balance of account.

A special meeting of the Electrical committee was held on Monday, to consider the reports of the electrical engineer (Mr. N. Appelbee), the assistant engineer (Mr. Teasdel), and the mains superintendent (Mr. Pengelly) on the failures of the electric light in October last. Mr. Appelbee in his report said that the cause of the failure of the arc lights was due to the condition of the mains and not the rectifiers. The mains were defective because water had found its way into six or seven of the joint boxes, the presence of which was not revealed by the daily test as to their condition. The responsibility for the presence of this water must be divided between Mr. Teasdel and Mr. Pengelly. He, however, accepted all responsibility for past failures. Mr. Teasdel's report located the defects, and stated that now all the lamps, with two exceptions, were running. Mr. Pengelly's report was to the effect that the defects on the arc circuits were extensive, and that he had failed to remedy them in time. He could not supervise each box being made watertight because he had too much work to do. Mr. Appelbee's report as to subsequent failures was that, as regarded the arc lighting the failures were generally due to the rectifiers. Out of 14 short extinctions, varying from half a minute to five minutes, 11 were due to the rectifiers. A year ago he recommended getting rid of the rectifiers. The failure on Friday, Feb. 2, was due to water in a transformer chamber. Everything that human intelligence and engineering skill could devise was done to keep matters right. The matter was was discussed at considerable length, but finally a resolution that "the chief of the department have complete control over all the men, including the deputy engineer and the mains superintendent, and have power to discharge or engage all employés except the two mentioned, but that he should have power to suspend either of them and report them to the committee," was carried, with one dissentient. This arrangement is to continue for six months.

Cork.—The proposal of the Cork Electric Tramways and Lighting Co. to extend their system from Ballen Temple to Blackrock has been approved by the County Council.

Croydon.—A deputation from the Corporation, accompanied by the consulting engineer (Mr. E. W. Monkhouse), are visiting the principal towns where electric tramways are in operation. This week visits have been paid to Liverpool, Sheffield, and Leeds.

Darlington.—Thirty-one arc lamps are to be erected in the principal thoroughfares of the town.

Dartmouth.—Mr. J. G. W. Aldridge is advising the town council in connection with the application of the Urban Electric Supply Co. for a provisional order.

Derby.—Mr. Moss has resigned the position of chief assistant at the electricity works. The electric light mains are to be extended to Thornhill road.

Discounting Bills in Germany.—We would draw the attention of those who have business dealings with Germany that the German bankers have decided not to discount, accept, or negotiate any bills that have the figures 18 or 189 altered to 1900, even though the alteration should be initialed. The figures 1900 must appear on the bills without alteration.

Durban (Natal).—The whole of the local tramways are to be converted to the overhead trolley system at an estimated capital expenditure of nearly £250,000. The total length is about 17 miles of single track. On another page particulars will be found of the Council's requirements for tram rails, &c. The borough engineer's estimate of the expenditure is as follows: For track and overhead equipment, £88,776; 22 motor cars, £14,000; power station, including power and boiler house, car sheds, repairing shops and offices, coal siding, and 5 per cent. for contingencies, £10,000; generating plant and cables, £21,765, or a total cost of works of £134,541. After allowing an extra 5 per cent. for engineering and other contingencies (£6,727), the gross expenditure works out at £141,268. Deducting the realisable assets of the old tramway undertaking, with profits for one and a half years' working (£22,171), and adding cost of purchase of tramway company's undertaking (£114,000), the total estimated cost of the tramways works out at £233,097, to cover which sum the creation of a municipal loan of £250,000 has been approved by the Council. An annual surplus of £12,150 is estimated for the tramway enterprise.

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Ealing.—The Council have adopted a report of their engineer (Mr. J. D. Knight) recommending extensions of the electricity works. These extensions, comprising a new steam alternator and an exciter and storage battery, are to be provided to meet the anticipated increased load next winter.

Eccles.—In a report from the General Purposes committee just submitted, it was stated that at a recent conference between representatives of the Salford and Eccles Corporations it was suggested that Eccles should obtain powers to construct the lines proposed by the South Lancashire Tramways Bill, and lease them to Salford for at least 21 years, electrical energy being taken from Eccles. As rental 10 per cent. on the capital outlay was suggested, this to include improvements. The Eccles Corporation decided to support Salford in the matter, and to arrange for a continuous passenger service between the Corporation boundaries at Peel Green, Patricroft, and Manchester. It was also resolved, with the view of obtaining protective clauses, to oppose the South Lancashire Tramways, the Manchester and Liverpool Electric Express Railway, and the Lancashire Electric Power bills.

Edinburgh.—The Electric Lighting committee have adopted the recommendation of their chief engineer for the erection of additional generating plant at the Macdonald-road station, at an estimated cost of about £17,000.

Electric Traction Enterprise.—The New York *Commercial Advertiser* states that Mr. A. K. Baylor, recently with the British Thomson-Houston Co., has been in the United States for the past two months, in the interests of the London United, Bristol, and Isle of Thanet Tramway Cos. Previous to his return home, Mr. Baylor is reported to have said that "of the £1,100,000 which it will cost the London, Bristol, and Isle of Thanet Cos. for equipment, certainly 90 per cent. will find its way into American pockets. Already orders had been placed for electrical equipment to the value of £50,000, which amount would have been ten-fold had deliveries been procurable."

For the Front.—We understand that further members of the Edison and Swan Co.'s staff have joined the troops for South Africa, including Mr. Alister Flood-Page (son of Major Flood-Page) and Mr. F. Parsons from the London staff, both of whom have joined the C.I.V., and Mr. Theo. J. Ridge, from Ponder's End, who has joined the Imperial Yeomanry. An organised system of relief has been established at the works, and this fund is now relieving between 40 and 50 families of reservists within a radius of about ten miles of Ponder's End. A very creditable record.

Gateshead-on-Tyne.—The County of Durham Electric Power Distribution Co. have intimated to the Corporation that they propose to commence the execution of the works authorised by the Gateshead provisional order (1899). The Tyneside Electrical Power Co.'s bill is to be opposed by the Corporation.

Grantham.—Formal consent to the application of the Urban Electric Supply Co. for a provisional order has been given by the Town Council.

Great Malvern.—The Council have received offers from two companies to take a transfer of their provisional order.

Guildford.—The Corporation are to be invited, at their next meeting, to open negotiations with the Guildford Electricity Supply Co. for the purchase of their undertaking.

Halifax.—The Electricity committee propose to grant a bonus to the members of the staff at the electricity works as an inducement to effect economies in the working of the station. Last year the total works and management cost per unit was 1·65d. The committee propose that for every one-tenth of a penny, and *pro rata* for every one-hundredth of a penny, a bonus of £130 be given to the staff in the following proportions: To the chief engineer, £50; to the assistant engineer, £40; to each charge engineer (three), £10; and to each driver (four), £2 10s. The scheme is to be in operation for the two years ending March 31st, 1902.

Hammersmith (London).—The Vestry have decided, as an experiment, to light the Grove by arc lamps, at an estimated cost of £941.

Hampstead (London).—In future the commencing salary of assistant electrical engineers is to be £130, instead of £117. West-End-lane is to be lighted by arc lamps.

Hendon.—Mr. Robert Hammond has been appointed consulting engineer to establish a municipal electricity scheme for the District Council on the usual terms—5 per cent. on the executed works.

Hereford.—The Electric Lighting committee reported on Tuesday that the equivalent of 2,283 8 c.p. lamps had been connected to the electric light mains, and 1,413 were awaiting connection. The estimated cost of the electricity works had not been exceeded, but owing to the steady demand for current, the committee are considering the question of providing an additional steam dynamo.

Heysham.—A meeting of the Council is to be held to consider the question of applying for a provisional order. It is probable that arrangements will be made with the Morecambe Council for the supply of current "in bulk."

Heywood.—The Council have approved the electric lighting scheme prepared by Mr. W. P. Adams, and application has been made for the necessary borrowing powers.

Hull.—The Tramways committee have decided to abandon the use of trailer cars on the electric tramways, and the trailers are being converted into motor cars. The city engineer has reported that 100 cars will be required for working the five tramway routes at present in course of construction. The number delivered and on order, exclusive of sample bogey car, is 60, and the five cars to be converted will bring this number up to 65. If trailers are not to be employed, 25 of those on hand could be converted into motor cars, leaving 10 complete motor cars to be obtained. The makers of the trailers, who were asked if they would undertake the conversion of 10 of the cars in four months, and the remaining 15 in seven months, are too busy to do so, and tenders have therefore been invited for 10 additional motor car bodies and for 35 equipments and trucks for the converted car and motor car bodies.

At the Corporation meeting last week the Electric Lighting committee recommended the acceptance of tenders (set out in our last issue) for additional electric lighting plant. Opposition was, however, made to the committee's recommendation to accept the tender of Messrs. Thomas Parker for dynamos (at £5,035), and an amendment, expressing surprise "that the committee did not accept the tender of Earle's Engineering and Shipbuilding Co., and rejecting that portion of the minutes," was carried. Earle's Co. is a local firm, the amount of its tender being £3,725.

Islington (London).—In a report presented to the Vestry by the Finance committee it was stated that they had had under consideration the question of the fire insurance on the electricity station, in connection with the recent extensions of the building and additions to the plant and machinery, the cost of which amounted approximately to £72,000. Having regard to the heavy premium which the Vestry already pays in respect of insurance, and to the considerable addition thereto which will result by the insurance of the extensions referred to, the committee advised that it be ascertained whether the Metropolitan Vestries who are undertakers under the Electric Lighting Acts would combine to form a mutual insurance fund in respect of electricity supply stations. In the meantime, the provisional insurance on the extensions is to be continued. The committee further recommended that a conference of the authorities above mentioned should be invited, in order that the matter may be discussed. The report was adopted in its entirety.

Leeds.—A report on the present position of the electric lighting undertaking of the Corporation has been prepared by the consulting engineers, Messrs. Hopkinsons and Talbot. The present plant at the Whitehall-road station is capable of dealing with a maximum load of 3,000 kw. The maximum demand last year was 1,500 kw. In the coming year it will probably rise to 2,250 kw. The report states that there is ample margin for meeting the increasing demand for some time to come, and if domestic lighting only were contemplated, little capital expenditure would be necessary for two or three years except for cable extensions. The units sold in 1898 were 1,200,000, and it is probable that this year the number will be about 1,800,000. The charges for interest and sinking fund on capital expended amount to £17,500 per annum. In addition, the Corporation is advised to set aside not less than 3 per cent. per annum on the cost of machinery, mains, and transformers, which would now amount to £4,500, to renewals or depreciation fund, and they should borrow, either now or very shortly, about £30,000, the interest and sinking fund on which would come to about £1,500. The total standing charges would then be £23,500 per annum. Assuming an annual sale of 2,400,000 units, in order to meet those charges they would have to make a gross profit of 2·35d. per unit. The total costs in 1898 were 1·4d. per unit, but with the larger output this might be slightly reduced. On a scale of 2,400,000 units, the estimated maximum output of the present plant, therefore, they would have to charge 3¾d. per unit to pay their way. When the plant has to be extended, standing charges would then be increased, but not in proportion to the increased output, and a further reduction in price would be possible. Such reduction would, however, certainly be small, and they might regard 3¼d. as the lowest average price at which they would be able to sell if they confined themselves to domestic lighting. It is intended to expend the balance of £5,000 expected this year on the replacement of the defective rubber cables, the total cost of which will be about £25,000. The supply of electricity for power is next considered by Messrs. Hopkinsons and Talbot, who state that, broadly speaking, the users of power in a city like Leeds might be divided into two classes. Throughout the business districts of the city there will be no places where small motors could be used with advantage. Such small motors would be scattered over a considerable area compared with the total H.P. On the other hand, in the manufacturing centres of the town power was used continuously and on a large scale for manufacturing purposes. In such a district the motors would be of much greater size, and a large amount of power would be concentrated in a small area. To serve the first class properly it was necessary to have mains capable of distributing power

laid over a large area, so that the Corporation might be in a position to supply power for light work without delay. The lighting mains, if of sufficient capacity, and if supplied with a type of current suitable for power distribution, might well be used for this purpose. With manufacturers' power it was different. If a man decided upon working a factory, employing 20 H.P. and upwards, electrically, it would in many cases pay the Corporation to lay a special main for that purpose. Such a factory could not well be worked from the lighting mains, owing to the disturbance of the lights which might ensue. It was also remarked that motors would in general cause more disturbance of the lights in an alternate-current system, if worked off the lighting distributors, than in a continuous-current system, other things being equal. Looking first at the question of supplying what is called domestic power, they might say at once that they believed a good deal could be done in that direction without any change in the present plant. There were several single-phase alternating-current motors on the market which would do fairly well for any purpose in which it was not necessary to start on a load. Broadly speaking, it might be said that where a fast and loose pulley could be used, the single-phase motor could do the work almost but not quite as well as the polyphase motor. They had considered the way in which power could be distributed for all purposes unlimited by the conditions which determine the field of operation of single-phase motors, and practically there were two methods of doing this. The first, which is from an engineering point of view the more satisfactory, was to feed continuous instead of alternating currents into the existing distributors. The change would, however, be so costly that they could not recommend it, an immediate capital expenditure of upwards of £50,000 being required. The question at issue was whether they should leave things as they were, contenting themselves with extending as far as might be the use of single-phase motors; or whether they should change over to three-phase distribution. In the latter case they would gain in being able to supply power for all purposes, including such as required the motor to start on a load, and the public gained to a similar extent in the convenience of having such power at their disposal. Against that must be set an expenditure which they might say with certainty would be between £10,000 and £20,000, and the trouble and inconvenience attendant upon a change of system. The answer to the question must obviously depend on the number and size of the machines in the city which could not be properly driven by single-phase motors. The only objection which could be fairly urged against the two-phase alternating-current system was that it was not satisfactory for the direct supply of arc lights. It would be necessary, therefore, if it was desired to light the streets by means of arc lights, to lay separate mains for the purpose and to supply them with continuous current. This might be done either by rotatory converters or by special arc machines driven by alternate-current motors. The method would depend upon the number and distribution of the lights. The chairman of the Lighting committee (Ald. Wigram) appended to the report the following notes:—

Though it is doubtful whether the provision of power in Leeds will pay, it is desirable to provide it, seeing—

(1) That the centre of Leeds is covered by the single-phase system of current, and that single-phase motors have been greatly improved lately, nor is there any reason to suppose they have reached their maximum perfection;

(2) That there is no apparent demand for power in central Leeds;

(3) That small trades and warehouses tend rather to decrease than to increase;

(4) That the expenditure (£60,000) necessary to introduce direct current into the occupied area could not be reproductive; and

(5) That the distribution of three-phase current in the particular manner suggested by Messrs. Hopkinsons and Talbot is an experiment, and would commit the Corporation to the Westinghouse Co.

He recommends Messrs. Hopkinsons and Talbot's alternative scheme as follows:—

(1) That no change in the current supplied in the occupied district be made at present;

(2) That the committee provide for hire single-phase motors;

(3) That a scale be drawn up covering all charges for motors in a single charge excepting the current used;

(4) That the scale be based on the size of motor; and

(5) That the Britannia Mills site be at once developed, and buildings and machinery be provided to supply current on the two-phase system at 50 alternations, as recommended by Messrs. Hopkinsons and Talbot.

This he contends would render possible the provision of mains, converting stations, and plant to convert two-phase current into direct if found desirable. These recommendations were adopted at Wednesday's meeting of the Council.

Leith.—Sanction to the raising of a further loan of £10,000, for electric lighting purposes has been received.

Light and Power Contracts.—We are informed that amongst the contracts completed during the past year by Cox-Walkers, of Darlington, is an extensive plant for the Tees Union Shipping Co., Middlesboro', comprising two direct-coupled steam dynamos, with Belliss engines developing 175 I.H.P., which supply current for electric cranes on the wharf. Two of these cranes (each to lift five tons) out of a total of eight, have already been erected. Each crane has a 30 H.P. lifting and a 20 H.P. slewing motor, and both motions can be operation at one time. Bare copper mains of 0·5 sq. in. sectional area are carried on porcelain insulators under the wharf, and special flexible couplings are provided, so that the cranes may be attached at any desired position. Motors have also been fixed for driving the fitting and joiners' shops, and a 13 H.P. motor for the circular saw. The wharf has been lighted by ten 3,000 c.p. double carbon arc lamps, erected on 60ft. poles. There are also about 150 incandescents in the warehouses, shops and offices.

Light Railways.—The Board of Trade has confirmed the Essington-Darlaston (Staffs.) light railway order. The Redditch to Astwood Bank and the North Lindsey (Frodingham and Scunthorpe to Whitton, Winterton and Winteringham) light railway orders have also been confirmed in a modified form.

Liverpool.—The estimates of the Tramways committee were presented by Ald. Petrie at the Corporation meeting on Wednesday. Provision has been made for the reconstruction in the course of the present year of the whole of the existing horse tramways, in addition to the laying of about 20 miles of new routes at a total capital expenditure of about £600,000. The estimates were passed. Ald. Petrie also announced that the committee did not intend to purchase any further foreign tramcars.

London County Council.—At Tuesday's meeting the Finance committee reported that the following electricity loans had been completed: Hackney £30,000, Whitechapel £20,000, St. Pancras £400 (for street lamps). The Parliamentary committee recommended the Council to withhold its consent to the South-Eastern Metropolitan Tramways bill, by which power is sought to make certain tramway extensions in Lewisham and Penge, and also outside the County of London.

Longton.—A deputation has been appointed to confer with the clerk to the Fenton Council in connection with the proposal to establish joint electricity works for the two towns.

Ludlow.—Mr. J. Enright has been appointed consulting engineer to prepare an electric lighting scheme.

Manchester.—At the Council meeting on Wednesday, the Corporation's tramways bill was formally approved. The chairman of the Electric Lighting committee (Ald. Higginbotham) said, in reply to Mr. Brocklehurst, that a request had been received from the Board of Trade for a full report as to the explosion which recently took place in front of the Royal Exchange. The explosion arose from one of the electric cables having been damaged by workmen engaged in street work. Another explosion occurred on Monday week in Market-street. The sole cause of that was that the original indiarubber cables had deteriorated in consequence of the moisture that existed in the Manchester atmosphere, and they were now being replaced as quickly as possible. Mr. Trotter, the electrical inspector of the Board of Trade, approved of the steps taken, and stated that the troubles which were being experienced in Manchester were only in accord with the experience of other towns using the same kind of cable. Three hundred men were being employed in laying down the newer form of cable.

The Tramways committee having further considered the question as to the most suitable type of overhead equipment for adoption in the city, recommend the use of the span wire system of construction, with the trolley wire immediately over the support of the trolley pole, in all causes except in wide streets, where centre-poles, having the trolley wire suspended by flexible supports immediately over the base of the trolley pole should be adopted. The city electrical engineer (Mr. C. H. Wordingham) has been instructed to proceed with the drawing of the specifications for equipment of the lines first proposed to be dealt with.

Marylebone (London).—The Vestry have adopted the following resolution: "That notice be given to all parties entitled thereto that the Vestry intend at the proper time to apply for a provisional order for generating and supplying electricity to the inhabitants of Marylebone."

Mexico.—According to the report of the United States consul at Progreso the Electric Lighting Co. of Merida (Compania de Luz Electrica de Merida) is about to order additional electric and steam plant and materials. The president of the company is M. Rafael Peon.

Municipal Telephony—Major-Gen. C. E. Webber, who was recently appointed by the Grantham Town Council to prepare a report on the advisibility of establishing a municipal telephone service, has presented his report. Major-Gen. Webber explained to a meeting of the Council in committee the chief points in establishing a municipal system for Grantham and neighbourhood, and the committee expressed the opinion that a need exists for the establishment of such a system as will, while affording subscribers the benefits of communication with other towns over the trunk wires, mainly afford a local service. The consulting engineer assured the committee that if a licence were obtained such a system (provided a sufficient number of subscribers were obtained) would be self-supporting. The follow-

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ing rates were tentatively suggested for the local service: Subscribers in town £2. 10s. per annum, rural subscribers £2. 10s. plus 10s. per annum per mile distant from Grantham. The committee recommend the Council to petition the Postmaster-General for a licence under the Act of 1899, and to authorise Gen. Webber to sign and make such application on behalf of the Council, and this has been agreed to by the Council.

Naples.—The electric tramway route from the extreme west-end of the city to Capodimonte is now working, and progress is being made with the section from Naples to Torre del Greco. On the completion of this portion of the line the ascent of Posilipo will be put in hand.

Nuneaton.—A light railway inquiry was held on Friday into an application to authorise the construction of a light (electric) railway from the London and North Western and Midland Railway stations, through Nuneaton to Ansley. The application, which was supported by the Nuneaton Council and the Warwick County Council, was granted after slight modification.

Oswestry.—The Local Government Board have intimated to the Council that they cannot sanction their application for the borrowing of £18,000 for the purchase of the undertaking of the Oswestry Electric Light and Power Co. and for carrying out certain extensions of same. The Council's application for a provisional order to take over the undertaking thus falls to the ground.

Photographic Centenary.—The right to the title to be called the discoverer of photography is claimed by the French for M. Daguerre, but this claim is contested. It is asserted that on Feb. 11, 1900, the hundredth anniversary of the birth of Henry Fox Talbot, an Englishman, will be celebrated, for whom it can justly be claimed that he was the discoverer of the method of photography which was the precursor of the present-day systems. Talbot's public announcement of a successful photographic process anticipated Daguerre's by some months, and, except as a curiosity, Dagnerre's method and all modifications thereof have been dead for half-a-century. Particulars of the work of Fox Talbot, with examples of photographic plates, are to appear in the *Photogram* for February, March, and April, 1900.

Poplar (London).—Pending the acquisition of powers to wire consumers' premises, the District Board of Works has decided to invite schemes for wiring premises, and for hiring motors and fittings, &c. The Board has also decided to ask the London County Council, as the central authority, to promote a bill to enable metropolitan local authorities to borrow money for the purpose of wiring consumers' premises, and to carry out such work. The metropolitan local authorities are also to be urged to support this proposal.

Private Bill Legislation.—By arrangement between the chairmen of committees (Lord Morley and Mr. J. W. Lowther), private bills have been allocated between the two Houses of Parliament as follows: The Blackpool, St. Annes and Lytham Tramways, Knott End Railway, Lancashire Electric Power, Lancaster Corporation, Liverpool Corporation, Manchester and Liverpool Electric Express Railway, South Lancashire Tramways, Southport Extension and Tramways, Southport and Lytham Tramroad bills will be introduced in the House of Commons, while the Liverpool Overhead Railway, Mersey Railway, Preston Corporation, and Wirral Railway bills will commence their career in the House of Lords.

Railway Carriage Lighting.—We are informed by Messrs. Ellis and Ward, of Birmingham, that several orders for the electric lighting of railway carriages on the Natal and Cape Government railways have been recently placed with that firm, who have during the past few months executed a number of orders of this character.

Salford.—The Corporation have increased the salary of the borough electrical engineer (Mr. C. L. Turner) from £300 to £340 per annum, while the salary of the principal of the Municipal Technical Institute (Mr. W. Wilson, M.A.) has been increased from £450 to £500. Some friction having arisen between the Tramways and the Electric Lighting committees as to their respective spheres of influence, the following resolution was passed at the meeting of the Corporation on Wednesday—

That the Electric Light committee fix and maintain all plant up to the point of contact of the trolley wheel and overhead wires required to work the tramways, and charge the capital cost and maintenance thereof to the Tramways committee, and charge for electric current separate from any cost of maintenance or other expenses whatever.

Shoreditch (London).—The Vestry have decided to appoint two representatives to attend the conference convened by the Battersea Vestry with a view to united action by all the vestries affected by the County of London Co.'s bill.

Mr. Moss, chairman of the Lighting committee, stated at the last meeting that the well at the electric light station had been sunk to a depth of 362ft. at a cost of £1,385, and that after a week's trial the yield of water had amounted to 6,000 gallons per hour.

The Finance committee reported that the consulting engineers estimated the cost of the new generating station at Haggerston at £96,000, of which £32,095 was for buildings and £63,905 for machinery and plant. It was decided to apply to the County Council for sanction to a loan for that amount. Mains are to be laid in Canal-road, at an estimated cost of £900.

South Wales Electrical Power Scheme.—A conference of local authorities affected by this scheme was held at Cardiff on Wednesday, when it was decided to oppose the second reading of the bill, and the local authorities in the area scheduled have been requested to urge their members of Parliament to support the opposition.

Stockton.—The maximum demand system of charging for electric current will be adopted by the council, the charge for the first hundred hours' maximum use per quarter will be 6d. per unit and 2½d. after.

Telephones at Glasgow.—At the last meeting of the Corporation the minutes of the Telephone Service committee (fully set out in our last issue) were discussed, and the motion for their adoption was approved.

Telephone Statistics.—On Dec. 31 last the number of exchanges on the National Telephone system was 930, compared with 853 for 1898. The number of call offices was 2,394, compared with 1,665; and the number of stations 169,927, compared with 120,144 for the corresponding period of 1898.

Walker.—Terms for the supply of electric current have been submitted by the two companies who are seeking authority to supply electricity in bulk in the Tyneside district, and the District Council have appointed a sub-committee to arrange details with one of the companies.

Wallasey.—The Local Government Board have refused to sanction the proposed loan of £18,500 for electric tramway purposes pending the result of the appeal of the Wallasey Tramways Co. to the House of Lords in the action as to determination of the purchase price of the tramways.

Warrington.—Sanction to a loan of £44,966 for electric lighting and £9,336 for refuse destructor works has been obtained by the corporation.

Whitechapel (London).—Messrs. Mather and Platt having intimated their inability to supply three new 275-kw. steam dynamos at £7,395, owing to the increased price of materials, the price has been increased to £7,500 plus £257. 10s. for certain spare parts.

Worcester.—The accounts of the electricity department for the past year show a net profit of £90.

The Electricity committee reported at Wednesday's meeting that they had claimed a penalty of £10 per week, under a contract with Messrs. S. Z. de Ferranti (Ltd.) for the erection of a steam alternator for delay in completing the work from August, 1898, to September, 1899, and that the firm had offered, if the penalty were waived, to alter the plant so as to increase its capacity from 300 kw. to 400 kw. The Council decided to accept the offer, the work to be completed in six weeks.

The Council have decided that, in future, discounts on electricity accounts shall be allowed in cash, instead of supplying incandescent lamps for renewals

PATENT RECORD.

The following list of Applications for Patents and Specifications published has been compiled for this journal by Messrs. J. C. CHAPMAN and Co., *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs, and Trade Marks may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after the acceptance of the complete Specification. The names within parentheses are those of communicators of inventions. When complete specification accompanies application, an asterisk is affixed.*

January 15, 1900.

862. W. BRADLEY. Southport. Improvements in phonographic diaphragms for combining two glass diaphragms in one cell, thus obtaining more than twice the usual volume of sound.
863. W. NEWELL. San Francisco. Power motor which is particularly designed to utilise the action of waves.*
892. R. HUMPHRIES. London. Improved trolley for overhead electric tramways.

January 16, 1900.

927. C. WILSON and J. MARRIOTT. Sheffield. Improvements in machinery for double wrapping and insulating electric cable wires.
945. C. CAULTON and C. CAULTON. Cheshire. Electric bell push indicator for front doors when out of order.
949. D. SINCLAIR. London. Improvements in telephony.
956. D. H. WILSON. London. Improvements in telephone apparatus.*
1,009. C. B. MCCABE and L. GOUGHENOUR. London. Improvements in electrically or magnetically operated locks.*
1,012. W. M. MORDEY and G. C. FRICKER. London. Improvements in electricity meters.

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1,022. G. C. MARKS. London. Improvements in the mounting of electric arc lamps. (Continentale Jandus Elecktricitäts A.-G. (société anonyme), Belgium.)
1,024. S. H. HEYWOOD and H. W. HEYWOOD. London. Improvements in electrical switches.
1,026. A. W. LAWTON. London. An electric heater for heating water or other fluids.*

January 17, 1900.

1,033. F. BATHURST. London. Improvements in wiring electrical installations.
1,078. H. A. KENT. London. Covering wires with insulating material for electrical purposes.
1,089. H. EDMUNDS. London. Improvements in electrical conductors or cables.
1,100. W. LANGDON-DAVIES and A. SOAMES. London. Improvements in electric motors and dynamos.
1,101. W. F. JONES. London. Improvements in electric switching apparatus.

Januuary 18, 1900.

1,133. A. J. BOULT. Improvements in or relating to incandescent electric lamps. (M. Sanvalle, France.)*
1,134. THE BERLINER ELECTRO-MECHANISCHE WERKSTATTEN G.m.C.H. London. A coin freed phonograph.
1,147. P. JENSEN. London. Improvements in electric motors for rotary dental tools and the like. (The Browning Manufacturing Co., United States.)*
1,148. SIEMENS BROS. AND CO. (LTD.), A. E. FOSTER and H. J. NOTT. London. An improvement in troughs for electric cables.*
1,159. H. J. ROBSON. London. Improvements in telephone receivers.
1,160. A. J. PROTHEROE. London. Improvements in or connected with dynamo-electric machines.
1,167. A. J. FABRE. London. A new or improved adjustable suspension device for electric lamps.*
1,168. J. E. KINGSBURY. London. Registering apparatus and circuits for telephone measured service. (The Western Electric Co., United States.)

SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1898.

27,390. ABEL. (Soc. Anon Continentale pour la Fabrication des Compteurs a Gaz et autres appareils.) Coin-freed apparatus for electric and and fluid meters.
27,541. WAKELIN and WESTON. Detachable and swivelling electric light fittings.

1899.

153. MONNARD. Dynamo electric machines or motors.
903. ECKSTEIN and GUTHRIE. Telephone exchange switchboards.
2,428. GOVER and HUISMAN. Electric switches.
4,124. DOWSING. Electric stoves.
5,707. SMITH and CORRIE. Electric fuses for firing, blasting, and other explosives.
14,207. BENARD. Telephone apparatus.
20,753. BIHELLER. Lanterns or globes chiefly for incandescent gas lights, arc electric lights, and the like.
23,755. DARLING and HARRISON. Electrolytic apparatus.
23,813. SIEMENS BROS. AND CO. (LTD.) (Siemens and Halske Aktien-Gesellschaft). Galvanic batteries.

COMPANIES' MEETINGS AND REPORTS.

City and South London Railway Co.

The thirty-first ordinary general meeting of this company was held at Winchester House, Old Broad-street, on Monday, under the presidency of Mr. C. G. MOTT.

The SECRETARY (Mr. W. F. Knight) read the notice calling the meeting, and other formal business having been disposed of,

The CHAIRMAN said: This is the first time since the opening of the line that we have to meet the shareholders with a reduced dividend. Hitherto we have always—or nearly always—had the satisfaction of being able to recommend a steadily increasing dividend; but there is this consolation on the present occasion—that practically the reduction is entirely due to the fact that we have to provide a dividend on the increased amount of ordinary stock, which has been issued to provide the funds for carrying out our extensions, which, as you know, are not yet open and are giving us no return. As far as the existing railway itself is concerned, we are practically in the same position as we were in at this time last year, and we could have paid the same dividend had it not been for this additional stock. We have suffered a little, as all other railway companies have, in our expenses, owing to the increased cost of materials—coal and other stores—but the amount with us has been small, and our actual receipts have been very much the same as they were a year ago. We should have had a better return to give you as to the question of receipts, had it not been that we have been suffering, as I told you on a previous occasion, from the County Council competition with their tramways. That has affected our short-distance traffic. As regards our general traffic—our long-distance and residential traffic—we have had a satisfactory increase, but this has been more than counterbalanced by the diminution in the short-distance traffic. Still, I think we pretty well know the worst of that and it has not seriously obstructed the general progress of the line itself. The question that will mostly interest you is as to the opening of the extensions which we have made, so that they can return to us sufficient to pay the expenses incurred upon them—the interest on the outlay, and we hope a considerable surplus to go to the increase of our dividend. Well, we have been extremely disappointed that the extension to Moorgate-street is not opened at the present time. I told you last August that we anticipated that it would be open some time in October; but electric railways are not quite like steam railways. You must have everything, however small it is, all in perfect order before you can open an electric railway, and the whole system of working is so inter-dependent that it is not possible to open for traffic until every detail is completed. Having a number of different contractors on a railway like this, with the special appliances we require, it has been difficult to get them all to keep up to the mark, and the result has been that the opening has been postponed from day to day and week to week, much to our disappointment. I believe, however, that we have now arrived at such a stage that there is every probability that we shall open the extension to Moorgate-street some time within the next fortnight. I do not like to say positively that that will be the case, because the very smallest failure in one department would prevent it; but we have already run experimental trains over the extension, and we practically only await the Board of Trade certificate. The extension to Clapham is also practically completed, as far as the tunnelling and all the arrangements go. The stations on the surface are not yet finished, but they are being proceeded with, and various other matters have to be carried out; but we hope that within three months we shall be able to open that extension also. There will then only remain the Islington extension, in connection with which more than one-fourth of the tunnelling has been excavated, and they are beginning the underground stations. I am sorry that we have had some delay, and are still having some delay, through the difficulty of settling matters with the London County Council, who are a most difficult body to deal with. At Islington we bought houses—built at the time when the place was in the country—with long gardens. They now tell us that we cannot cover those gardens with any kind of building whatever, and the public must approach the stations over them and stand outside in the wet. We want a one-storey building on that front. We have offered to give a portion of it up to the public if we are allowed to erect this building, but so far we have not received permission. We are still negotiating, and of course all this means delay. It is unfortunate that these things will delay the opening of the Islington extension for some time, but we are doing our best. Works of this kind, however, which are for the benefit of the public, and give their shareholders only a moderate return at the best, should, I think, be encouraged by a public body, and obstructions should not be put in the way of their being carried out. As to connections with other lines, we have arranged with the Brighton Co. for a subway at London Bridge. There has been some delay in proceeding with that subway, but I hope that it will not be many weeks before those works will be put in hand. The agreements are all settled. We have also arranged with the Great Northern and City Railway Co. for a joint station at Old-street. Some details have to be settled with them for that station, but the works are going on. Then there is a bill in Parliament for the extension of the Baker-street and Waterloo Railway at one end from Baker-street to Paddington and at the other end from Waterloo, to join our station at the Elephant and Castle. That will be a very great public convenience to give to the south of London—to give a connection right through to the heart of the very busiest West-end parts of the metropolis. It will be a great public convenience, and at the same time I believe it will add considerably to our revenue. We have a bill in Parliament ourselves—which I shall ask you to approve to-day—for an alteration of the station at Islington. Having determined that the Islington station shall be our final terminus there—for the present, at all events—we have been trying to make the station there as convenient as possible for the working, and we found that it would be much better to do as we have done at the Clapham extension—to make one very large arch 30ft. in width rather than two smaller ones. That will add much to the safety and convenience of the work. We cannot, however, make this alteration without this bill; but it will not cost us very much, because there is no probability of any opposition to it, and it can be easily and economically passed through Parliament with your approval. I will now refer to the accounts, as I usually do. You will see in the capital account that we have received on calls on shares during the half-year £105,703, and on debentures and premiums upon them £12,075, making a total of £117,778. On the other hand, we have spent £178,665, and the balance of that is at the debit of capital account, which debit has been increased by £60,883. That has been met by loans. We preferred to borrow on our debenture stock rather than to issue it during the latter part of the past year, when, as you know, we should have had to take a very much lower price for it than we shall get by keeping it, the time having been very bad for issuing it. As regards the revenue account, you will see that we have received from passengers £122 less in the half-year, owing to the diminution of the short-distance passengers, and also to little difficulties that our season ticket holders have had in the past half-year in not knowing when to renew their tickets and when the line would be opened. They are now, however, satisfied in that respect. Parcels receipts show a decrease of £9, transfer fees of £7, and rent of £19; but, on the other hand, sundry receipts are higher by £75. There is therefore a net decrease of only £82 in the receipts for the half-year. As regards the expenditure, the maintenance has decreased £134, carriage repairs are down £66, and law charges £2. On the other hand, locomotive and generating power expenses show an increase of £387, chiefly owing to coal; the traffic expensesare £118 more, and the general expenses are £56 higher; and rates and taxes—which are constantly increasing—are up £111, making a net increase of £470.

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With the decrease of £82 in the receipts which I have just mentioned, we therefore have a diminution of £552 in the net profits. We have an increase in the debenture stock interest of £1,128, and an increase in the dividend on the first issue of preference stock of £1,279. On the other hand, we have an increased receipt of £2,818 from interest and discounts, leaving us with a debit of £141. The dividend of 1½ per cent. on the new stock is the same as a dividend of 2 per cent. on the old stock within £112. That and the alteration in the balance carried forward make the small difference of £253. There was a decrease in the number of passengers of 19,872 in the half-year. We very seldom have to mention a decrease in the number of our passengers, and this falling off has arisen from those who travel short distances, but, on the other hand, our general residential and longer-distance passengers have shown a steady increase. We have run during the half-year 7,807 more miles—that is, we have increased the number of our trains. Of course, with the increased train mileage run and the smaller number of passengers carried, the number of passengers per train has slightly decreased, and the figures for the past half-year have been 44·82, against 46·58 for the December half of 1898. The receipts per train mile have been 2s. 3·28d., against 2s. 4·28d., or 1d. per train mile less. The receipts per passenger were about the same. The working expenses for the half-year were 58·05 per cent, against 56·18 per cent., and we are up in that respect, like most of the English railway companies. The expenses per train mile were 1s. 3·84d., against 1s. 3·85d., or rather less; and the locomotive charges were 5·85d., against 5·65d. Our line therefore is working very much on the old lines; there is no practical alteration. If it had not been for this question of the new capital, I believe that our balance would have been sufficient to keep up our dividend to its former rate. Our new generating station is nearly complete, and the engines are at last running satisfactorily. Our new locomotives are also giving satisfaction, and everything points to our being able to work the extensions in a way that will, I hope, be both economical and give satisfaction to the public. I now move—

"*That the report and statement of accounts for the half-year ended Dec. 31, 1899, now submitted to the meeting, be received and adopted.*"

Mr. EDWIN TATE seconded the motion.

Mr. JARVIS inquired who made the subways opposite the Mansion House, and who was going to bear the expense of keeping them up.

Mr. HART wished to know how the fares would be arranged when the new line was opened.

The CHAIRMAN: With respect to the subways mentioned, they have nothing to do with this company at all. They belong to the Central London Co. We have a subway, but it is 100ft. down below from the platform of the Central London line to the platform of our station. We have nothing to do with those public subways, which are entirely a question between the City and the Central London Railway Co. With regard to the question about the fares, we shall have to abandon the turnstile system. I am very sorry for that, because it has many advantages, but we cannot retain that system with the extension of the line and the necessity we may have to book through with other lines; nor could we have a uniform fare for so long a distance. We shall therefore have to return to the usual mode of all railway companys, of issuing tickets. As to the Brixton and the Walthamstow lines, these lines are, I think, waiting until better times for financing have arrived. Things in the City have been in such a condition that it has been impossible to raise money advantageously for new undertakings of that kind; but I hope, if we happily see this war over and we have cheaper money, that both those lines will be carried out. The Walthamstow project is under the ægis of the Great Eastern Co., and I should think that they would take such steps as will ensure that line being carried out.

The motion was carried unanimously.

Resolutions were afterwards passed declaring the dividends recommended and re-electing the retiring directors—Mr. Sampson Hanbury and Mr. S. Barclay Heward, and the retiring auditor, Mr. James L. Oliver.

A vote of thanks terminated the proceedings.

Anglo-American Telegraph Company (Ltd.).

The ordinary general meeting was held on the 2nd inst., at Winchester House, Old Broad-street, under the presidency of Mr. FRANCIS A. BEVAN.

The SECRETARY (Mr. T. H. Wells) having read the notice convening the meeting,

The CHAIRMAN moved the adoption of the report and the payment of the dividends therein recommended. He said that it gave the directors much pleasure to meet the proprietors on that occasion, and to be able to present such a satisfactory account of the working of the cables during the past half-year. The traffic receipts had been £197,318, being an increase over those of the December half of 1898 of £6,757. The charter of the steamship "Minia" had brought them in £9,850, or £6,050 more, and there had also been an increase of £335 in interest. Altogether the receipts had been £13,183 more. The working expenses had been £47,412, or an increase of £869. The expenses were now only £37. 10s. per cent., and there had been a gradual decrease in them since 1894, when they were 48 per cent. He thought that this reflected great credit on the management, the traffic having been carried on as efficiently as before, or more efficiently. Rather a large amount had been spent on repairs of cable—£18,060 (including the value of the cable expended), showing an increase of £3,040. This increase represented not only the work done upon their own cables, but also upon those of their friends. Omitting one or two small items, the receipts had been £13,162 more, and deducting the additional expenses, the net improvement was £9,396 for the half-year; but in addition to this £24,701 was brought forward, or £7,120 more than was brought forward a year previously. The result was that there was a divisible amount of £153,605, after setting aside the £12,000 which, he thought he might say by mutual agreement, they were in the habit of putting to the renewal fund. Of the divisible amount the directors proposed to distribute £152,250, giving the preferred stockholders their full £6 for the year, the ordinary stockholders receiving £3. 13s. 6d. for the year, and the deferred stockholders £1. 7s. This was a larger amount than had been paid to the deferred stockholders since 1878. It was after that that the company had to provide for the 1880 cable, which took a very large amount out of their renewal fund. The sum carried forward was £1,355. He believed that the proprietors would agree with him that this was a very satisfactory account of the half-year's working. During the past year the renewal fund, to which the directors attached so much importance, had been increased from £765,000 to £820,000 of which £730,000 was invested in securities, £40,000 was in cables, and between £20,000 and £30,000 was invested in their premises in Throgmorton-street. What remained was practically the company's working capital. All securities had depreciated considerably in the past year, but there was still a surplus—although only a small one comparatively—in the value of the company's securities beyond the amount at which they stood in their books. A considerable portion of the dividend recommended on the deferred stock represented the earnings of the "Minia," and he need not say that this was a precarious item of revenue. There were also the possibilities of what might happen through the laying of the new German cable. The company's agreement with the German Government expired on the last day of 1899, but up to the present they had nevertheless been carrying the German messages exactly as they did during the continuance of the agreement. How long this would last he of course could not say, but there was no doubt that a new cable would be laid between Germany and America, *viâ* the Azores, this year; and he also feared that there was no doubt that a large portion of the German traffic from this side, which the company had hitherto carried to the entire satisfaction of the German Government, would then be diverted to that cable. It was probable, however that, they might still be able to obtain some of the German messages even on this side, while their partners, the Western Union, the Direct, and themselves would get a good deal of the traffic from the other side of the Atlantic. The German company were of course anxious to arrange for an alternative line in view of possible interruptions in the new cable which was to be laid, and they also wished, if possible, to secure the whole of the traffic from America to Germany. In order to obtain that, the German company had entered into some arrangement with the Commercial Cable Co., but for some reason the former did not seem to have sent any more messages as yet by the latter company's cable. One of the objects aimed at between these two companies required the sanction of the British Government, but it being represented to the latter that the interests of the owners of British cables would be seriously injured if the proposed arrangement were carried out, the British Government refused to give their sanction to it. They must all feel very much indebted to the Government in this matter. There was a good deal of negotiation between the company and the Direct Co. on the one side and the Foreign Office and the British Post Office on the other, and he was glad to say that the Foreign Office and the Post Office took the view put before them by the Atlantic cable companies. When the new German cable was laid he feared that they must certainly expect a falling off in their traffic, but there was always a normal growth in the traffic, and he believed that if their lines were maintained in efficient working order, as they were at present, and if attention were given to keeping down expenses, the company would still be able to do good business. How far, however, the deferred stockholders were likely to receive the dividend which they were to get this year, it was not for him to say. With regard to the French law suit, as he told them at the last meeting, the company had had a decision given in their favour for £258,000, but the details were referred to a committee of experts to see whether they could not find out something to set off against this amount. He believed that it was some time before the experts met, but their acquaintance had been made by the company's solicitor and general manager, who had paid more than one visit to Paris. How long the experts would be at work he could not say, but some very curious figures had been put before them by the other side. Mr. Chapman would shortly pay another visit to Paris, where he believed that the company were very ably represented.

The Deputy Chairman (Sir GERALD FITZGERALD) seconded the motion for the adoption of the report.

A SHAREHOLDER inquired if the company were likely to benefit from the Pacific cable.

The CHAIRMAN, in reply, said that the Pacific cable was still some way off; but he might state that they had been approached by the promoters of the scheme, and had been asked whether the company could not enter into some arrangements with them.

The motion was then unanimously adopted, and the usual complimentary vote terminated the proceedings.

St. James' and Pall Mall Electric Light Co. (Ltd).

The directors' report for the year to Dec. 31 last states that the Carnaby-street and Mason's-yard stations have been working satisfactorily throughout the year, and have proved fully adequate to meet the largely increased demand for current. Property adjacent to the Carnaby-street station has been duly acquired, and the extension of the station is in progress. The bill promoted by this company, in conjunction with the Westminster Electric Supply Corporation (under the title of the Central Electric Supply Co. (Ltd.), authorising the establishment of a station in the parish of St. Marylebone, has received royal assent, and steps are being taken to give effect to its provisions.

The 100 founders' shares of £1 each, which formed part of the original capital of the company, have now been cancelled and their nominal value has been carried to capital reserve. 8,020 ordinary

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shares, balance of the new capital created in February, 1898, and January, 1899, were offered to the shareholders, *pro rata*, in October last at £12. 10s. per share, and have all been issued. The premium on calls payable up to Dec. 31, 1899, amounting (less expenses) to £36,923. 0s. 11d., has been carried to capital reserve. On the other hand, the premium of 5 per cent. paid on the redemption of the debenture stock (amounting to £2,500) has been charged to this account.

The net earnings for the year 1899 were £31,834. 9s. 10d., less £11,495 interim dividend paid in August last for the half-year ended June 30, at rate of 7 per cent. on preference and 10 per cent. on ordinary shares. Adding £83. 19s. 1d. brought forward, there remains £20,428. 8s. 11d. to be dealt with, and the directors propose to divide this amount as follows:—

(A) Dividend at the rate of 7 per cent. per annum on preference shares	£3,500	0	0
(B) Dividend on the ordinary shares of 7s. 6d. per share, and bonus of 2s. per share, making (with interim) a total distribution of 14½ per cent. for the year	15,190	10	0
(C) Carried forward	1,737	18	11
	£20,428	8	11

British Insulated Wire Co. (Ltd.).

The directors have issued their report for the year ended Dec. 31 last. The gross profits are £92,653, and after deducting costs of administration, fees on patents, interest on debentures, depreciation, &c., there is a balance of £54,473. Added to this is the balance from the previous account and transfer fees, bringing the total to £56,557. The dividend on the preference shares and an interim dividend on the ordinary shares have already been paid, and the final balance is £36,432. The directors recommend that a dividend of 15 per cent. on the ordinary shares be declared for the year, which, after deducting the interim dividend, will leave a balance of 10 per cent. to be now divided. This will absorb £20,000 and leave £16,432, out of which the directors recommend that a bonus of 5 per cent. be paid to the ordinary shareholders and £6,432 be carried forward. The directors state that the results of the year's working have been most satisfactory. The existing capital is fully employed, and it is absolutely necessary to provide a large amount of additional working capital, which can at once be profitably utilised. To this end, after the annual meeting on the 16th inst., an extraordinary general meeting will be held to authorise the increase of the capital of the company to £1,000,000 by the creation of 60,000 new preference shares of £5 each and the same number of ordinary shares of the same value.

BRISTOL TRAMWAYS AND CARRIAGE CO. (LTD.)—The directors' report for the year ended Dec. 31 states that the gross receipts amounted to £168,727 19s. 6d., and the working and general expenses and renewals to £108,233 16s., leaving net revenue £50,494 3s. 6d. It is proposed to pay a dividend for the half-year at the rate of 8 per cent. per annum (less tax), and to carry to reserve and renewals funds (including electrical renewals, £1,000), £7,260 5s. 1d. The reserve funds will thus be increased to £90 444 11s. 6d., and the company's investments from £75,091 12s. to £87,438 3s. 3d. The total number of passengers carried during the year by the company was 25,330,805. The important works in connection with the extension and reconstruction of the tramways, and more especially the conversion of the entire system preparatory to electrical working, have continued to make satisfactory progress during the year. Ten and a half miles of new lines have been laid, and 16½ miles of horse tramways reconstructed with girder rails and copper bonded, leaving 10 miles of track still to be completed. The cable conduits have been laid for a length of 10½ out of 12¼ miles, and the major portion of the requisite street standards and overhead equipment have been erected. The foundations and harbour wall of the power station were finished in November last, and the building will shortly be sufficiently advanced to admit of the installation of the electric and steam plant. Similar progress is being shown with the building of the new depots, those at Brislington and Bedminster approaching completion. All efforts are being directed to the introduction of electrical working over the completed undertaking in the course of the ensuing summer. The extension to Arno's Vale, and the sections of the system serving Totterdown and the Joint Railway Station in connection with both the Tramways Centre and Old Market, were converted from horse to electric traction in July last, and have been in successful operation since that time. The capital expenditure during the year was £236,000.

CAMBRIDGE ELECTRIC SUPPLY CO. (LTD.)—The report of the directors of this company for the year ended Dec. 31, 1899, states that during the year there has been added to the company's mains, the equivalent of 3,043 8 c.p. lamps, making the total 28,123. The number of units supplied has been 298,392, an increase of 38,085 or 14 per cent. In spite of the large increase in the price of coal the cost per unit sold for this item has been reduced by over 8 per cent. To meet the growing demand for electricity it has been necessary to largely increase the machinery as well as the mains and transforming apparatus in the town. A new 500 kw. dynamo and a fourth boiler have been installed which it is expected will effect some saving in the expense of coal and labour. The capital outlay for the year has been £12,310. 6s. 2d. The supply mains now extend along 8¾ miles of street. The Company, after paying all charges, placing £250 to the reduction of preliminary expenses, £750 to depreciation, and £150 to suspense, has a balance of £3,766. 11s. 2d., added to £123. 11s. 9d. brought forward. An interim dividend of £1,176. 1s. 10d., and interest on temporary overdraft £68. 3s. 5d., have already been paid, leaving a nett balance of £2,645. 17s. 8d., out of which the directors recommend a dividend of 4½ per cent., making, with 2½ per cent. already paid, 7 per cent. for the year. £233. 1s. 4d. is carried forward.

NEWCASTLE AND DISTRICT ELECTR'C LIGHTING CO. (LTD.)—The annual report of this company states that 1,008,622 units of electrical energy were supplied last year, against 778,823 in 1898. The gross receipts were £8,811; and, after paying interest, placing £1,000 to reserve, and providing for depreciation, the directors recommend a dividend of 5 per cent. for the half-year, making, with the interim dividend, 8½ per cent. for the year.

WATERLOO AND CITY RAILWAY CO.—The twelfth half-yearly meeting was held yesterday at Waterloo Station. Mr. Wyndham S. Portal presided, and gave particulars of the capital expenditure during the six months to Dec. 31 last. He said that it was expected that the construction of the whole line would cost about £600,000, which was the sum he had previously spoken of as the probable total outlay. The board had authorised the spending of £2,000 to deal with the leakage of water. This leakage was not from the Thames, but was owing to the soil, through which the tunnels were pierced, being of a wet and gravelly nature. The expenditure during the half-year in the way of electrical equipment came to £648, and it was expected that a corresponding item would appear in future accounts. After payment of Government duty, the gross receipts for the period under review aggregated £13,000, and the working expenses £7,341, or 55 per cent. The difference between the two sums not being sufficient to pay the guaranteed interest of 3 per cent. on the capital, the London and South Western Railway had made up the deficiency of £2,500. The receipts for the past month showed a considerable improvement over those for January, 1899, the daily average in the former case being £86 against £91 in the latter. He attributed the increase in the traffic, to some extent, to the improved facilities for reaching the City station as the result of the opening of additional entrances to the subways in the vicinity of the Mansion House. Half the cost of these subways was borne by this company.

NEW COMPANIES, STATUTORY RETURNS, &c.

C. EVANS & CO. (LTD.)—This company was registered on Jan. 30, with a capital of £10,000 in £1 shares, to acquire the business carried on by C. Evans, and to carry on the business of mechanical, electrical, and general engineers, founders, signal manufacturers, and manufacturers of electrical and magnetic apparatus and appliances. The subscribers are W. E. Reynolds, T. Titzé, J. R. Dick, G. Fabesch, S. Karl. F. Pammant, and H. C Beloe.

IDEAL GAS CO. (LTD.)—This company was registered on Jan. 31, with a capital of £5,000 in £1 shares, to carry on the business of calcium carbide and acetylene gas manufacturers, makers of acetylene gas generators, founders, users of electrical, smelting, and other furnaces.

FRED. SMITH AND CO. (LTD.)—This company was registered on Jan. 31 with a capital of £1,000 in £1 shares, to acquire the business carried on by Fred. Smith, and to carry on the business of mechanical, electrical, and general engineers, millwrights, &c.

THOMSON-DAVIS TELEPHONE SYSTEM (LTD.)—This company was registered on Jan. 30, with a capital of £6,000 in £1 shares, to acquire the patent of Messrs. A. T. M. Thomson and P. W. Davis for improvements in telephone systems and apparatus, and to manufacture and deal in electric, magnetic, telegraphic, telephonic, and other apparatus. The subscribers are Percy W. Davis (ivory and metal plater), E. Maxwell-Davis, J. P. Bell, A. T. M. Thomson (electrical engineer), J. H. S. Thomson, Max Byng (manufacturer and engineer), and F. Samuelson. The first directors are A. T. M. Thomson, P. W. Davis, and M. Byng.

VOLT ELECTRICAL CO. (LTD.)—This company was registered on 3rd inst., with a capital of £3,000 in £1 shares, to carry on the business of electrical engineers, manufacturers, factors, &c.

CITY NOTES.

MEMORANDA.—Bank rate 4 per cent. (since Jan. 25, 1900). Price of silver 27 5/16d. per oz. (Feb. 8). Consols (2¾ per cent.) 100⅜—100½ for money, 100⅜—100⅝ for account; 2½ per cent. 98½—99 (Feb. 8). Stock Exchange Settling Day: Consols, Mar. 1; Stocks and Shares Continuation Day, Feb. 21; Ticket Day, Feb. 22; Pay Days, Feb. 9 and 23; Mining Share Carry-over Days, Feb. 20 and Mar. 10.

BRITISH ELECTRIC TRANSFORMER MANUFACTURING CO. (LTD.)—With reference to the dividend notice inserted in our last issue, this should read "at the rate of 10 per cent. per annum for the six months to Dec. 31," and not "6 per cent."

CHARING CROSS AND STRAND ELECTRICITY SUPPLY CORPORATION (LTD.)—The directors, after providing £8,000 for depreciation and carrying forward £4,400, have decided to recommend a dividend for the half-year to Dec. 31 at the rate of 10 per cent. per annum, making (with the interim) 9 per cent. for the year on the ordinary share capital, against 8 per cent. for 1898.

DUBLIN AND LUCAN STEAM TRAMWAY CO.—The directors' report for the half-year ended Dec. 31 states that the electrical equipment of the line is practically complete. The Board of Trade inspection will take during February.

DUBLIN UNITED TRAMWAYS (1896) CO. (LTD.)—The directors of this company have declared a dividend at the rate of 6 per cent. per annum on the preference and at the rate of 6 per cent. per annum (free of tax) on the ordinary shares. This dividend will absorb £32,831. 4s. 7d., leaving £1,338. 4s. 9d, to be carried forward. During the half-year the recon-

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struction of all the existing tramways necessitated by the electrical equipment, except a portion of the Sandymount, Donnybrook and Blackrock lines, was completed. Of the works authorised by the Privy Council Order of 1898, the extension and doubling of the Glasnevin line, the doubling of the Drumcondra line, and the construction of the new line through Leeson-street, have been completed. The Britain-street and Summerhill new line, and the new line viâ Brunswick-street and Ringsend to join Sandymount line at Irishtown, authorised by the same order, are in course of construction. The new power station at Ringsend was opened on Aug. 16 last. The result of its operation has completely justified the expenditure incurred in the construction and equipment of what is at this date (the report states) the finest and most effective generating station in Europe.

GREAT NORTHERN RAILWAY (OF IRELAND) CO.—The directors of this company have decided to oppose the bill for the incorporation of a company for the purchase of the Newry and Bessbrook tramway, and for the construction of a light (electric) railway between Bessbrook and the Clogher Valley railway at Tynan. The construction and electrical equipment of the Howth tramway have not proceeded as rapidly as anticipated, and, in view of the work not being completed by August, the company have inserted a clause in their bill for an extension of time for twelve months.

INDO-EUROPEAN TELEGRAPH CO. (LTD).—We are informed that Mr. W. Andrews has resigned his position as managing director, and that Mr. T. W. Stratford-Andrews has been appointed to the vacant position.

NATIONAL TELEPHONE CO. (LTD.)—The transfer books of this company in respect to the preference and ordinary shares will be closed from 12th to 22nd inst. inclusive, preparatory to the payment of the dividend for the half-year to Dec. 31.

ST. JAMES'S AND PALL MALL ELECTRIC LIGHT CO. (LTD.)—The share transfer books of this company are closed from 7th to 21st inst. inclusive, preparatory to the payment of dividends for the half-year ended Dec. 31.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee has appointed Wednesday, 14th inst., a special settling day in the further issue of £50,000 4½ per cent. debenture stock of the *Chelsea Electricity Supply Co.* (*Ltd.*), and has ordered the stock as well as the further issue of £54,415 5 per cent. debenture stock of the *Buenos Ayres and Belgrano Electric Tramways Co.* (*Ltd.*), and the further issue of 1,937 £10 fully-paid shares (Nos. 205,994 to 207,930) of the *Western Telegraph Co.* (*Ltd.*) to be quoted in the official list.

TELEGRAPH CONSTRUCTION AND MAINTENANCE CO. (LTD.)—Subject to audit the directors propose to pay a dividend of 10 per cent. (£1s. 4s. per share) in addition to the 5 per cent. already paid, making 15 per cent. for the year.

WIRRAL RAILWAY CO.—At a special meeting of the shareholders on Monday, the bill for authority to adopt electric traction on the Wirral and Mersey Railways was approved.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	'99–1900	£	£		£	£
*Birmingham Tramways.	Feb. 3	3,822	+ 270	5	19,826	+ 1,233
Blackpool Corporation...	„ 1	139	+ 19	44	21,361	+ 4,423
Blackpool and Fleetwood	„ 5	167	– 5	5	740	+ 3
Bradford Corporation ...	„ 4	349	+ 101	77	25,652	...
Brisbane Trams	Dec. 20	1,857	+ 599	12	26,667	+ 8,221
*Bristol Trams & Carriage	Feb. 2	2,476	+ 202	5	13,335	+ 1037
*Buenos Ayres & Belgrano	Jan. 7	2,651	+ 877	1	2,654	+ 877
City & South London Ry.	Feb. 4	1,119	– 16	5	5,590	– 62
Dover Corporation	„ 3	149	+ 25	44	8,954	+ 1,044
Dublin United	„ 4	2,871	+ 360	5	13,740	+ 1516
Dublin Southern Dist....	„ 4	570	+ 24	5	2,803	
*Glasgow Corporation ...	„ 3	8,148	+ 514	...	...	...
*Liverpool Corporation...	Jan. 27	6,598	+ 1,095	4	26,626	+ 3,315
Liverpool Overhead Rly.	Feb. 4	1,527	+ 254	5	7,553	+ 1,020
*Sheffield Tramways	„ 5	1,779	+ 619	5	9,120	+ 3,098
*South Staffs. Trams.....	„ 2	661	+ 73	5	3.010	+ 114

* Partly electrical.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Jan. 31.	Price Wednesday, Feb. 7.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Feb. 7. Highest	Lowest
			TELEGRAPHS.			£ s. d.			
£110,900	100	4%	*African Direct Telegraph 4% Mort. Deb. (red.)	99 103	99 103	3 17 8	January and July	...	...
25,000	10	...	Amazon Telegraph	3 4	3 4	...	June and December	...	...
£125,000	100	5%	Do. 5 per Cent. Debentures	85 90	85 90	5 11 1	...	...	...
£875,520	Stock	15/0	Anglo-American	65 68	65 68	5 1 3	Feb., May, Aug., Nov.	...	...
£3,062,240	Stock	30/0	Do. Preferred	115 116	115 116	5 3 4	„ „	116	115½
£3,062,240	Stock	18/0	Do. Deferred	17 17½	16¾ 17½	5 4 4	...	17½	17
$10,000,000	$100	$2½	Commercial Cable Capital Stock	165 175	165 175	...	Jan., Apr., July, Oct.	...	...
£1,563,078	Stock	4%	* Do. 4 per Cent. Debenture Stock	102 104	102 104	3 16 11	„ „	104	103½
16,000	10	8/0	Cuba Submarine Ordinary	8½ 9½	9 10	8 0 0	February and August	...	...
6,000	10	10/0	Do. Preference 10 per Cent.	19 20	19 20	5 0 0	„ „	...	...
12,931	5	2/0	Direct Spanish Ordinary	4 5	4 5	4 0 0	April and October	...	...
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference	9 10	9 10	5 0 0	„ „	...	...
£30,000	50	4½%	Do. 4½ per Cent. Debentures	101¾ 105¾	101¾ 105¾	4 5 9	January and July	...	...
60,710	20	3.0	Direct United States Cable	11½ 12	11½ 12	5 16 8	Jan., Apr., July, Oct.	11⅞	...
£120,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red.)	99 102	99 102	4 8 3	June and December	...	...
£4,000,000	Stock	5%	Eastern Ordinary	153 158	153 158	4 8 7	Jan., Apr., July, Oct.	158	155
£1,795,000	Stock	3½%	Do. 3½ per Cent. Preference Stock	98 101	98 101	3 9 3	„ „	100	98
£1,432,268	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.)	115 120	115 120	3 7 3	May and November	...	...
250,000	10	2/6	Eastern Extension	15¼ 15¾	15¼ 15¾	4 8 11	Jan., Apr., July, Oct.	15⅝	15⅜
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	117 122	117 122	3 6 6	February and August	118	...
£16,200	100	5%	* Do. 5% (Austln. Gov. Sub.) Deb.,1900 (reg.)	99 103	99 103	4 17 1	January and July	...	...
£64,400	100	5%	Do. (Bearer)	100 103	100 103	4 17 1	„ „	...	...
£300,000	100	4%	*Eastern and S. African 4% Mort. Deb., 1909	101 104	100 103	3 18 5	February and August	102	101
£200,000	25	4%	Do. 4 per Cent. Mauritius Sub. Debs.(red.)	101% 104%	101% 104%	3 16 10	May and November	...	...
180,227	10	1/9	Globe Telegraph and Trust	11 11½	11 11⅜	4 11 4	Jan., Apr., July, Oct.	11⅞	11½
180,042	10	3/0	Do. 6 per Cent. Preference	15 15½	15½ 16	3 15 0	„ „	15¾	15½
150,000	10	5/0	Great Northern of Copenhagen	30 32	30 32	3 18 2	January and July	...	...
£86,300	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb.(red.)	99 102	99 102	4 8 3	...	...	...
17,000	25	12/6	Indo-European	49 53	49 53	4 14 4	May and November	50½	...
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904	106 109	106 109	5 10 1	March and September	...	...
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.)	101 104	101 104	3 16 11	June and December	...	...
11,839	8	4/0	Reuter's	7 8	7 8	5 0 0	April and October	...	...
3,381	£100 Cert.	6%	Submarine Cables Trust	125 130	124 129	4 14 6	„ „	...	...
15,609	10	...	West African Telegraph	2½ 3½	2½ 3½	4 9 3	December and July	...	...
£200,000	100	5%	* Do. 5 per Cent. Debentures (red.)	98 101	98 101	4 18 9	March and September	...	...
30,008	2½	...	West Coast of America	½ 1	½ 1	...	...	...	...
£150,000	100	4%	* Do. 4 per Cent. Debentures	100 103	100 103	3 17 8	January and July	...	...
88,321	10	6d.	West India and Panama	¾ 1⅛	¾ 1⅛	...	May and November	⅛	...
34,563	10	6/0	Do. 6 per Cent. 1st Preference	9¼ 9¾	9¼ 9¾	6 3 1	„ „	9⅛	...
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	7 8	7 8	7 10 0	„ „	...	...
£80,000	100	5%	* Do. 5 per Cent. Debentures	104 107	104 107	4 13 6	January and July	...	...
£389,731	Stock	4%	Western & Brazilian 4 per Cent. Debenture Stock	100 104	100 104	3 16 11	June and December	...	...
205,993	10	3/0	Western Telegraph (late Brazilian Submarine)	14½ 15¼	14¾ 15¼	4 11 10	Mar., June, Oct., Dec.	15¼	14¾
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1900)	106 109	106 109	4 11 9	June and December	...	...
£158,100	100	6%	*Western Union 6 per Cent. Sterling Bonds (red.)	98 103	98 103	5 16 6	March and September	...	...
			TELEPHONES.						
44,000	£5	3/0	Chili Telephone (fully paid)	2 3	2 3	6 13 4	August	2⅜	2¼
224,850	10s.	0/1½	Consolidated Telephone Const. & Manufacturing	¼ ⅜	¼ ⅜	4 15 3	July	...	...
72,680	1	2½%	Monte Video Telephone Ordinary	¾ 1	¾ 1	5 0 0	November	...	...
86,492	1	1 0	Do. 5 per Cent. Preference	¾ 1	¾ 1	5 0 0	„	...	...
490,000	5	3/0	National	5⅛ 5¾	5⅛ 5¾	5 4 4	February and August	5⅝	5⅜
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Preference	14 15	14 15	4 0 0	„ „	...	...
15,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference	14 15	14 15	4 0 0	„ „	14¾	...
250,000	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref.	5⅜ 5⅝	5⅜ 5⅝	4 8 11	„ „	5¾	...
1,329,471	Stock	3½%	* Do. Debenture Stock 3½ per Cent. (red.)	98 100	98 100	3 10 0	June and December	98½	98¾
171,504	1	0/4	Oriental	¾ 1	¾ 1	5 0 0	April and October	...	...
58,000	5	2/6	United River Plate	4¾ 5¼	4¾ 5¼	7 2 10	July	...	...
16,639	5	1/4	Do. 5% Cumulative Preference	4¾ 5¼	4¾ 5¼	4 15 3	June and December	...	...
£179,947	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	103 106	103 106	4 14 4	„ „	...	...

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Jan. 31.		Price Wednesday, Feb. 7.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Feb. 7.	
								£ s. d.		Highest	Lowest
			ELECTRICITY SUPPLY COMPANIES.								
100,000	1	...	Bl'okh't'n & Gr'nw'ch D'st'ct Elec.Lt.Ord.(fully pd.)	⅛	⅛	⅛	⅛	...	...	...	...
6,000	10	7/9½	Bournemouth and Poole Elec. Supply Ord.	12	13	12	13	3 0 0	...	...	...
6,000	10	4/6	Do. 4½ per Cent. Cumulative Pref.	10	11	10	11	4 1 10	...	...	...
19,661	5	2/6	Brompton & Kensington Electricity Supply Ord.	7	8	7	8	3 15 0	...	7⅞	7⅛
12,000	5	3/6	Do. 7 per Cent. Preference	8½	9	8½	9½	3 13 8	March and September	8⅞	...
20,000	5	...	Calcutta Elec. Supply Ordinary (fully paid)	6½	6¾	6½	7	...	...	...	...
30,000	5	4/0	Charing Cross & Strand Electricity Supply Corp.	10	11	10½	11½	3 18 3	February and August	11	10½
20,000	5	...	Do. (Nos. 30,000 to 50,000)	9½	10½	10	11	...	...	10	...
20,000	5	2/3	Do. 4½ per Cent. Preference	5⅞	6⅛	5⅞	6⅛	3 13 0	,, ,,	...	...
34,000	5	2/6	Chelsea Electricity Supply Ordinary	7⅛	8⅛	7⅛	8⅛	3 10 7	March	8	...
£100,000	Stock	4½%	* Do. 4½ per Cent. Debenture Stock (red.)	109	111	109	111	4 1 1	June and December	...	...
$1,200,000	$1,000	5%	Chicago Edison 1st Mort.5% 30 year Gold Bonds(red.)	100	110	100	110	4 10 11	April and October	...	...
60,000	10	7/0	City of London Electric Lighting Ordinary	10½	11½	10½	11½	5 4 4	February and August	11	10⅞
40,000	10	6%	Do. 6 per Cent. Cumulative Preference	13	14	13	14	4 5 9	January and July	13⅞	13½
£400,000	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	122	127	122	127	3 19 9	June and December	125⅛	...
40,000	10	...	County of London and Brush Prov. Ordinary	9½	10½	9⅛	10⅛	...	...	...	...
20,000	10	6/0	Do. 6 per Cent. Cumulative Preference	13⅞	14⅞	13⅞	14⅞	4 2 9	March and September	...	...
£200,000	Stock	4½%	Do. 4½% Deb. Stock Certs. (all pd.) (red.)	108	111	108	111	4 1 3	...	110⅛	...
15,000	5	10%	Kensington and Knightsbridge Ordinary	12	13	12	13	4 1 6	...	...	...
10,000	5	6%	Do. 6 per Cent. 1st Preference	7½	7¾	7½	7¾	3 17 5	January and July	...	...
110,000	3	...	London Electric Supply Ordinary	2	2⅛	1⅞	2⅛	...	...	...	...
48,050	5	3/0	Do. 6 per Cent. Preference	5	5⅛	4⅞	5⅛	5 14 3	...	...	...
£100,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures	101	103	101	103	3 18 1	Mar., June, Sept., Dec.	...	...
62,500	10	5/0	Metropolitan Elec. Supply Ord. (Nos. 1 to 62,500)	14⅛	15⅛	14⅛	15⅛	3 4 6	April and October	15⅛	14⅜
22,500	10	3/7½	Do. (Nos. 62,501 to 85,000)	14	15	14	15	3 5 8	...	14	...
£220,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage	115	117	114	117	3 16 11	June and December	...	...
£125,000	Stock	2¾/8	Do. 3½ per Cent. Mort. Deb. Stock (red.)	95	97	95	97	3 12 2	...	95½	...
6,452	10	6/0	Notting Hill Electric Ordinary	15½	16½	15½	16½	3 15 0	March	...	...
10,000	5	5/0	Oxford Electric Ordinary	6¾	7¼	6¾	7¼	3 9 0	,,	...	...
300,000	1	8%	Rand Electric	⅞	1	⅞	1	10 13 4	...	...	...
£130,070	Stock	5%	River Plate El.Lt. & Tr'ct'n, Ltd., 5% 1st Mor.Deb.	75	85	75	85	5 18 0	...	...	...
150,000	$100	$2	Royal Electric Company of Montreal Shares	150	170	150	170	4 14 2	...	...	...
£123,200	100	4½%	* Do. 4½ per Cent. 1st Mortgage Debentures	104	106	104	106	4 5 6	April and October	...	...
31,960	5	5/0	St. James's and Pall Mall Electric Ordinary	15½	16½	15	16	4 10 8	February and August	16⅛	...
20,000	5	3/6	Do. 7 per Cent. Preference	9	9½	9	9½	3 13 6	,, ,,	...	...
65,000	5	...	South London Electric Supply Ordinary (fully paid)	4	4½	4	4½	...	...	...	...
79,900	5	5/0	Westminster Electric Supply Ordinary	14½	15½	14½	15½	3 17 5	March and September	15½	14½
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
125,000	1	7½d.	Aron Electricity Meter 6 per Cent. Cum. Pref.	⅜	½	⅜	½	6 17 2	...	...	...
45,000	1	...	British Electric Works Co. Ordinary	⅜	½	¾	1	...	...	...	...
50,000	1	...	Do. 5 per Cent. Cumulative Preference	½	⅝	¾	1	...	...	...	...
£50,000	100	...	Do. First Mortgage Debentures	97	99	97	99	4 5 8	...	...	...
40,000	5	5/0	British Insulated Wire Ordinary	13	14	13	14	3 11 5	...	...	...
27,500	5	3/0	Do. Preference	6	6½	6	6½	4 12 4	...	...	...
90,000	2	2/0	Brush Electrical Engineering	1⅞	2	1⅞	2	5 0 0	September	1⅞	...
90,000	2	1/2½	Do. 6 per Cent. Pref. Non-Cumulative	2⅛	2⅜	2⅛	2⅜	5 1 1	,,	...	...
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Deb. Stock	110	115	110	115	3 18 5	February and August	...	...
£50,000	Stock	4½%	* Do. 2nd Debenture Stock (red.)	102	105	102	105	4 5 9	June and December	...	...
20,000	5	5/0	Callender's Cable Construction Ordinary	13½	14½	13⅛	14⅛	5 3 5	,, ,,	14⅛	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5½	6	5⅛	6	4 3 4	...	...	...
£90,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb. (red.)	110	115	110	115	3 18 3	November and May	...	...
300,000	1	0/9½	Castner-Kellner Alkali Co. (fully paid)	1⅛	1⅜	1⅛	1⅜	5 16 5	...	...	...
60,000	1	0/7½	Chadburn's Ship Telegraph Ordinary	⅞	1⅛	⅞	1⅛	5 6 8	...	...	...
60,000	1	0/7½	Do. 6 per Cent. Cumulative Preference	⅞	1⅛	⅞	1⅛	5 6 8	...	...	...
32,098	3	1/0⅝	Crompton and Co. (Nos. 1 to 32,098)	3¾	4	3¾	4	4 10 9	January and July	...	...
£100,000	100	5%	* Do. 5 per Cent. First Mortgage Deb. (red.)	99	101	98	101	4 19 0	,, ,,	...	...
60,000	1	0/3	Davis and Timmins 6 per Cent. Cum. Pref.	⅜	1	⅜	1	...	...	...	...
99,261	5	1/9½	Edison and Swan United ("A" Shares) (£3 paid)	2	2⅛	2	2⅛	7 3 9	February and August	...	...
17,139	5	2/9½	Do. (£5 paid)	3¾	4⅛	3¾	4⅛	6 13 4	,, ,,	...	...
£314,023	Stock	4%	Do. 4 per Cent. Mortgage Deb. Stock (red.)	93	95	93	95	4 4 3	June and December	...	...
26,100	5	5/11½	Edmundson's Electric Corporation Ord.(fully pd.)	4⅜	5⅛	4⅜	5⅛	5 14 3	Half-yearly	...	...
112,100	2	1/2½	Electric Construction Co. (Limited)	2	2⅛	2⅛	2⅛	5 1 1	January and July	2⅛	2⅛
25,000	2	2/9½	Do. 7 per Cent. Cumulative Preference	2⅞	3⅛	2⅞	3⅛	4 6 2	July	...	...
182,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	103	106	103	106	3 15 6	January and July	...	...
30,300	5	...	Henley's Telegraph Works Ordinary	13	14	13½	14½	...	February and August	14	...
15,000	5	...	Do. 4½ per Cent. Preference	5½	6	5½	6	3 15 0	,, ,,	5⅝	...
£50,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock (red.)	111	114	111	114	4 0 0	,, ,,	...	...
50,000	10	10/0	India Rubber, Gutta Percha, &c., Works	21	22	21	22	4 11 10	,, ,,	21⅛	21⅛
£300,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	100	104	100	104	3 16 11	March and September	...	...
37,350	12	12/0	Telegraph Construction and Maintenance	37	41	37	41	4 7 9	March and July	39	37½
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909	102	105	102	105	3 16 2	...	...	...
20,000	5	3/0	Do. Manufacturing Ordinary	9	10	9	10	3 10 0	...	...	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5½	6	5½	6	4 3 4	...	...	...
30,000	5	5/0	Willans and Robinson Ordinary	9½	10½	9½	10½	4 5 9	April and October	...	...
30,000	5	3/0	Do. 6 per Cent. Cumulative Preference	7	7½	7⅛	7⅝	3 17 5	,, ,,	7⅛	...
£100,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Debentures	104	106	104	106	4 0 2	May and November	...	...
			ELECTRIC RAILWAYS, TRAMWAYS, &c.								
12,000	10	6/0	Blackpool and Fleetwood Tramways	17½	18½	17½	18½	3 15 8	...	...	...
£167,900	100	5%	Brisbane Tramway 5 per Cent. Debentures	104	106	104	106	4 14 4	...	...	...
50,000	10	7%	Bristol Tramways and Carriage Ordinary	23	24	23	24	2 17 2	February and August	...	...
25,000	10	...	Do. Cumulative Preference (£6 paid)	6½	6¾	6½	6¾	...	...	...	...
£100,000	Stock	4%	Do. 4 per Cent. Debentures	117	118	117	118	3 7 3	...	...	...
30,000	10	9/0	British Electric Traction Ordinary (Nos. 1 to 30,000)	16	17	16	17	3 10 7	...	16⅜	...
£15,000	10	...	Do. (Nos. 60,001 to 75,000)	15½	16½	15½	16½	...	...	...	...
30,000	10	6/0	Do. 6% Cum. Pref. (Nos. 30,001 to 60,000)	13½	13⅝	13⅜	13⅝	4 7 3	...	13⅛	13⅛
£200,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures	125	128	125	128	3 18 6	...	128	...
40,000	5	1/9	Buenos Ayres & Belgrano 6% "A" Cum. Pref.	4⅞	5⅛	4⅞	5⅛	5 17 1	...	5⅛	...
27,500	5	...	Do. "B"	4⅛	5	4	4⅛	...	...	...	...
320,000	Stock	5%	Do. 5 per Cent. Debentures	105	108	105	108	4 12 7	...	107	105⅝
213,553	10	3/0	Central London Ordinary	9½	10	9½	10	3 0 0	June and December	10	9⅝
£955,000	Stock	2½%	City and South London Railway Con. Ordinary	58	61	59	62	3 1 3	January and July	61	59½
37,000	10	...	Do. (Nos. 22,501 to 60,000) (£5. 10s. paid)	4½	5½	4	5	...	...	...	...
£150,000	Stock	5%	Do. 5 per Cent. Perpetual Preference (1891)	143	148	143	148	3 8 0	January and July	...	...
£200,000	Stock	5%	Do. (1896)	135	140	135	140	3 11 11	...	...	...
£187,701	Stock	4%	Do. 4 per Cent. Perpetual Debenture	125	130	125	130	3 1 11	May and November	128	...
20,000	10	7½%	†Imperial Tramways Ordinary	23	24	23	24	...	March and September	...	...
10,000	10	6%	† Do. 6 per Cent. Preference	15½	16⅛	15	15½	3 13 10	,, ,,	15½	15
£30,000	Stock	4½%	† Do. 4½ per Cent. Debenture	113	116	113	115	3 17 11	January and July	...	...
30,000	10	1/3	Kidd'rm'nst'r&Dist.E.L.&Tr'ct'n 5% Pref.(£8 pd.)	8		8	8½	4 14 1	May and November	...	...
37,500	10	2½%	Liverpool Overhead Railway Ordinary	9⅜	9½	9⅜	9½	3 8 5	February and August	...	...
10,000	10	5%	Do. 5 per Cent. Preference	13	13½	13	13½	3 15 6	,, ,,	...	...
125,000	Stock	4%	Do. 4 per Cent. Debenture	105	107	105	107	3 14 11	January and July	...	...
24,000	5	...	New General Traction Ordinary	3½	4	3½	4	...	...	...	...
30,000	5	6/0	Do. 6 per Cent. Cumulative Preference	5	5½	5	5½	5 9 1	May	5⅜	...
4,000	10	...	Oldham, Ashton and Hyde Elec. Tramway Ord.	...	...	19	19	...	February and August	...	...
4,000	10	5/0	Do. 5 per Cent. Preference	...	...	10½		4 11 11	,, ,,	...	...
13,334	10	...	Potteries Electric Traction Ordinary	11½	12½	11½	12½	...	...	...	...
20,000	10	5/10	Do. 5 per Cent. Cumulative Preference	10	11	10	11	4 10 11	...	...	...
£540,000	Stock	3%	Waterloo and City Ordinary	101	104	101	104	2 18 4	June and December	103½	103

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.
† The London Stock Exchange Committee refuses to quote these.

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THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED First Series (Weekly) 1861; Second Series (Weekly) 1878.

No. 1,135. [No. 17. Vol. XLIV.] FRIDAY, FEBRUARY 16, 1900. PRICE SIXPENCE (by post, 6½d.). Abroad, 8d., or 16 cents. or 80 fr., or 70 pf.

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NOTES.

A pleasing announcement, and one which displays the characteristic generosity of the late Prof. D. E. Hughes, was made by the President at the meeting of the Institution of Electrical Engineers last week—viz., that Prof. Hughes has bequeathed the sum of £2,000 for the foundation of a "David Hughes Scholarship" in connection with the Institution. This announcement was received with great acclamation, and all present must have been gratified that the name of this distinguished electrical scientist and inventor will be perpetually associated with the future history of the Institution in a manner so thoroughly practical and useful. We give below the text of that portion of the will of the late Professor which relates to the bequest:—

> I direct and declare that the legacy of two thousand pounds, so bequeathed to the said Institution of Electrical Engineers, of which I am Past President, shall be invested by them in any manner for the time being authorised by law for the investment of trust funds, for the purpose of founding in connection with that Institution a Scholarship Fund, to be called the David Hughes Scholarship Fund. And I direct that the annual income produced by the investments for the time being constituting the fund shall be given each year to a student preparing himself for the career of an electrical engineer, under conditions similar in all respects to those under which the fund now known as the Sir David Salomons Scholarship Fund is administered, but so that if and so often as for any reason the Scholarship hereby founded shall not be for any given year awarded to any student, the annual income of the Fund for that year shall be invested in manner aforesaid and added to the capital of the David Hughes Scholarship Fund.

The experiments made by Prof. Gotch and Mr. Burch and described in another column, point almost conclusively to the correctness of Prof. Gotch's hypothesis as to the seat of the "shocking" E.M.F. of the *malapterurus electricus*. He is of opinion that the seat of the E.M.F. is in the nerve centre, and not in the so-called electric organ. But what, then, is the function of this organ? We are still inclined to think that it combines the duties of connection board and condenser, and that it is for this reason that Nature has made the "discs" thin and of high resistance to serve as dielectrics between the conducting albuminous fluid in the compartment spaces. The observation, that the excursions of the electrometer due to transitory currents passed through the same circuit were different in nature to the currents generated by the fish itself, does not necessarily disprove this, as to realise the same conditions it would have been necessary to charge simultaneously each of the surfaces of the 530 discs with a transitory E.M.F. of 0·048 volt.

The policy of the London County Council with regard to telephony is not, as it should be, to look after the interests of Londoners and to do its best to promote an efficient service. We publish in another column an account of the debate on a report of the Highways Committee with regard to Mr. Gaine's recent circular letter to London telephone users, and from this it is evident that the policy pursued is simply and unreservedly "*à bas la* National Telephone Co." In Mr. Gaine's reply to the committee's report it is seen that, in exchange for underground facilities, the company offer a service at the same cost as that to be offered by the Post Office—that is to say, Londoners would obtain at once, or as soon as the removal of the wires from overhead to underground can be started, a better service than at present and at a lower cost, instead of having to wait until the promised Post Office service is developed from practically zero to full magnitude. The London County Council will not accept this "sporting offer," however, unless the proviso is added that the company afford subscribers to Post Office exchanges free inter-communication facilities within the metropolitan telephone area. Were the company to give way in this, it would mean that, if there are say 1,000 subscribers to the Post Office exchange (which would be a fair number to start with), these subscribers are to have free inter-communication with all the National Telephone Co.'s subscribers, numbering 30,000. It should be remembered that the company already pays to the Post Office 10 per cent. of its gross receipts from subscriptions, a tax which during the last six months amounted to £64,176, or almost exactly half the sum paid as dividend to the shareholders.

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The above figure is taken from the directors' report of the National Telephone Co., which is given in full in another column. It will be seen that the usual dividend of 6 per cent. is recommended on the ordinary shares, but the reserve fund is to be increased by £80,000, as against £60,000 for the preceding half-year, this total of £140,000 comparing well with the £100,000 of 1898, and bringing the reserve fund to over £760,000. This sum will have grown automatically (apart from subsequent half-yearly additions) to over £1,000,000 by the date of the expiry of the company's licence, even assuming that there is to be no renewal after the year 1911; and it will be remembered that £1,000,000 is what has been computed as the amount of "water" in the company's capital. It is interesting to note, however, that the reserve fund is apparently invested in the company's own business. The actual amount set aside for depreciation is not stated, but is included in the item for administration, management, wages, &c. Probably the company consider that the publication of the exact figure for depreciation might interest competitors even more than its own shareholders. The threatened competition, however, and the frequent complaints against the service appear to have had little effect in warning off new subscribers, for the erection of 10,000 additional lines is announced as having been carried out during the half-year, this work and the capital-account share of laying underground lines representing an increase in the value of the company's undertaking by nearly £370,000.

Telephone engineers are always glad to consider systems in which some of the operators' work is done by the subscriber himself, especially if the capital cost of an exchange is thereby diminished. Thus, the call-wire system has been patiently tried in some cases, although its success has been limited, owing to the difficulty of educating the average telephone subscriber up to it. The Kellogg "divided exchange" system is an attempt to solve the problem in a different manner, and as is seen by an article in another column, a large exchange utilising this system has just been built in St. Louis. The subscribers are divided into four sets. The board is divided into four corresponding divisions, which are in their turn divided into multiple sections in the usual manner; but the subscribers in any one division are multipled only over the sections of that division, and are only represented on the other division by indicators and answering jacks. Each subscriber is provided at his end of the line with four keys, marked to correspond with the four divisions, and these send positive or negative currents between one of the two lines and earth, according to which key is depressed. The indicators at the four divisions at the exchange are polarised accordingly, the calling subscriber having found out from his telephone directory in which set the wanted subscriber is, presses the corresponding key. At present the Kinloch exchange is only equipped for 2,200 lines, a number which could easily have been dealt with on the ordinary multiple system, and unfortunately no figures are given to enable the costs to be compared. The diminished cost of the multiple sections has of course to be compared with the extra cost of the indicators and of the subscriber's extra switch, to enable an estimate to be made of the size of exchange at which an economy is apparent. The boards at St. Louis are intended, however, for an ultimate capacity of 20,000 subscribers (there being room for 5,000 jacks on each section) a number which would be large to deal with in a single exchange on the ordinary multiple system without transfer boards.

Cable Interruptions:—	Date of Interruption.
Latakia—Cyprus	June 21, 1899
Cayenne—Pinhieros	Oct. 11, 1899
Tangier—Tarifa	Jan. 3, 1900

Glass Making by Electric Furnace.—An American glass maker has applied the electric furnace to the melting and moulding of glass.

Delay on Telegraph Land Lines.—Owing to snowstorms, there has been some delay on the Post Office land telegraph lines during the week.

South African Land Lines.—Reuter's Lorenço Marques correspondent stated yesterday that telegraphic communication with Pretoria had been interrupted for the last two days.

The Electrical Engineers (R.E.) Volunteers.—The sum of £3,000 previously allotted to the detachment of the Electrical Engineers Volunteer Corps for the purchase of plant is to be increased to £5,000.

The Taunton Municipal Technical Institute.—This institute was opened on the 13th inst., with some ceremony, by Prof. S. P. Thompson. Subsequently Prof. Thompson gave a lecture on "England's Leeway in Education."

The Cape University.—By the will of Dr. W. Hiddingh, a wealthy Afrikander, the Cape University is benefited to the extent of £25,000, with a site for new university buildings, and £5,000 for the foundation of a scholarship. The South Africa College likewise receives £10,000.

Personal.—According to the *Electrical Review* of New York, Prof. Reginald A. Fessenden has resigned his chair in the electrical engineering department of the Western University of Pennsylvania, to accept a position in the signal department of the United States Weather Bureau at Washington.

The Royal Society.—Among the Papers down for reading yesterday was one by Prof. R. W. Wood on the "Photography of Sound Waves and the Kinematographic Demonstration of the Evolutions of Reflected Wave-Fronts, with especial reference to the Relation of the Wave-Front to the Caustic."

The Cambridge Mathematical Tripos.—The proposals for remodelling the Mathematical Tripos came up for decision at the meeting of the Senate held yesterday afternoon. The whole of these proposals were rejected, thus leaving unaltered the schedule of subjects in Part I., and the Senior Wranglership and order of merit are retained as before.

Niagara Power.—According to the *Electrical World* of New York, about one-sixth of the total power used in Buffalo comes from the Falls. The United States Government now proposes to use the current in the new post office, and in every direction the use of Niagara Falls current is rapidly extending.

Motor Cabs in Berlin.—Germany appears to have been somewhat behind the rest of the world with regard to motor cabs, as it is only just announced that an accumulator cab has been put on the streets of Berlin. It carries 44 cells in a box slung beneath the cab, and these will suffice to carry the vehicle a distance of 80 miles. The cabs are fitted with taxameters.

The Birkbeck Institute.—The biennial conversazione of the students of this well-known institution was held on Saturday evening last, Feb. 10. In spite of the heavy snowstorm which was falling, the number of those present was very large, amounting to nearly 1,000. There were numerous scientific exhibitions of a very interesting character dealing with various branches of physics and chemistry. A most enjoyable evening was spent.

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General Electric Co.'s Staff Dinner.—Last Saturday the annual dinner of the General Electric Co.'s staff took place. There was a large attendance both of ladies and gentlemen, and the function was as successful as it always is. Among the speeches especial interest attaches to Mr. R. E. B. Crompton's reply to the toast of "The Navy, Army, and Auxiliary Forces." Mr. Hugo Hirst was in the chair, and among the other speakers were Mr. Dane Sinclair, Mr. Roger Wallace, Q.C., Mr. Max Byng, and Mr. J. S. Raworth.

Newcastle Section of the Institution of Electrical Engineers.—At the meeting of the Institution of Electrical Engineers held on February 8 the President (Prof. Silvanus P. Thompson) announced that the following gentlemen had been elected on the committee of the Newcastle section of the Institution of Electrical Engineers: Chairman, Mr. A. W. Heaviside; vice-chairman, Mr. W. D. Hunter; hon. sec., Mr. J. F. C. Snell; committee, Messrs. C. Burnett, H. F. Friederick, J. H. Holmes, J. A. Jeckell, W. C. Mountain and the Hon. C. A. Parsons.

The "Send-Off" Dinner to the Electrical Engineers' Volunteers.—A letter from the honorary treasurer (Mr. H. Edmunds) appears in another column. Mr. Edmunds has subsequently informed us that Major R. E. Crompton has arranged that the date for this dinner shall be Saturday, March 3, 1900. It will probably be given at the Great Eastern Hotel, Great Eastern Station, Liverpool street, E.C., at 6.30 p.m., but full particulars will be forwarded together with tickets to entertainers of the corps. Mr. Edmunds adds that it would very much facilitate matters if intending entertainers would send in their names at once.

The Nernst Lamp.—A German contemporary states that the Allgemeine Elektricitäts Gesellschaft, which is erecting a supply station at Göttingen, is taking steps to introduce the Nernst lamp there, and the necessary arrangements are being made with intending consumers. In addition to the ordinary tariff for current metered, a charge of 50pf. (6d.) per week will be made for the hire of the lamp, which will include the spirit lamp for lighting it. Automatically-lighting lamps will not be supplied in the first instance. A candle-power of 25 Heffner candles (about 22 English standard c.p.) is guaranteed with about the same consumption of current as that of a 10 c.p. incandescent lamp.

Peculiar Accident to Underground Telegraph Wires.—A peculiar, but at the same time most unfortunate, accident occurred in connection with underground telegraph cables in the City of London on Wednesday afternoon. One of the Post Office workmen, while repairing wires in a surface box at the corner of Queen-street and Cheapside, upset his naphtha lamp and set fire to the gutta-percha wires within the manhole, of which there were some 300. Considerable inconvenience was caused thereby, as all the wires were interrupted, and it took some time to restore them, owing to the lead tablets bearing the descriptive particulars of the circuits having been fused by the excessive heat. It was not alone the Post Office telegraph service which was disturbed, but also to a certain extent that of some of the cable companies whose wires pass through the same tubes.

Telephone Control in Massachusetts.—A bill has been introduced into the Massachusetts Legislature with the object of bringing the telegraph and telephone services (particularly the latter) under the official supervision of the Board of Gas and Electric Light Commissioners. For two or three years past bills of a similar character have been introduced into the Massachusetts Legislature, but hitherto they have failed to become law. The present bill differs from the one presented last year in that the authority granted to the Commissioners is recommendatory rather than mandatory, they being empowered only to make recommendations when they think that the tariff of the companies should be reduced. The Railroad Commissioners in the same State have similar powers, and it is found in practice that any recommendations made by them are effective, the railroad companies probably considering that the Legislature will enforce the recommendations if the company fail to follow them.

Transformation of Phases without Change of Voltage.—The *American Electrician* states that the Niagara Power Co. has installed a pair of transformers which are notable on account of the fact that they change the phase of the power passed through them without any change whatever of the pressure. The transformers are rated at 500 kw. each, and are designed to supply some three-phase 2,200 volt loads on the Canadian side of the Niagara river. These were previously supplied from machines belonging to the same company but located in the power house of the Niagara Falls Park and River Railway Co., which was burnt down some months ago. This load will hereafter be supplied from the large 2,200 volt two-phase power plant on the New York side of the river, requiring therefore a transformation from 2,200 volts two-phase to 2,200 volts three-phase. The two transformers are "Scott connected" on the secondary sides. One, the main, has a transformation ratio of 2,200 to 2,200, while the other has a transformation ratio of 2,200 to 1,900.

An Electrical Pilot Torpedo.—The employment of a pilot engine in advance of a special train is a common practice on railways, and proposals have not been wanting of methods of connecting this engine to the train by electrical means, in order that any obstruction on the line may be at once communicated to the driver of the train. The Obecchioni "pilot torpedo," described in some of our Continental contemporaries, is designed by its inventor to perform a similar function in protecting ships from collision. Its shell resembles that of a Whitehead torpedo, and it is connected to the vessel it is to protect by two pairs of wires. One pair conveys current to the motors driving the screw propeller of the torpedo. Two metal feelers project from the head of the torpedo, and if these collide against anything, they close a contact connected in an alarm bell circuit on the ship by the other pair of wires. A mechanical switch worked by a lever attached to these feelers reverses the direction of rotation of the motors at the same time, by switching over from one set of field windings to another wound in the reverse direction, the switch falling back to its original position as soon as the torpedo is no longer in contact with the foreign object. It is proposed to let this apparatus, floating half-submerged, precede the ship by about a quarter of a mile; but no indication is given in the description how the torpedo is to be steered.

Paris 1900 Exhibition.—The Paris correspondent of the *Daily Telegraph* states that there is considerable probability of the Paris International Exhibition not being ready for public inauguration next Easter Sunday, April 15th, as previously arranged. Even should the official opening take place on the date fixed, it seems likely that many of the buildings will be incomplete, and further, that the Exhibition will only be opened during daylight for some time after its inauguration. He says that owing to the flooding of the Seine "the monumental palace of electricity has sunk in at one extremity to a depth of nearly 10ft., and the architects are extremely doubtful of being able to raise the building or even to provide against the possibility of further shifting." This is not the only electrical calamity associated with the Exhibition, for it transpires that "the contracts for the lighting of the entire grounds and buildings have fallen through, and that therefore arrangements of a satisfactory nature cannot at this date be concluded, as no firm can be found willing to undertake to supply the enormous plant required at so short notice." A similar report, but not quite of such a pessimistic nature with regard to the electrical contracts, is published in the *Courrier du Soir*. This journal also says that it is unlikely that the Exhibition will be sufficiently advanced to be opened on April 15th, and suggests May 1st as being more probable. This state of affairs, however, it attributes merely to difficulties which have arisen with regard to the supply of electric light cables, the demand for electrical energy having by far exceeded what was originally anticipated, and the cable manufacturers being unable to supply sufficient material in time.

The New York Rapid Transit Tunnel.—After several years of hopes and disappointments over the rapid transit tunnel question in New York, there is at last a promise that the enterprise will soon be undertaken and completed within three years. Recently bids were received by the Rapid Transit Railroad Commissioners for the construction of the under-

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ground railroad, and one of these—that of Mr. John B. McDonald—was accepted. Mr. McDonald's estimate for the entire work is $35,000,000. The cost of the road will not be confined entirely to the amount of the accepted bid. The city, in addition to agreeing to give the contractor every facility for pursuing his work, is to acquire for him by condemnation or purchase all the real estate needed for terminals, and to pay the cost of the terminals with a 10 per cent. profit to the contractor; and for this purpose an extra sum is allowed of $1,750,000 in addition to the contract price. The lease of the road is to begin with the completion for operation of each section, and is to continue for 50 years. At the end of that time it may be renewed for 25 years, at a rental not less than that which has been paid during the last ten years of the first term. The lessee is to pay as rental all the interest on the bonds issued by the city to pay for building the road, also the interest on the bonds issued during the time of construction to meet these interest charges. All of that part of the road which is in the lower part of the city will be underground, but the sections in the upper part of the city will be run partly on the surface and partly on overhead structures. The terms of the contract require that every portion of the tunnel shall be made waterproof with felt and asphalte so that no water whatever can enter it from the ground. Mr. McDonald intends to begin work on the road at the points where the greatest difficulties are to be met, and then to open up at other places in turn, so timing the beginning at each place that the entire road will be finished and ready for the equipment at the same time. The work, he states, will give employment to 10,000 to 12,000 men.

The Functions of the Engineer.—At a meeting of the Glasgow Association of Students of the Institution of Civil Engineers, on February 8, Sir William Preece delivered an address on "The Functions of the Engineer." He attributed the success of the modern engineer to the displacement of rule-of-thumb methods, although in his own branch of the profession, practice had always been in advance of theory. He divided the practice of engineering into three branches: civil, military, and naval. In the term civil engineering he included all those branches of engineering which were applied to supplying people's wants and comforts; to providing the home with pure air, pure water, pure food, pure light; to the improvement of the means of transport and communication by railway, tramway, telegraph, and telephone. The engineer utilised matter wherever it could be found: he delved into the crust of the earth for ores and minerals; he surveyed the bottom of the sea as a bed for his cables; he explored the surface of the earth, and irrigated the land to prepare it for the growth of articles of necessity, use, and luxury. He utilised the great principle of energy to transform it into its various forms of heat, light, electricity, sound, "chemism," and material motion. He added:

> Life is not free from his grasp. He has developed further the Empire of Bacteria, and has encouraged the minute microbe in countless armies—to liquefy and purify our sewage, and to become the scavenger of our homes and our cities. He has by defensive measures freed the soil and the river from those ruthless bacterial enemies who invade our frames and bring disease and death in their train. . . . . The rapid progress of modern engineering is phenomenal. . . . Take any form of energy and examine its utilisation in any field of industry. Take only one instance of the application of electricity. See how it comes to the aid of the sailor! It controls the rudder, it ventilates the interior and the living space of the ship, it forces the draught and assists the raising of steam, it revolves the turrets, it trains and controls the guns, it handles the ammunition, it purifies the drinking water, it lights up the ship internally, it enables the captain to sweep the horizon with the brilliant rays of the searchlight, and to communicate with his tender or with his commanding officer across space independent of weather, night, reason, fog or rain.

As regards the *making* of the engineer, he strongly advocated a broad, solid, general education in the first instance, not specialised in any way until the pupil had reached the stage when he could work and think for himself. He did not advocate the early teaching of science, but strongly approved the cultivation of the love of Nature and of science by encouraging in children the collection and naming of plants, the love of animals and a knowledge of their habits, and the observation and explanation of the daily occurrences of life.

The "Malapterurus Electricus."—Some time ago (*The Electrician*, Vol. XLII., p. 746) we referred to the interesting research being carried out by Prof. Francis Gotch in connection with the electric organ of the *malapterurus electricus*, the electric fish of the Nile. Some further experiments, made in conjunction with Mr. G. J. Burch, of capillary electrometer fame, with a nerve preparation from one of these fish, are described in the latest number of the *Proceedings* of the Royal Society. The fish was anæsthetised and then killed, and a strip of organ with the nerve was carefully dissected out and kept at a temperature of 5°C. As a result of observations with a capillary electrometer, a curve was plotted for a length of 15mm. of the electric organ, representing about one-eighth part of the whole E.M.F. of the shock from the entire fish. The time-lag between the excitation of the nerve and the record of an E.M.F. proved larger than on a previous experiment, but of the same order—viz., 0·017sec. or 0·018sec., instead of 0·010sec.; and the duration of the organ response was also longer—0·039sec. instead of 0·021sec. There was no trace of a change in sign during the discharge, the voltage, after the time-lag mentioned, rising fairly sharply to a maximum (in 0·007sec.), and then falling more gradually (in 0·016sec.) to zero. The experimenters made obvervations of induction currents, condenser discharges, and transient currents passing through the same circuit, but in no case obtained a curve of time relation resembling the organ response. The length of the nerve fibre from the seat of excitation to the organ strip was 40mm., and the authors think it probable that the greater part of the time was occupied by the slow transmission of the excitatory state along the finest subdivision of the nerve within the organ near the ultimate endings. The maximum E.M.F. obtained was 25·10 volts, so that for a whole organ the E.M.F. would be about 200 volts. As the number of "discs" in the piece of organ tested was about 530, this works out to 0·048 volt as the E.M.F. of any one disc, which it is interesting to compare with that of the sciatic nerve of the frog, found by the same experimenters to be 0·038 volt. It should also be mentioned that, while Prof. Gotch was dissecting the anæsthetised animal, the division of a nerve branch with metal scissors whilst the organ was grasped by a metal forceps caused a strong shock to pass, which he felt up to the elbow. After a comparatively few successful experiments the excitability of the nerve suddenly failed, and this was attended by inability of the organ to respond, whether a stimulus was applied to the nerve or to the organ substance. Measurements of the resistance of the organ were made, and it was found by taking measurements longitudinally to the column and transversely (*i.e.*, across and parallel to the "discs" respectively) and obliquely, that the resistance of the thin "discs" was considerably higher than that of the albuminous composition between them.

MEETINGS OF SCIENTIFIC AND ENGINEERING SOCIETIES, &c.

SATURDAY, February 17th.

INSTITUTION OF ELECTRICAL ENGINEERS.

11 a.m. Students' Visit to the Davies-street Station of the Westminster Electric Supply Co.

INSTITUTION OF MECHANICAL ENGINEERS

2.30 p.m. Graduates' Visit to the Central London Railway Depôt. Assemble at Caxton-road entrance, 200 yards from Shepherd's Bush Green.

WEDNESDAY, February 21st.

ROYAL MICROSCOPICAL SOCIETY.

8 p.m. Meeting at 20, Hanover-square, W.

THURSDAY, February 22nd.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary General Meeting, when the adjourned discussion on R. P. Sellon's Paper, "The Standardisation of Electrical Engineering Plant," will take place.

FRIDAY, February 23rd.

PHYSICAL SOCIETY.

5 p.m. Meeting in the Rooms of the Chemical Society, Burlington House. Agenda: Prof. R. W. Wood, of the Wisconsin University, U.S.A., will exhibit and describe his (1) Photographs of Sound Waves and the Kinematographical Demonstration of the Evolutions of Reflected Wave-fronts; (2) a New Seudoscope; (3) Diffraction Colour-Photographs; (4) Artificial Parhelia.

ROYAL INSTITUTION.

9 p.m. Evening Discourse by Prof. J. H. Poynting, F.R.S., entitled "Recent Studies in Gravitation."

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CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

Asymmetries in the Zeeman Effect.—In observing spectrum lines resolved into triplets by the action of the magnetic field, one is struck by the symmetrical position and the equal intensity of the outer components of these triplets. There are, especially in the case of iron, a number of the stronger lines which seem to represent ideal cases of triplets, as originally predicted by Lorenz's theory. It is only after more attentive inspection that several faint triplets are seen in which one of the outer components appears more intense than the other. P. Zeeman mentions that he had concluded that there was no evidence of a directing influence of the magnetic field on the orbits of the light-ions. Voigt, however, deduced from his theory that normal triplets must show in weak magnetic fields a greater intensity in the outer component towards the red, and a greater distance of the outer component towards the violet. Zeeman has confirmed these results separately, having observed a small difference of intervals in the iron line 3733·46, and a decided difference of intensities in the triplet and quadruplet of cadmium 4678 and 4800, and in the triplet and quadruplet of zinc 4680 and 4722. He considers that these asymmetries do not decide the relative merits of Voigt's and Lorenz's theories, but confirm the common basis of both.

[P. Zeeman, *Proc. Akad. Amsterdam*, Dec. 30, 1899.]

Ionisation of Complex Solutions.—To theoretically determine the ionisation of complex solutions of given concentration, J. G. MacGregor first finds, from conductivity observations made on simple solutions 1 and 2 respectively, corresponding values of dilution and ionic concentration for a sufficient number of solutions of each, and plots curves with dilutions as ordinates and ionic concentrations as abscissæ. They have, roughly speaking, the shape of rectangular hyperbolas, and thus have no rapid curvature except at moderate dilutions. Having obtained the curves for both solutions, it remains to find two points having the same abscissa and having ordinates satisfying the conditions of the equation

$$N_1V_1 + N_2V_2 = 1,$$

where N_1N_2 are the concentrations and V_1V_2 the original dilutions. This can be done by inspection, or by drawing a new curve with ordinates equal to the sum of the ordinates of the first curves and N_2/N_1 times the ordinates of the second curve, drawing a line parallel to the ionic concentration axis and at a distance $1/N_1$ from it, cutting the new curve in a point, a normal from which on to the concentration axis cuts the two curves in the points required. The ionisations are then equal to the product of the abscissa into the ordinate of each point respectively. The author also solves the converse problem of determining the concentration from the ionisation, and shows that both methods are experimentally confirmed.

[J. G. MacGregor, *Trans. Nova Scot. Inst.*, 10, 1898-99.]

Molecular Susceptibilities.—The magnetic susceptibilities of the elements are being gradually unravelled, but we are still far from a clear and accurate insight into their system. The molecular susceptibilities of the elements of the iron group have been studied by O. Liebknecht and A. P. Wills, and those of the rare earthy elements corresponding to the same group by H. Dubois and O. Liebknecht, chiefly by the method of dropping the solutions in a strong magnetic field. In the former group Jäger and Meyer's interesting series of atomic susceptibilities of *Mn*, *Fe''*, *Co*, and N, in the ratio 6 : 5 : 4 : 2, is not confirmed, the numbers being 6·98 : 5·86 : 4·70 : 2 instead. Wiedemann's series a, $a+b$, $a+\frac{3}{2}b$, $a+2b$ agrees rather better with facts, but a still closer approximation is obtained by putting $b = 1{\cdot}25a$ instead of $1{\cdot}15a$. In any case there is a sudden rise from chromium to manganese and ferric iron, and a gradual fall from the latter to cobalt, nickel, and copper. In the rare earths investigated there is, on the other hand, a gradual rise from cerium to praseodymium and neodymium; a decided rise in samarium, gadolinium, and erbium; and a sudden fall to ytterbium at the end of the series. Slight admixtures of any of these to iron may lead to surprising results. Some of the elements have almost ceased to be rare.

[Liebknecht, Wills, and Dubois, *Ann. d. Physik*, No. 1, 1900.]

Specific Electric Strength.—The "electric strength" of a gas as defined by Maxwell—*i.e.*, the E.M.F. at the instant of discharge—is not a true constant for any given gas, since it increases in all gases on diminishing the width of the spark gap, slowly at first and then more rapidly. Baille and Paschen define as the "specific electric strength" the spark potential in any gas referred to air under the same conditions. This ratio, again, is not constant, as it increases in hydrogen and carbonic acid on reducing the spark gap. A. Orgler proposes another definition, and shows that it actually leads to a quantity truly characteristic for each gas, and independent of the pressure and the width of the gap. He divides the difference of potential required to bridge the gap into two parts, one of which overcomes the transition resistance at the surface of the electrodes, while the other perforates the gas itself. Since the former is independent of the width of gap, it can be eliminated by differentiation. If δ is the width of the gap, and A and B the spark potentials in the gas and in air respectively, the author defines the specific electric strength by the formula

$$\kappa = \frac{dA}{d\delta} \cdot \frac{dB}{d\delta}$$

κ is unity for air, 1·050 for nitrogen, 0·888 for carbonic acid and oxygen, and 0·568 for hydrogen.

[A. Orgler, *Ann. d. Physik*, No. 1, 1900.]

Magnetic Viscosity.—When iron is introduced into a feeble magnetic field it does not at once assume the magnetic intensity corresponding to the field. The retardation has been described by the term magnetic viscosity or magnetic after-effect. In its numerical evaluation a difficulty occurs in the determination of the initial value of the magnetic intensity. But that difficulty is avoided by keeping a disc of the metal in question rotating. It is evident that whatever magnetisation is then indicated, especially if it is constant for various speeds of rotation, must be the initial or instantaneous magnetisation itself. Such a disc has been studied in this manner by Lizzie R. Laird. The disc was made of rolled iron 0·062cm. thick, 4·5cm. in diameter, and twice annealed. The ratio of the initial to the final magnetic intensity was 0·872. To follow the course of the after-effect in time, the authoress employed a system of photographic registration, every other system having failed owing to the rapidity of the phenomenon. In the particular case investigated the final state of things was attained in 12 seconds, during which the intensity rose from 87 to 100 per cent. and the susceptibility from 57 to 100 per cent. of its final value. This result is purely empirical, and no formula can as yet be given.

[L. R. Laird, *Ann. d. Physik*, No. 1, 1900.]

Magnetic Dispersion of Becquerel Rays.—The action of the magnetic field reveals a heterogeneity in Becquerel rays which is of the greatest interest. The dispute as to whether Becquerel rays are deflected by a magnet or not is closed by the fact that some are and others are not. P. Curie has devised a method of testing the magnetic deflection which admits of quantitative measurements. The radiant substance is placed on a block of lead and surrounded on two sides by other blocks of lead, and on the remaining sides by the pole pieces of an electromagnet. Above this apparatus are placed two metallic plates facing each other, one of which is kept at a high potential, while the other is connected with an electrometer. When the magnet is unexcited the rays pass between the plates and produce a discharge. When it is excited it may happen that the rays are deflected and absorbed by the lead walls, in which case there will be no discharge. It is found that when the distance between the plates and the radiant body is small, say 3cm., only some 25 per cent. of the rays are deflected. At greater distances they are all deflected. The fact that polonium rays are not deflected at all leads the author to believe that the most penetrating rays are the most easily deflected, a very remarkable result, considering the behaviour of Röntgen rays.

[P. Curie, *Comptes Rendus*, Jan. 8, 1900.]

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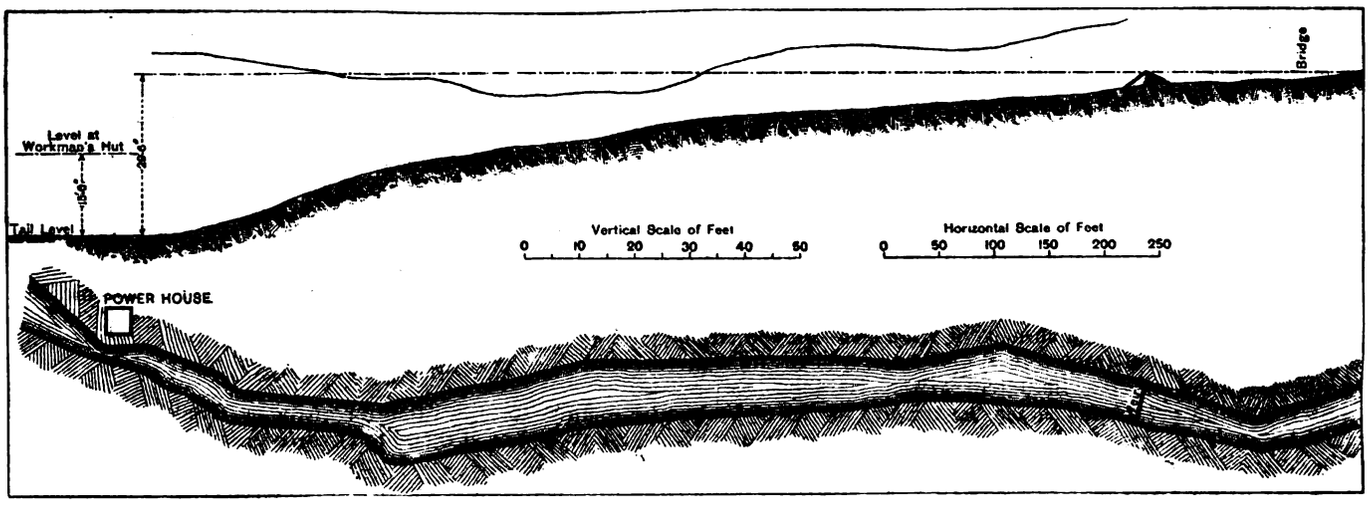
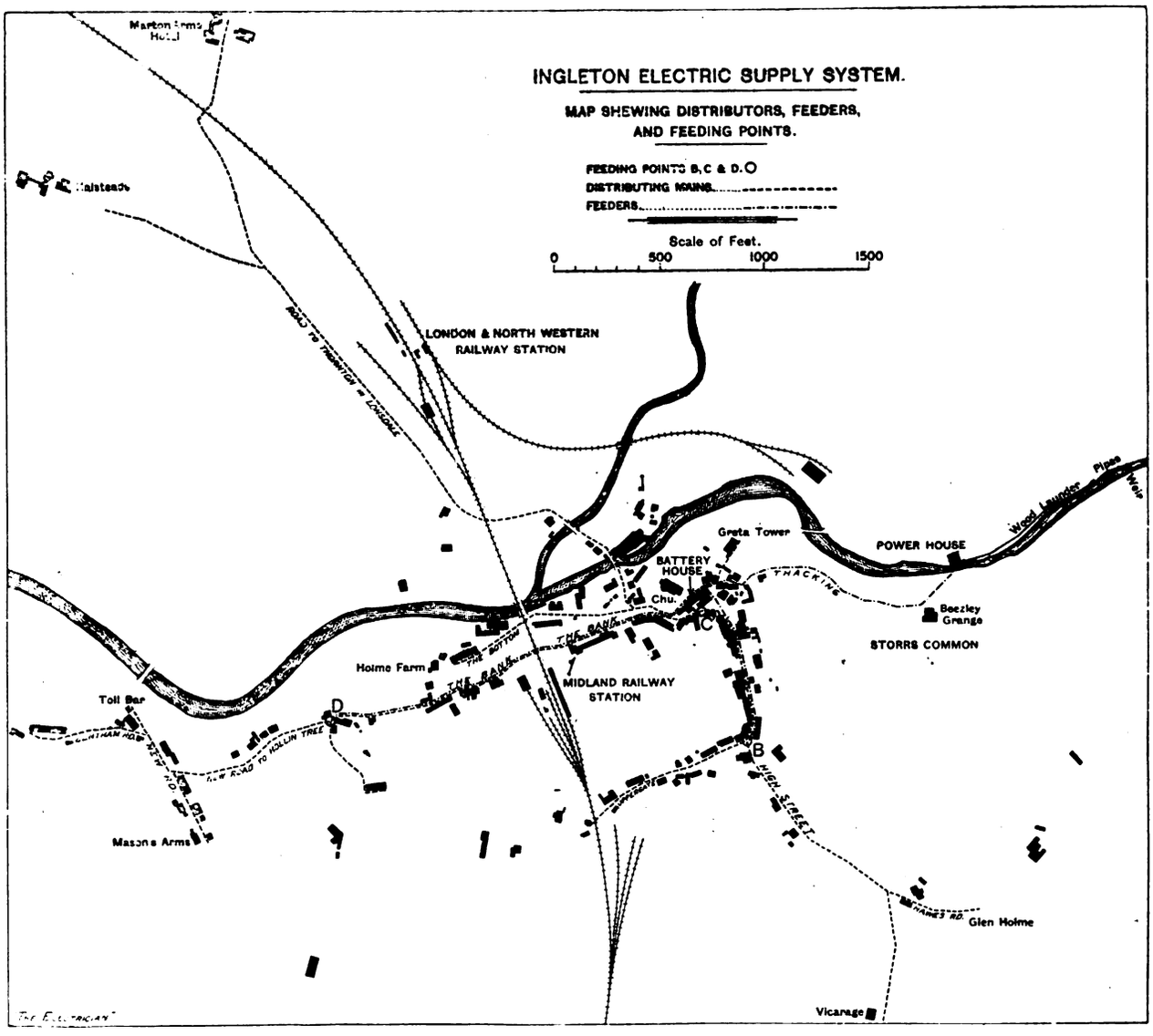
INGLETON WATER-POWER ELECTRIC SUPPLY WORKS.

Ingleton is a picturesque little Yorkshire village of some 1,600 inhabitants. Its chief attraction is its healthful situation on the hill slopes of the West Riding; its principal village electric lighting. Out of all proportion to the size of the hamlet or the magnitude of the undertaking, the Ingleton electric supply works merit careful consideration and study



PLAN AND ELEVATION OF MILL SITE, AND PORTION OF RIVER GRETA UTILISED.



trade, apparently, granite quarrying. This sequestered spot has recently presented to electrical engineers an unusually instructive object lesson in the utilisation of water power for on the part of electric light engineers; and we make no apology, therefore, for devoting to so small a scheme such a large proportion of our space this week.

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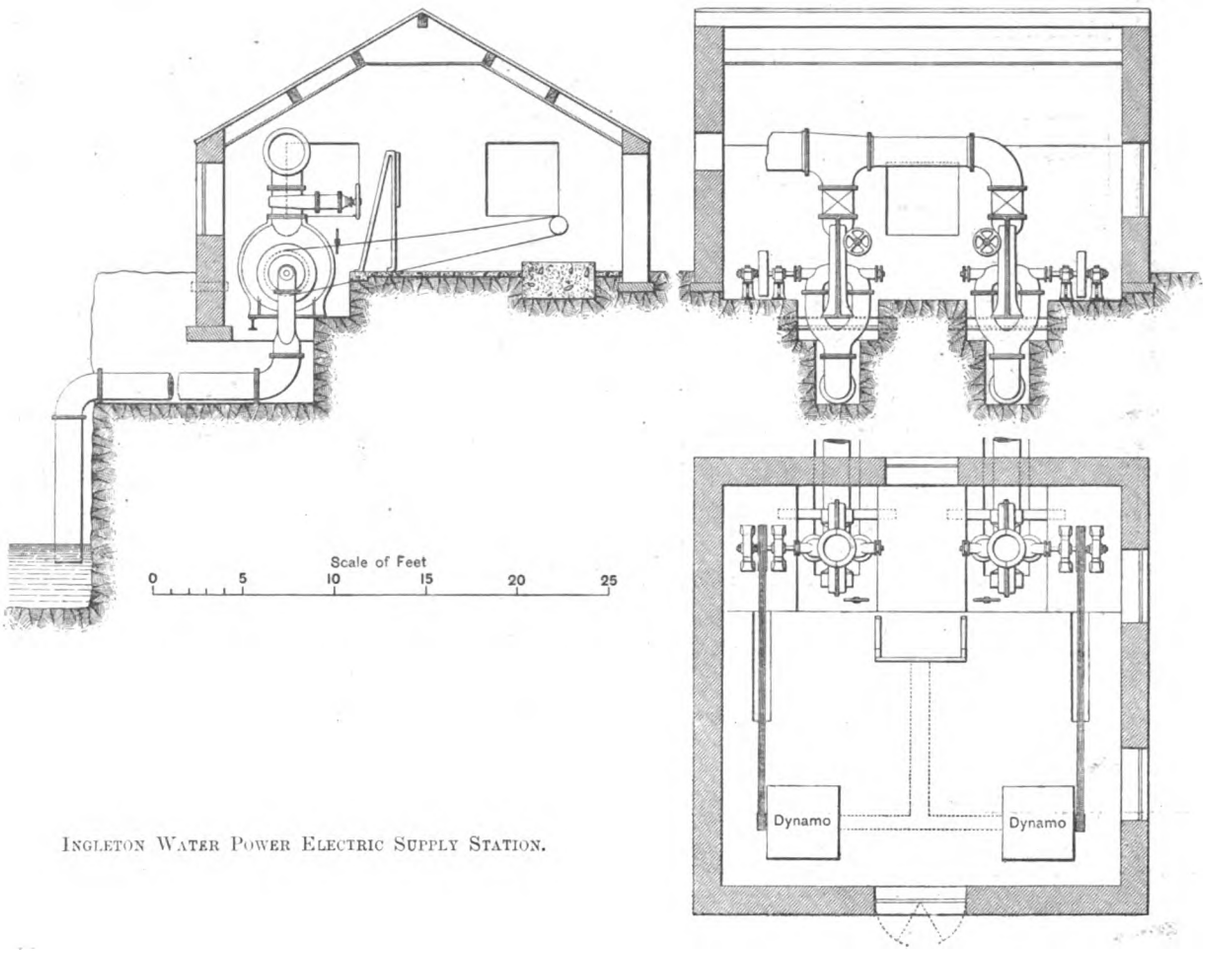
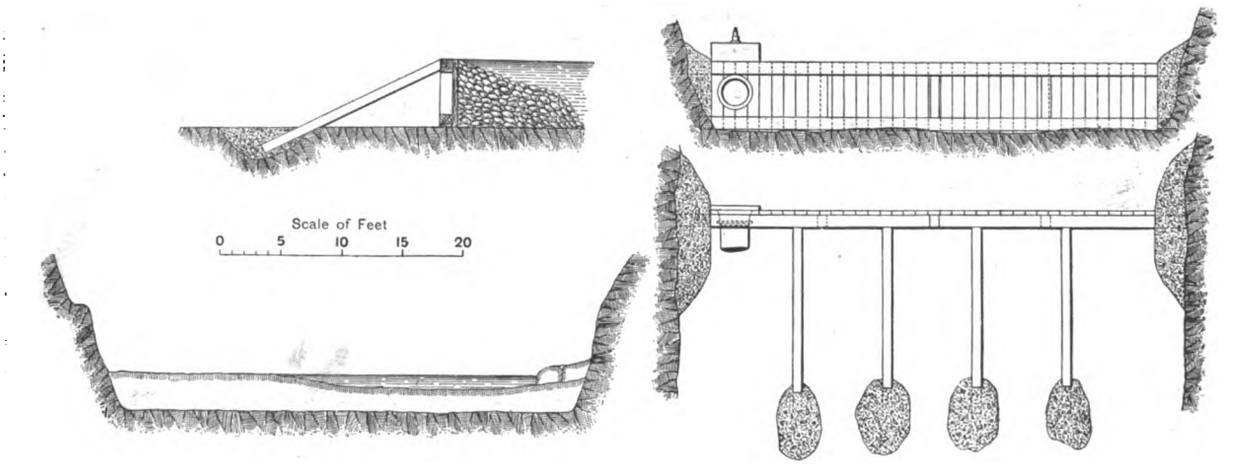
The attitude of electrical engineers towards water power utilisation in this country has been very diversified. While some have held the extreme view that the rivers and coast tides of Great Britain afford a prolific source of power for electrical supply, others have proclaimed the opposite extreme view, that coal, and coal alone, is the source of our energy, and that all attempts to utilise water power are a delusion and a snare. In both extremes there is lack of reason; for while it is demonstrably true that there is no very widely distributed nor large amount of water power commercially available in this country, it is equally patent that here and there throughout the land there are specially favoured spots, affording a sufficiently abundant and steady supply of water power to work, either entirely or in part, electricity works large enough for local demands.



Ingleton Water Power Electric Supply Station.

Unfortunately, electrical engineers have not always been happy in the selection of these spots. At Worcester, for example, the utilisation of the Teme has not met with unqualified approval, but has been, on the contrary, much lamented locally; at Buckingham a small electricity supply works was originally driven by the Ouse, but steam power subsequently replaced the energy of the stream. Better success, however, has attended other efforts in this direction; and we may cite the recently remodelled works at Carlow, Ireland, and the water power plant at Laxey, as evidence of this.

The neighbourhood of Ingleton would appear to afford remarkably good means for running electric supply works entirely by water power. The river Greta flows through the village, and the sharp declivity of its course immediately above Ingleton has enabled an effective fall of some 30ft. to be obtained, with only a moderate capital outlay on retaining works and conduits. At a point about 900ft. above a convenient location for the power house, a weir was thrown



Details of the Weir Construction.

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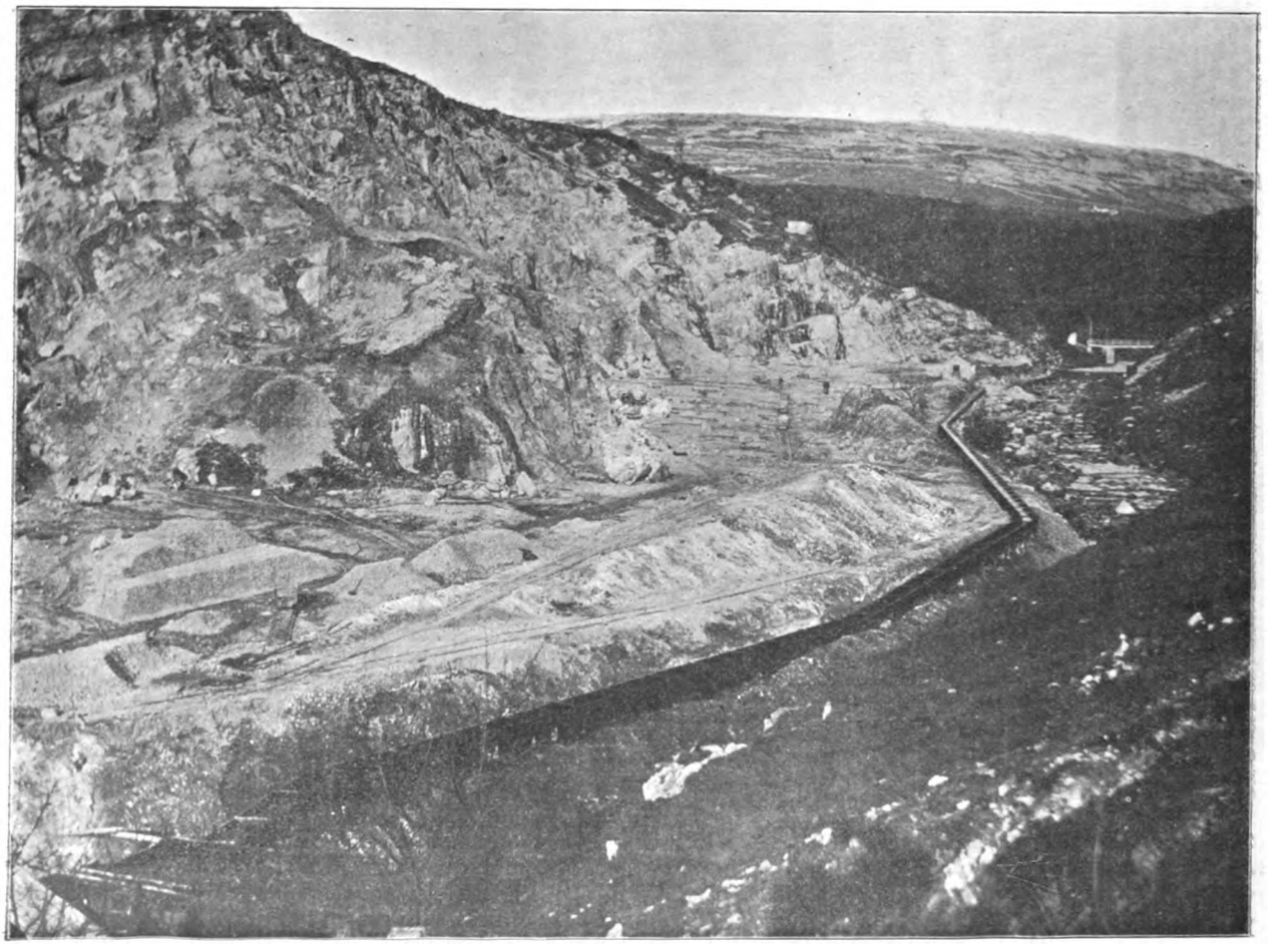
A Wintry View of the Power House and Fenstock.



View of the Water-Chute above the Ingleton Water-Power Station.

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across the stream. Details of the construction of the weir are shown in an accompanying scale drawing; the principal dimensions include a width of 40ft. and a height of 5ft. Near the right bank, the weir has a sluice admitting to a 30in. wrought iron pipe line, which follows for a short distance the course of the stream. The lower end of this pipe dis-

One of the Dynamos.

charges into a wooden chute, by which the head water is conveyed the remainder of the distance to the penstock above the power house. The course of this channel is shown in the map and in the photographic view of the chute. At the present moment the iron hand of winter has

Cable Laying in Ingleton.

been laid on the works, which will account for the frozen appearance in the view of the penstock, &c.; but, we may add, severe as the frost has been, it has not once interfered with the maintenance of electric supply.

Our readers will have been enabled by the foregoing brief account, and with the aid of the illustrations, to perceive how thoroughly Messrs. Gilbert Gilkes and Co., of Kendal, the contractors for the entire undertaking, have developed all the possibilities of this mill site. The result of the construction work thus far described has been to create an effective working head of 27ft. at the turbines. We will now enter the power house and see how this is utilised. It seems almost absurd to dignify the simple little structure, with its one room, with the lofty name of "power house"; yet in design and equipment the building is amply adapted to all present requirements. Within the machinery room are two "Vortex" turbines, each provided with a separate intake from the penstock and a separate draught pipe leading to the tail race. The turbines run on horizontal shafts, each developing from 15 H.P. to 20 H.P. according to the condition of the water supply at the time. Each turbine drives its own continuous-current dynamo by means of rope gearing. Our illustrations show exactly how this is arranged, and the type of dynamo employed. The dynamos are shunt wound, to give either 45 amperes at 250 volts or 35 amperes at 330 volts, as required for charging cells. A simple switchboard is erected near the centre of the room, facing the dynamos, and is equipped with the necessary switches and instruments.

A Street Lamp.

Such are the provisions for generating electric current by means of water power at Ingleton. So simple, indeed, are these provisions, that probably no power house in the world requires less attention. Beyond the fact that the manager calls once a day to oil up and see that all is in order, it is found quite practicable to leave the place locked up. All other necessary regulation is done at the battery house, which is situated at about 500 yards from the power house and nearer the centre of the village. The battery house is a three-storeyed structure, and has been equipped with 116 cells of 780 ampere-hours capacity by Messrs. Drake and Gorham. In this ample storage battery the Ingleton Electric Lighting Co. have wisely provided themselves with a strong bulwark against the evils of breakdown at the power house; and it cannot be doubted that the security of an installation of this description is greatly increased by abundant storage capacity. One of our illustrations shows the switchboard connections at the battery house and the power house.

Distribution is effected on the three-wire system, by means of Callender three-core lead-covered and armoured cable.

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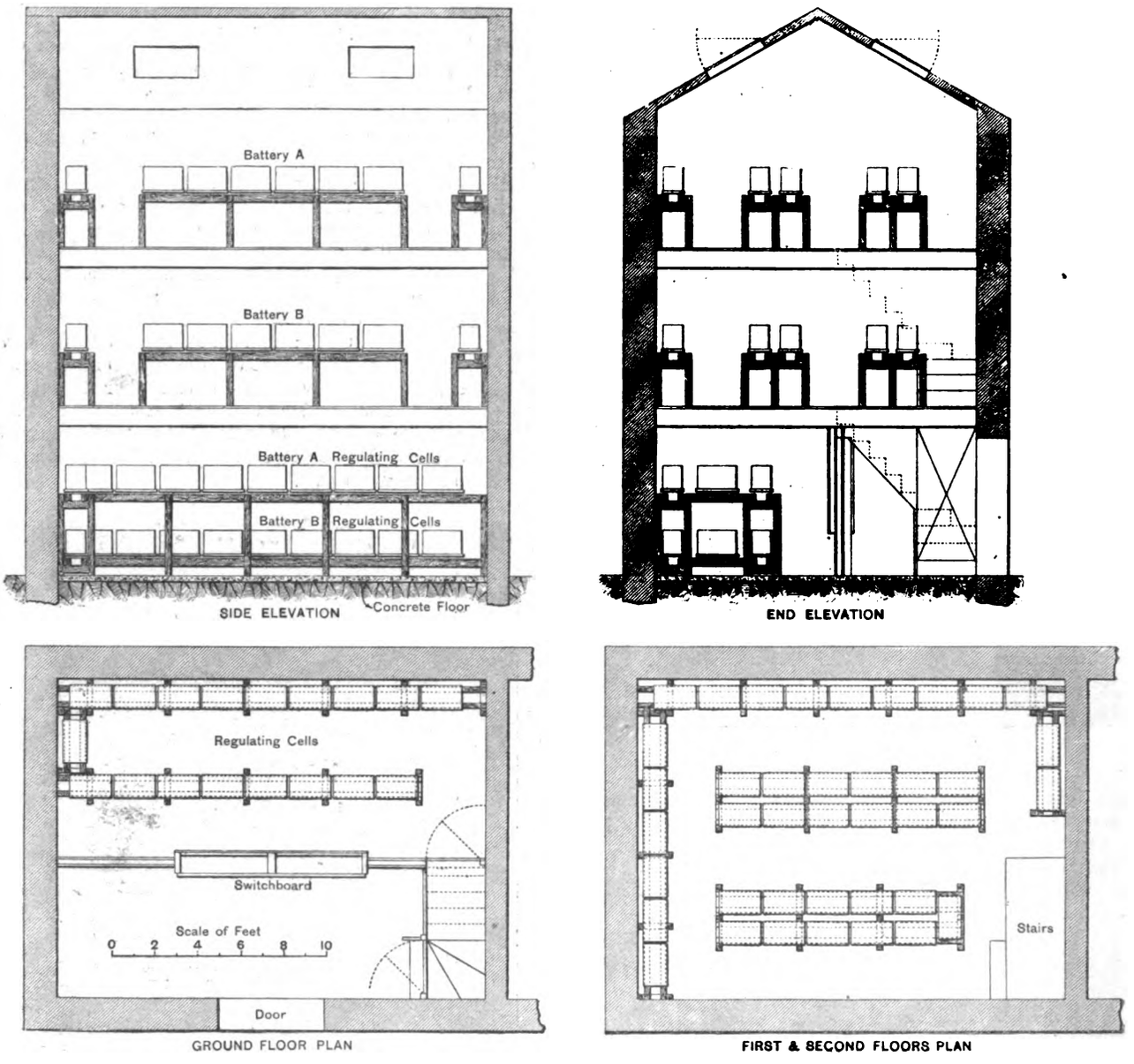
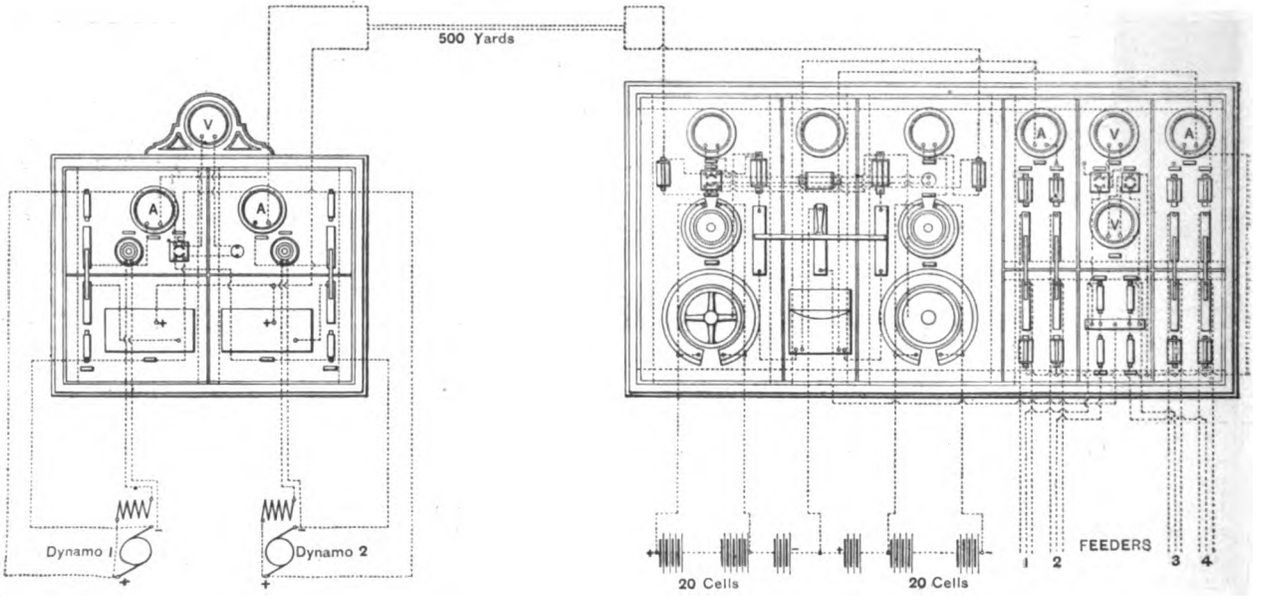


PLANS AND ELEVATIONS OF THE BATTERY HOUSE AT INGLETON.



SWITCHBOARD CONNECTIONS AT THE POWER STATION AND BATTERY HOUSE.

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There are three feeding points, fed by Callender triple-concentric lead-covered and armoured cables. The entire system has been designed for about 2,000 8 c.p. lamps. A considerable amount of public lighting has already been carried out, some 32 gas lamp-posts having been fitted with 32 c.p. glow lamps, one lamp in each post. Formerly street lamps were not lighted when the moon was supposed to be shining over Ingleton, and even on dark nights all lights were extinguished at 10 p.m. The advent of electric light has made moonlight a superfluity, and has added half-an-hour to the time when the village folk are expected to have turned indoors.

In conclusion, we wish to express our thanks to the principal contractors for the undertaking, Messrs. Gilbert Gilkes and Co., for their kindness in supplying us with material for the numerous illustrations accompanying this article. We believe that, when the accounts for the first year's working of this interesting little station are published, they will be found to be fully as interesting and instructive as the works have been in their initiation. Indeed, if good management is well maintained, the analysis of future Ingleton accounts should teach many a useful lesson as to the cost of water power electric supply works in this country.

CORRESPONDENCE.

THREE-PHASE RAILWAYS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In the discussion on the Swiss visit, Mr. A. P. Trotter is reported as having said: "Mr. Ferranti had already spoken of the enormous complication of the switching arrangements, but surely the diagram seen that evening of the gearing on the locomotive showed what an enormous handicap they had to struggle against. It seemed that there was room for a considerable amount of simplification in the locomotive switchgear, to say nothing of the immense amount of work which was spent on the resistances."

Something in the slides—which I fear I exhibited somewhat hurriedly—has evidently given Mr. Trotter a fright: it may be interesting, therefore, to give a few further particulars.

In designing the Jungfrau locomotive a very short wheel base was necessary, because the axles (two for rack wheels and two for ordinary supporting wheels) have fixed centres. At the same time, very great power was required to mount the 25 per cent. gradient and overcome tractive force and rack friction, and these points, combined with the low speed, resulted in a lot of bulky machinery having to go into very little space. Perhaps at first sight the locomotive has the appearance of being complicated, but as a matter of fact, when the different parts of the gear are analysed, we find that a three-phase locomotive is more than usually simple.

Curiously enough, the horse-power of each motor on the Jungfrau locomotive (*see* Fig. 1) is about the same as each of the motors on the Central London Railway locomotive (Fig. 2), the respective sizes being :—

Jungfrau.	*Central London.*
Speed, 550 revs.	Speed, 240 revs.
Diameter of rotor, 25in.	Diameter of armature, 22½in.
Length of rotor, 16½in.	Length of armature, 28in.

Considering that the Central London motor is gearless, and crowded between road wheels 42in. diameter, we see that the Jungfrau motor is somewhere about the same over-all size as it would have been if driven by continuous current at the same speed. Another interesting fact is that, although

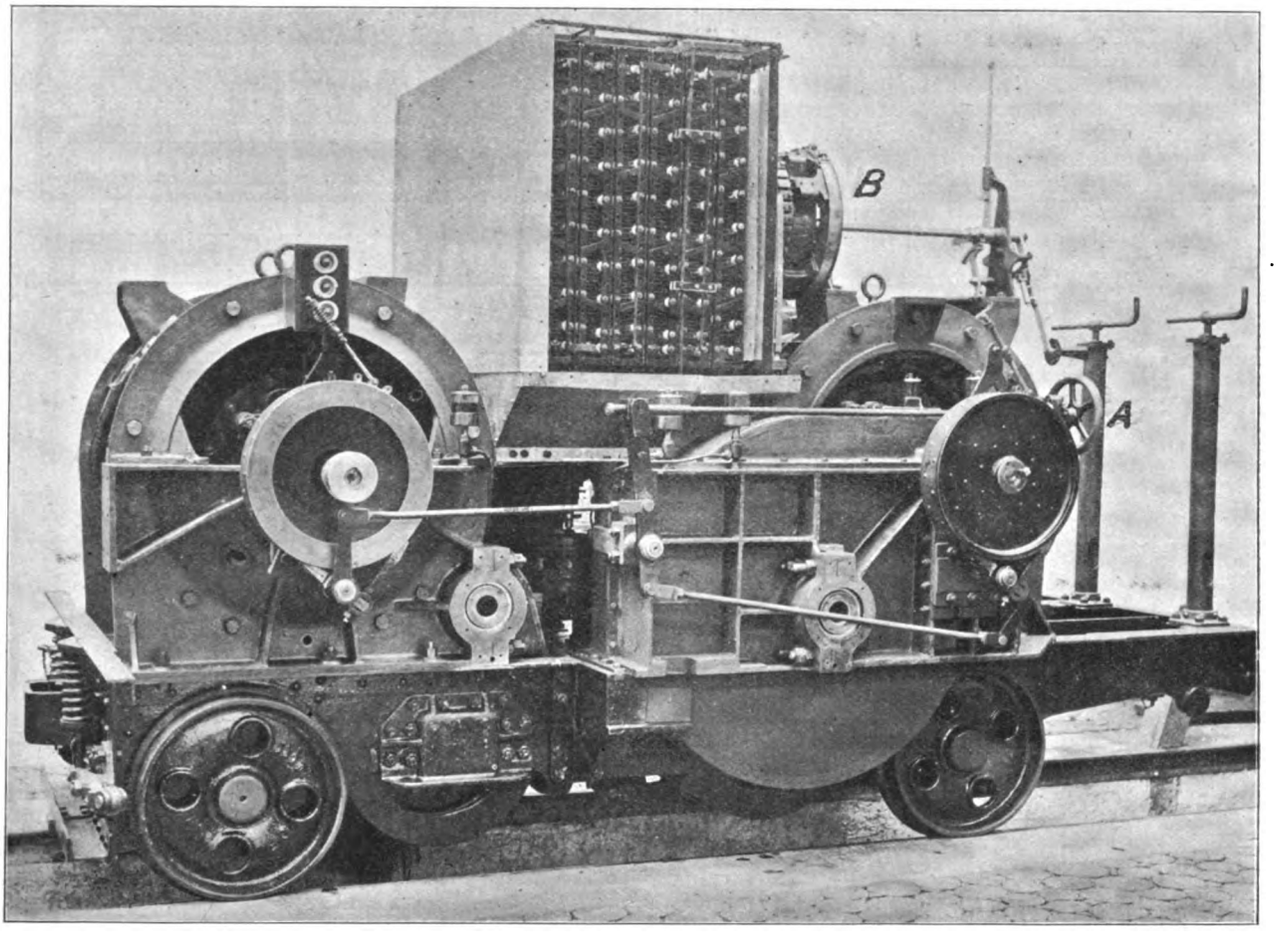

FIG. 1.—OERLIKON ELECTRIC LOCOMOTIVE.

The two handles to the extreme right are for working grooved brakes on the rack wheels. A is the handwheel for putting the two band brakes on rotor shafts on and off. B is the switch for the rotor resistance. The projection at the extreme left is for carrying one end of the coach.

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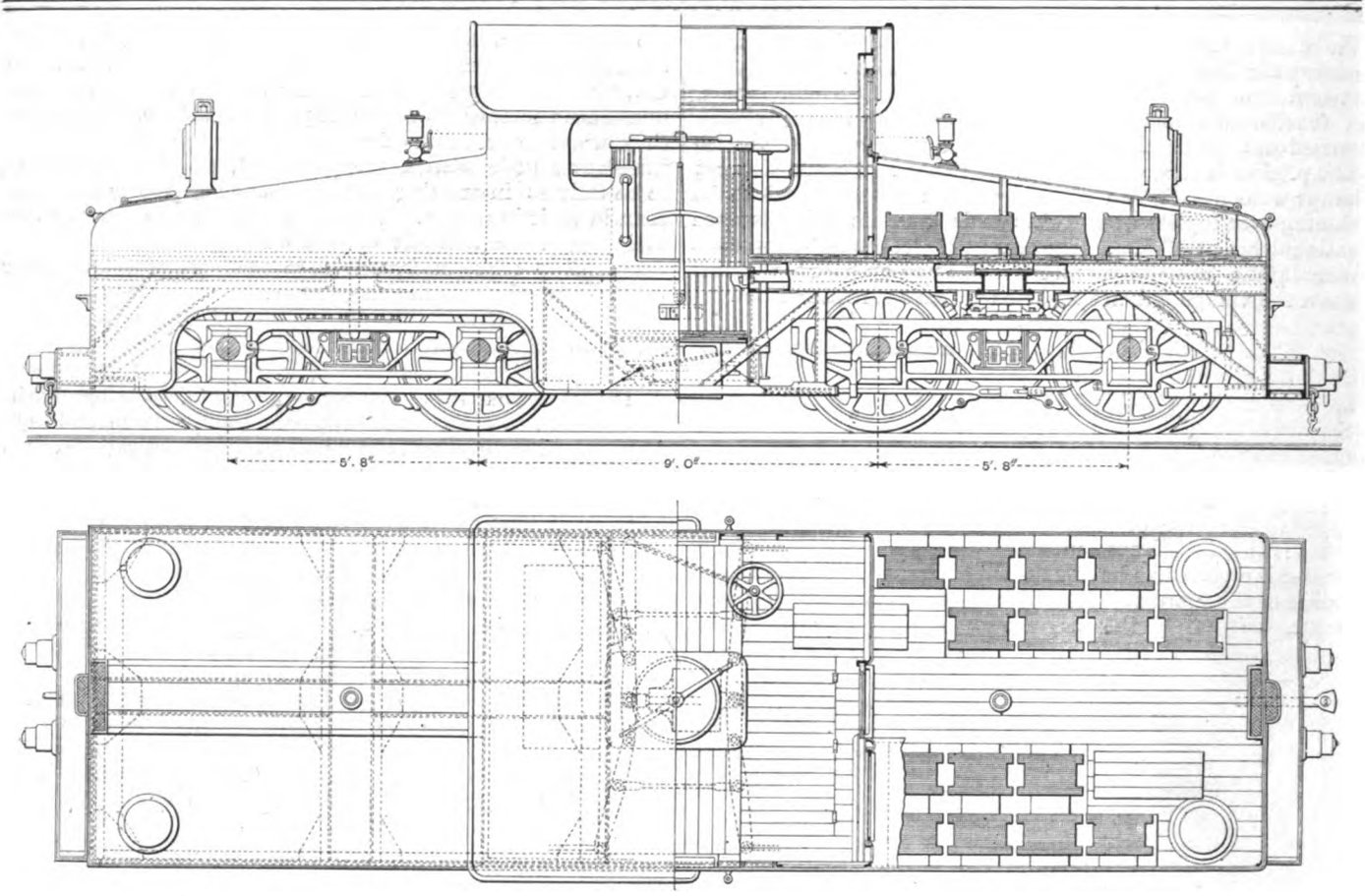
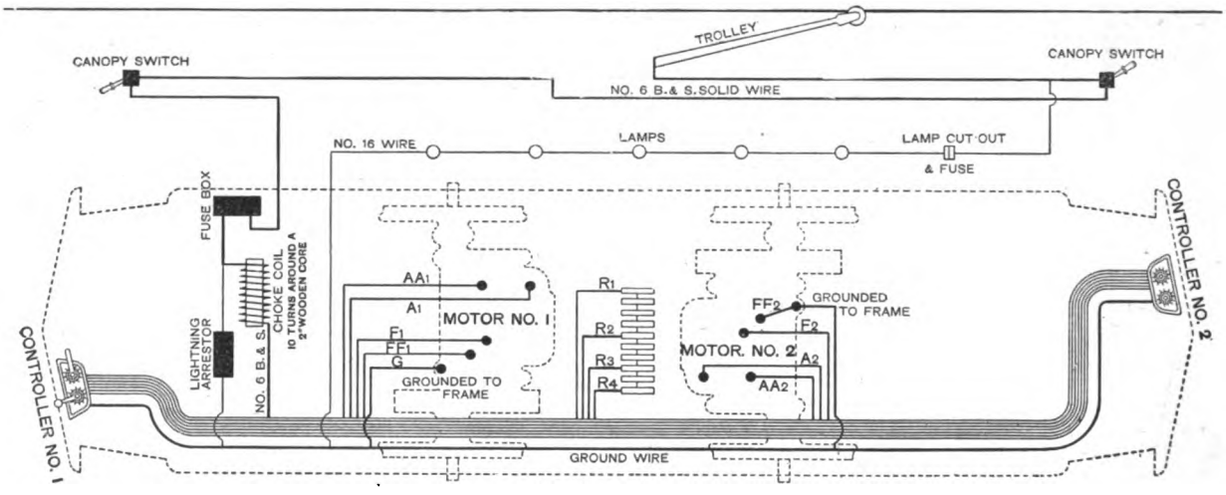


FIG. 2.—FOUR-MOTOR LOCOMOTIVE OF THE CENTRAL LONDON RAILWAY. THE SHADED PORTIONS SHOW THE RESISTANCES.



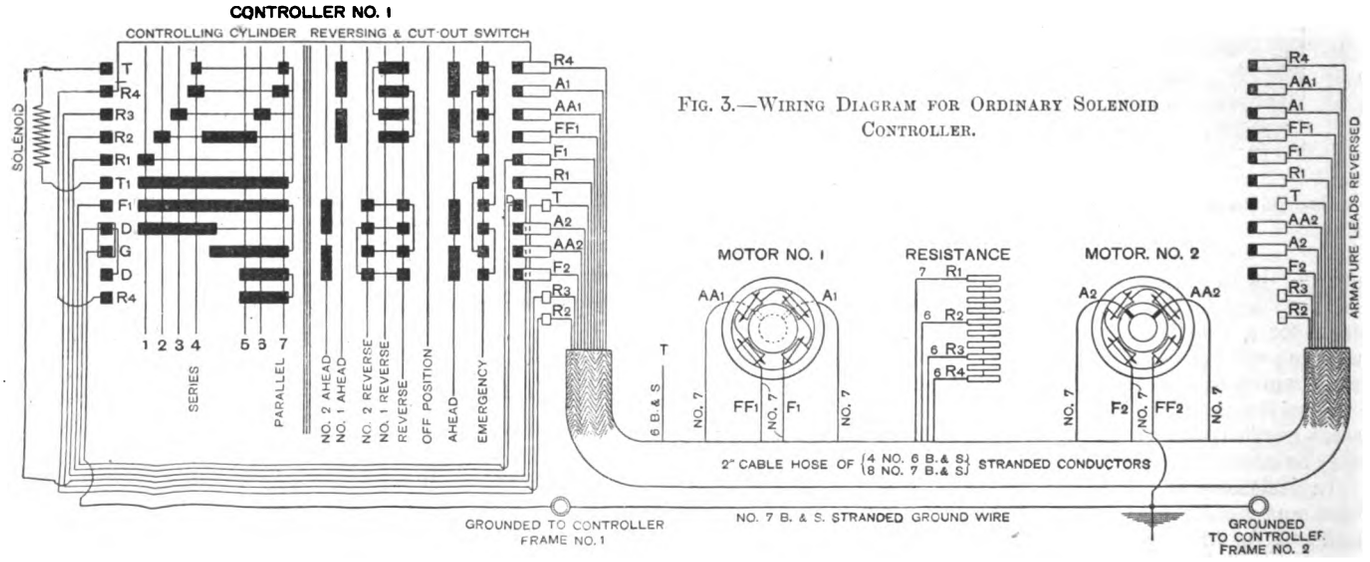


FIG. 3.—WIRING DIAGRAM FOR ORDINARY SOLENOID CONTROLLER.

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the Central London motors are worked series-parallel, they each have about (in bulk) as much resistance as have the Jungfrau motors, which are rheostatically controlled.

With regard to the other mechanism, it should be remembered that all these mountain railways carry a quantity of special gear in the way of brakes and automatic devices for working same. Some of this gear is put on to meet the Government regulations, and other gear is added by the contractors, because, like all contractors, they think they know more about the matter than Government officials can tell them. Anyhow, there is no harm done in having several alternative methods of stopping on gradients of 25 per cent. But if Mr. Trotter is trying to insinuate that because the motors are three-phase more brake mechanism is required, he is entirely off the mark. As a matter of fact, it is a characteristic of such motors that whilst in circuit their speed cannot exceed that of synchronism *plus* the slip of say 4 per cent. They therefore constitute an excellent brake in themselves, and this has told in no small degree in the adoption of three-phase traction.

I might explain that, as the traffic on the Jungfrau line is at present irregular, there is a possibility of a locomotive descending whilst the one going up is standing say at a station. In order, therefore, to prevent the generators being motored round, a resistance is inserted in the stator circuit.

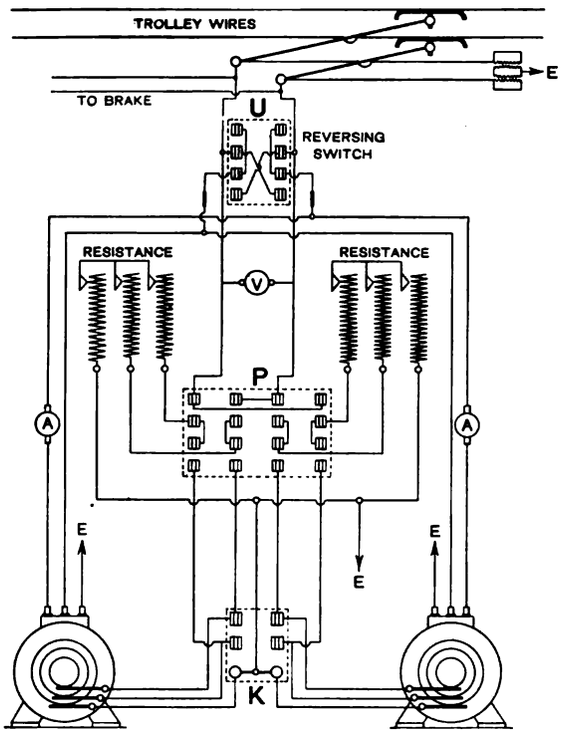

FIG. 4.—CONNECTIONS OF SWITCH-GEAR ON JUNGFRAU LOCOMOTIVE.

(On the Gornergrat line this resistance is in the central station.) When the line is finished, and there is considerable traffic, the inequalities of the load on the generating station will cancel out, and the power given back to the line by the descending will assist in working the ascending locomotives.

Possibly the series of levers to the front of the picture were considered a complication. However, if Fig. 1 is examined, it will be seen that these levers form the simplest arrangement of band brake.

Mr. Trotter's remark that there seemed to be room for simplification to the switchgear is, I think, best answered by showing side by side the two diagrams Figs. 3 and 4. Fig. 3 shows an ordinary car wiring diagram (solenoid controller) for two 30 H.P. continuous-current motors, whilst Fig. 4 shows the connections for the Jungfrau locomotive, which are surely simplicity itself. It stands to reason that a plain rheostatic switch without any magnetic blow-out or series-parallel connections should be much simpler. The writer especially looks upon the absence of any arc-suppressing device as a distinct advantage of the three-phase traction motor. Such arcing as does occur is at a low voltage and very feeble, due possibly to the short air-gap of the motors and the fact that the magnetic circuit is built up wholly of soft steel plates like a transformer.

The rheostatic method of control allows of an extremely regular, and therefore a *rapid*, acceleration, and there being no liability of jerk, as is often the case in changing continuous motors from series to parallel and back again.

Mr. M. B. Field sketched some curves showing the losses on the Central London as compared with the loss on an ideal three-phase railway. I think, however, that something like Fig. 5 would meet the case better; and from this (a bad case, by the way, so far as the railway is concerned) the advantage of having series-parallel control is not so evident, especially when we consider that it necessitates the use of the rotatory converter with its expensive first cost and attendance, constant loss of power and risk of breakdown, or being thrown out of step at a critical moment.

Towards the end of his remarks Mr. Field would appear to suggest that the Swiss firms did not understand the continuous-current series motor and the series-parallel controller; therefore, &c.! I wonder if anyone would dare to say so much at a meeting of the Swiss Institution of Electrical Engineers? My own impression is that America cannot teach the Swiss electrical engineers anything.

Mr. Mordey excuses the equipment of the Central London Railway by saying that the "Burgdorf-Thun line was started a few months ago, but the Central London was schemed years ago"; as much as to say the former line was schemed quite recently, which is, of course, very far from being the case.

Messrs. Westkunz and Thormann (who, some may remember, showed the Institution parties round the Oerlikon works) reported to the Jungfrau Railway Commission in favour of adopting three-phase traction at an earlier date than the

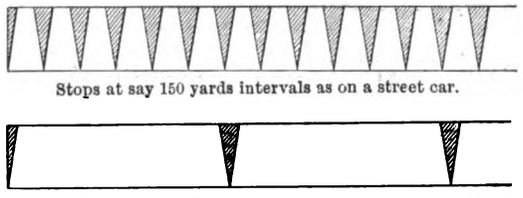
Stops at say 150 yards intervals as on a street car.
Stops at 920 yards intervals, which is the average distance on the Central London Railway.

FIG. 5.

decision to adopt the rotatory converter sub-station system on the Central London line. The Gornergrat line was opened in 1897, and the Stansstad-Engelberg line in 1898, so that the decision to employ three-phase currents in these cases must have been made somewhere about 1896 or earlier.

It seems to the writer, that in working railways by electricity, an essential for keeping a good time schedule is that the sub-stations should be at very frequent intervals and the *maximum speed as constant* as possible. Grant these, and the case for three-phase traction is strong indeed. On the six miles of track of the Central London there are four sub-stations (Notting Hill, Marble Arch, Davies-street, and General Post Office), whilst on the Jungfrau eight-mile track there are 12 sub-stations.

One advantage of having sub-stations at frequent intervals is that the driver of the locomotive on that section can tell the distance he is from any point by noticing the rise or fall in voltage as he approaches or recedes from a feeding point, and he may also know at once if another train enters that same section.

Mr. A. E. Levin thinks that an exceptionally heavy holiday traffic would disorganise a three-phase line; but surely such conditions upset any line to some extent. I take it that when asked to get out his quantities, powers, &c., the engineer to the three-phase line would take full cognisance of such a contingency. In the event of an exceptional overload I should be more afraid of the rotatory converters being thrown out of phase than of a three-phase motor refusing to turn for lack of voltage.

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Mr. Levin recommends increasing the continuous-current voltage from 500 to 750; but whatever advantage resulted from this in the direction of saving copper, &c., would also hold good for multiphase work.

After all, the point is not so much what should have been done on the Central London *Railway* or the Dublin and Middlesbrough tramways, but how future *railway* lines are going to be equipped.—Yours, &c., E. KILBURN SCOTT.

Old Charlton, Feb. 5.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: My attention has been drawn to the report of the "Discussion on the Visit to Switzerland," at the Institution of Electrical Engineers, in your issue of Jan. 19, in which it is stated that I said that the three-phase motors made for the Jungfrau Railway by Messrs. Brown, Boveri and Co. *were uglier* than those made by the Maschinenfabrik Oerlikon. I made no such statement. What I said was that the Brown Boveri motors *ran quicker* than the Oerlikon motors, having six poles as compared with eight in the latter.

In confining myself strictly to the ten minutes allotted to each speaker, I was unable, as I had intended, to express my opinion of the many excellent points possessed by the Brown Boveri locomotives, notably the great simplicity of their controlling arrangements, and the admirable way in which they handled the exceedingly heavy traffic throughout the whole of the summer season of last year.—Yours, &c.,

Westminster, S.W., Feb. 10. CHAS. A. CARUS-WILSON.

CAMBRIDGE ENGINEERING LABORATORY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your very kind and appreciative notice of the opening of the John Hopkinson Memorial Wing of this laboratory there is one point which I would beg leave to correct. The gift which I spoke of as having been announced to me by telegram is not a model, but a complete outfit of polyphase apparatus, suitable for demonstration and testing; and the donors are not the American but the British Westinghouse Co.—Yours, &c., J. A. EWING.

Cambridge, Feb. 12.

AN ELECTROLYTIC CENTRIFUGAL PROCESS FOR THE PRODUCTION OF COPPER TUBES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Some years ago I availed myself of the hospitality of the pages of *The Electrician* to make a reclamation of my discovery of the synchronous rotation (parallel running) of alternating dynamo-electric machines. Confiding in that spirit of impartiality which is characteristic of *The Electrician*, I have now to request that you will publish in your next issue the subjoined reclamation of the electrolytic centrifugal process described in *The Electrician* of the 9th inst. The reclamation is a copy of my contribution to the discussion on Mr. Cowper-Coles' Paper read at the meeting of the Institution of Electrical Engineers, when Mr. Cowper-Coles' Paper was read.—Yours, &c., HENRY WILDE.

Alderley Edge, Feb. 12.

[We give below the text of Mr. Wilde's contribution to the discussion, as furnished by him to us.—ED. *E.*]

"I have read with much interest the Paper of Mr. Cowper-Coles on an electrolytic centrifugal process of producing copper tubes. May I point out that the process described is identical with the one patented by me in 1875, No. 4,515, which has been in successful operation in Manchester and elsewhere for more than 20 years. By the publication of his Paper Mr. Cowper-Coles has, however, rendered an important service to the electro-metallurgical industry in exposing the fallacy of submitting electro-deposited surfaces to the friction of foreign substances during the process of deposition. His Paper also contains much valuable information on the electro-metallurgy of copper which is not available in other publications. Subjoined are extracts from the specification and claims of the patent referred to.

"Whereas attempts have been made from time to time to substitute iron rollers covered with a thin layer of copper by means of electricity, for the solid copper rollers used in calico-printing and in other processes, but owing to the expense of the battery power and the slow rate at which the copper was deposited in the reguline state, such attempts have not hitherto been commercially successful.

"Now my invention consists in giving to the electrolyte or depositing liquid in which the roller to be coated is immersed, or to the positive and negative electrodes themselves, a rapid motion of rotation, in order that fresh particles of the electrolyte may be brought successively in contact with the metallic surfaces. By this means powerful currents of electricity may be brought to bear upon small surfaces of metal without detriment to the quality of the copper deposited, while the rate of the deposit is greatly accelerated (page 4).

"Instead of producing the whirling motion of the electrolyte by the rotation of the roller *b* as above described, it may be produced by the rotation of the positive electrodes *y* mounted on a revolving frame, or by paddles revolving in the annular space between fixed electrodes and a fixed roller (page 5).

"This invention may also be applied to the electrolytic method of refining copper described in the specification of letters patent granted to J. B. Elkington, November, 1865, No. 2,838 (page 4).

"Claims—First, imparting a rapid whirling or rotating motion to a depositing solution in the manner and for the purpose described.

"Lastly, the application of the whirling or rotatory motion of the electrolyte in the refining of copper and the apparatus for effecting the same, as shown and described."

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It may be of interest to your readers to know that the centrifugal copper process, described by Mr. Sherard Cowper-Coles in a Paper which appears in your number of Feb. 9, was thoroughly investigated some years ago in one of the establishments producing copper by the Elmore process, and was abandoned on account of certain defects which their long experience of deposited copper had proved to them to be fatal.

As a laboratory process it may be very good, but it breaks down in practice.—Yours, &c.,

London, Feb. 13. W. STEPNEY RAWSON.

OHM'S LAW—WAS IT DEDUCTIVE OR INDUCTIVE?

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In reference to your reviewer's remarks in *The Electrician* on Friday, Feb. 9—viz., "that Ohm did *not* find out his law by experiment," I should like to refer you to Cajori's History of Physics, p. 227–231, in which he gives an abstract of the experiments by which Ohm established his law in January, 1826. His readings were "represented very satisfactorily by the equation $X=\frac{a}{b+x}$, where x is the intensity of the magnetic effect of the conductor whose length is x, a and b being constants depending on the exciting force and the resistance of the remaining parts of the circuit." By increasing the "exciting force" the value of a changed, but b remained constant. Afterwards he "established experimentally the formulæ giving the strength of the current for the cases when cells are grouped in series and when in parallel." It was in 1827, a year later, that he published his *theoretical* deduction of Ohm's law.—Yours, &c.

London, N., Feb. 18. VICTOR A. MUNDELLA.

ANNEALING ARMOUR PLATES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In the "American Notes," in the Jan. 19 number (p. 442) of your valuable paper, there appears an article on my process for annealing armour plates, at the conclusion of which there is the following paragraph:—

With the present system each transformer must have its own alternator and exciter, and in this connection the question arose in the discussion, why choking coils are not used in the secondary circuit instead, which would require the running of two wires only, and would enable both transformers to be supplied from the same alternator. The reason why this apparently simpler method is not used was not explained.

In reply thereto I will say that in a Paper read by me before the American Institute of Electrical Engineers on Oct. 23, 1895, a copy of which I herewith enclose, you will find on pages 642-643 a description and illustration of a choking coil as actually used, in the summer of 1895, at the works of Chas. Cammell and Co., Sheffield, England. In practice it was found that, since one annealer is fast enough to keep ahead of other work, the method of regulating the field of the alternator is far more simple and economical than the use of a choking coil. It had the further advantage that the wires were always dead except at the time when actual annealing was done. The primary average E.M.F. being 300 volts, with a

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maximum of nearly 500, might give some unpleasant shocks, especially on board of a man-of-war, which is practically one ground. If more than one annealer were to be used at any one time, the best arrangement would be to use a rotary transformer, to be operated from an 80 to 110 volt continuous circuit, which is always to be found on board a man-of-war. The rotary and choking coil could then be mounted on a truck with wheels, and brought into the vicinity of the annealer proper. You will also notice that the choking coil is placed in series with the primary of the annealer, and not with the secondary. A little reflection will show that a secondary of a single turn carrying 10,000 amperes is not suitable for the introduction of a choking coil in series therewith. The process has thus far been adopted by the American, English, and French navies.—Yours, &c.,

Lynn, Mass., U.S.A., Feb. 2. F. C. LEMP, JR.

DEPARTURE OF ELECTRICAL ENGINEER VOLUNTEERS FOR SERVICE IN SOUTH AFRICA.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: You will probably have seen a letter from Mr. McMillan, honorary secretary to the dinner committee who are arranging for a good "send-off" for the Electrical Engineers (R.E.) Volunteers leaving for South Africa. I would like to take this opportunity of saying that already a good response has been made to this appeal; and that many gentlemen from different parts of the country are sending their cheques, though frequently stating that they will not be able to be present at the dinner. Thinking that this may form a precedent with regard to others of your readers, I would intimate, by your courtesy, that we should like a good response from the entertainers of our friends who are going abroad, and shall be glad to receive cheques from those who also will not be able to attend the dinner.—Yours, &c.,

HENRY EDMUNDS, Hon. Treasurer.

Westminster, S.W., Feb. 12.

A YEAR'S EXPERIENCE OF THE "FREE WIRING" SYSTEM.

BY C. S. VESEY BROWN, A.M.INST.C.E.

During the past twelve months the writer has had so large a number of inquiries from local authorities as to the arrangements made by the Lincoln Corporation for free wiring, and also as to the results, good or otherwise, of these arrangements, that the following experience and opinion may serve the double purpose of giving some information to those who require it and release the writer from the almost daily occupation of answering queries.

First, as to the arrangements made with the National Electric Wiring Co. (Ltd.). A contract was entered into between both parties, which provided, amongst other matters, that the company should wire free of initial cost the premises of any householder who desired to use electric light and whose house was in proximity to the area of supply; and for the use of the installation the company charged the Corporation (who charge the consumer) the sum of 1d. per unit for all units used at the average maximum demand and ½d. per unit for all used beyond, the readings of the demand indicators and meters taken quarterly by the Corporation being accepted as correct by the company. The Corporation collect the "free wiring" rental, and remit same once a quarter to the company.

The Corporation provide a form of agreement to be signed by the consumer, the company doing the necessary canvassing. The contract provides that at any time after the expiration of five years the installation may be purchased by the Corporation or the consumer upon agreed terms. It also provides: (1) The company may not sell or transfer its business in Lincoln to any other party without consent of the Corporation; (2) the Corporation may not do wiring work for sale or profit, or contract for "free wiring" in a similar manner to that made by the company, as long as the contract is in force; (3) the contract may be determined by either party at six months' notice.

A consumer who vacates his premises does not require to give notice of his intention, other than the usual notice to the Corporation to disconnect his meter; neither is a succeeding tenant bound to take over the Free Wiring Co.'s installation or agreement.

In the comparatively short time that the contract has been in force in Lincoln the question of change of tenancy has not been tested. The foregoing are the principal clauses of the contract, and form with slight exceptions the basis of all the company's other contracts.

The operations of the company and the system in Lincoln may not appear large to many central station engineers, but it may not be generally known that gas is sold for 2s. 1d. per 1,000 cubic ft. inclusive of meter rents, &c., and that therefore the rental of the free-wiring installation added to the price of supply finds a strong opponent; however, the scheme has so far recommended itself that during the period under review 45 houses were connected out of a total of 185: of these 45, two installations were bought by private treaty before they were long in use, and the figures given are for the 43 in existence on Jan. 1, 1900.

The connections were as follows:—

	Shops, &c.	Residences.	Public-houses.
1st quarter	15	9	0
2nd do.	3	3	2
3rd do.	3	2	0
4th do.	5	1	0
Total	26	15	2

Number of lamps (8 c.p. equivalent) credited to these premises at the end of the year was as follows:—

Shops.	Residences.	Public-houses.	Total.
589	483	52	1,115

The units used during the year were as follows:—

Shops.	Residences.	Public-houses.	Total.
5,733	6,974	1,699	13,416

On investigating the records of the demand indicators, the following results appear:—

	Shops.	Residences.	Public-houses.
The daily use for each class of consumer of his average maximum demand for the whole year	1·53 hours	2·12 hours	2·32 hours

The low average of the public-houses was due to the fact that they only came on in the spring.

The results so far show that the class of consumer who has taken advantage of "free wiring" is on the average a good one for the Corporation.

The principle of "free wiring" has been criticised from all points of view, either by central station engineer, wiring contractor, or consumer, but it is beyond any doubt that, if the wiring is properly done and looked after, and the price of supply is not too high to compete reasonably with gas, there is a very large field in the lighting of houses occupied on short tenancies. It is just this class of property (a very large one in most towns) that the supply authority has hitherto been unable to reach, for it is seldom that a tenant will put what is practically a fixture on to other people's property, and competition amongst landlords is keen enough to prevent them spending money on wiring houses for what is still considered a luxury in some places.

Hitherto it has been the experience of central stations that the wealthier and more important business premises and private residences are wired and supplied as soon as supply is commenced; but along the line of route of these well-to-do houses and shops are others less pretentious, the owners or occupiers of which either cannot or do not care to run the risk of spending the capital required to fit up their premises for electric light, and yet are prepared to pay the annual cost in just the same proportion as their neighbours; and it is here that "free wiring" steps in to help both the supply authority and the would-be consumer. The latter is able to try the experiment; and if it succeeds, he is in the position of knowing that he may buy the wiring at a price certified by the supply authorities' officers; and if success is not obtained, then he need not trouble himself when vacating the premises as to the price of fixtures, &c.—usually a knotty problem to solve.

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From this very brief review of the experience of a first year's working of the system, the writer is convinced that no supply authority, be they Corporation or company, which has not power to do wiring, ought to be without some such aid to help to increase the demand at the central station. It has the effect of stimulating competition amongst wiring contractors to canvass for consumers, and it enables all who wish to use electricity to do so on comparatively easy terms.

It cannot fail to do good to the electric lighting works, even though these latter may be in a flourishing condition and classed amongst those stations which are "paying their way." Another feature, which applies more particularly to local authorities, is the "moral" duty of these authorities to place before every inhabitant of the district over which they have control the means of using electricity if they so desire it, seeing that the said authority have practically a monopoly. Limited companies have many ways of inducing householders to become users of electric light, which local authorities are unable to adopt by reason of their constitution and limited powers, but by a system of "free wiring" there should be no reason why every cottage should not be supplied, and thus fulfil Sir Wm. Preece's dream of the poor man's light.

ELECTRICITY WORKS ACCOUNTS.

The St. James' and Pall Mall Electric Light Co. (Ltd.).

Again we are able to record highly satisfactory results for the working of the St. James' and Pall Mall undertaking.

During last year excellent progress was made in the way of increased output. The units sold amounted to a total of 4,201,104, thus indicating an advance over the 1898 output of nearly 22 per cent. It will be remembered that in our comments last year we noted that the corresponding progress during 1898 was close on 14 per cent. It is gratifying to find an undertaking with an output of over 4,000,000 units per annum being able to show figures such as these.

The new business acquired during the year just passed gives excellent promise for the current year. The lamp connections have been increased by the addition of the equivalent of 26,612 8 c.p. lamps, thus raising the total about 18·6 per cent. In the following table we give the more interesting figures relating to the concern in the past :—

Year.	Lamp connections.	Output, units sold.	Plant capacity, kw.	Total cost per unit sold.	Ordinary dividend %
1890	...	...	...	...	5
1891	38,500	1,057,996	820	...	8½
1892	47,900	1,186,826	1,060	...	7½
1893	60,000	1,211,451	1,300	...	4½
1894	75,500	1,569,884	...	...	6½
1895	91,800	1,846,064	2,100	2·83d.	7½
1896	108,000	2,401,431	2,750	2·29d.	10½
1897	123,000	3,028,242	3,380	2·23d.	14½
1898	142,788	3,448,853	3,580	1·98d.	14½
1899	169,400	4,201,104	3,890	1·92d.	14½

From our table it will be seen that while the total costs figure of 1898 has been practically maintained in 1899, the chief items which constitute the aggregate have sensibly altered. Of the generating costs those of fuel and "repairs and maintenance at the station" have slightly increased, but they are still remarkably low in comparison with the averages of company stations at the output. "Oil, waste, water, stores" have remained steady at 0·066d. per unit, while wages at the station have dropped from the very fair average figure of 0·378d. in 1898 to 0·35d. Another item which has risen, and perhaps more conspicuously than any other, is that of "repairs and renewals of mains." The charge on this score comes out at more than double what it was in the preceding year.

As a set-off to the slight increase in the works costs, and by which it is practically neutralised, it is satisfactory to mark the fall of a shade more than 0·1d. in the management and property charges. At the present figure—viz., 0·61d. per unit—this item is certainly below the average in company stations, although included of course in it is a sum of £2,500 directors' remuneration. Owing to the largely increased output, and in spite of a drop of over 0·4d. per unit in the average total revenue derived, the working profit exceeded that of the preceding year by £1,724—amounting in total to £43,628. Out of this £12,281 was paid into the depreciation fund, thus leaving, with £487 received as interest and £89 from 1898, £31,923 available for distribution, and admitting of the payment of an ordinary dividend of 14½ per cent., besides one on the 7 per cent. preference shares.

Londonderry Municipal Electric Supply Works.

Interesting as being the results of the working of a station exclusively devoted to public arc lighting, we present to our readers some details of the costs obtaining at the Londonderry station.

Unfortunately, complete and accurate data are not available; nevertheless, the figures given are very probably sufficiently near to be of interest and value. There being no meters in use, the actual output is unknown, but the units generated are estimated by the engineer on the basis that the consumption of each lamp was 0·5 B.O.T. unit per hour. This estimate appears as applicable as the output supplied to the lamps as it is to units generated. Anyhow, we have, in the absence of closer data, used in our analysis the estimated units generated in the place of the number of units sold. We may direct attention to the interesting figures showing the number of units sold per 8 c.p. lamp capacity. These are the highest we have yet come across in our analyses, but the corresponding Glasgow figures are very little lower—viz, 32·3 and 42 respectively in the two years.

It may be observed that in the case of Glasgow the cause of the high ratio of the output to the plant capacity is due to the use of batteries, the load factor being at the unusually low value of about 5 per cent. At Londonderry, however, it is the high load factor which enables the plant load factor to rank so high, the load factor being something like 29·4 per cent. in 1897 and 32 2 in 1898 (estimated).

To this quality of the load is no doubt largely attributable the low aggregate costs of only about 1 81d. per unit, in spite of the moderate output upon which this result is obtained. Of course, the use of a high-pressure system, without wasteful transforming devices and low-pressure distributing circuits, must also have had a great influence on these costs.

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared :—

Aberdeen (Municipal)	Jan. 12, 1900	Kingston-on-Thames (Mun.)	April 21, 1899
Ayr (Municipal)	Sept. 22, 1899	Lancaster (Municipal)	Jan. 19, 1900
Bath (Municipal)	Feb. 9, 1900	Leeds (Municipal)	Dec. 1, 1899
Bedford (Municipal)	May 19, 1899	Leicester (Municipal)	Jan. 26, 1900
Belfast (Municipal)	Sept. 15, ,,	Leyton (Municipal)	Sept. 8, 1899
Birmingham (Company)	Sept. 15, ,,	Liverpool (Municipal)	June 9, ,,
Blackburn (Municipal)	Jan. 19, 1900	Manchester (Municipal)	Aug. 11, ,,
Blackpool (Municipal)	Sept. 29, 1899	Newcastle and District (Co.)	Oct. 6, ,,
Bournemouth (Company)	April 28, ,,	Newcastle-upon-Tyne (Co.)	April 14, ,,
Bolton (Municipal)	Nov. 24, ,,	Newport (Mon.) (Municipal)	Dec. 15, ,,
Bradford (Municipal)	April 14, ,,	Northampton (Company)	Oct. 20, ,,
Brighton (Municipal)	May 12, ,,	Norwich (Company)	Nov. 17, ,,
Bristol (Municipal)	July 14, ,,	Notting Hill (Company)	Mar. 17, ,,
Burnley (Municipal)	Aug. 25, ,,	Nottingham (Municipal)	July 21, ,,
Burton-upon-Trent (Mun.)	April 21, ,,	Oldham (Municipal)	Dec. 1, ,,
Bury (Municipal)	Sept. 22, ,,	Oxford (Company)	May 19, ,,
Cambridge (Company)	Mar. 10, ,,	Pontypool (Company)	May 5, ,,
Cardiff (Municipal)	Dec. 15, ,,	Portsmouth (Municipal)	July 14, ,,
Charing Cross (Company)	Mar. 17, ,,	Prescot (Company)	Dec. 8, ,,
Chelsea (Company)	Mar. 31, ,,	Preston (Company)	Sept. 29, ,,
Cheltenham (Municipal)	Nov. 10, ,,	Reading (Company)	Oct. 13, ,,
Chester (Municipal)	June 23, ,,	Richmond (Company)	Oct. 13, ,,
City of London (Company)	May 12, ,,	Scarborough (Company)	Nov. 3, ,,
Clerkenwell (Company)	Aug. 18, ,,	St. Helens (Municipal)	Dec. 8, ,,
Croydon (Municipal)	Feb. 9, 1900	St. James' & Pall Mall (Co.)	Feb. 24, ,,
Derby (Municipal)	Jan. 26, ,,	St. Pancras (Vestry)	May 26, ,,
Dewsbury (Municipal)	Nov. 24, 1899	Sheffield (Municipal)	Dec. 29, ,,
Dover (Company)	June 2, ,,	Shoreditch (Vestry)	Oct. 27, ,,
Dundee (Municipal)	Jan. 12, 1900	Southampton (Municipal)	Nov. 10, ,,
Eastbourne (Company)	Feb. 2, ,,	Southport (Municipal)	July 7, ,,
Edinburgh (Municipal)	Nov. 17, 1899	South Shields (Municipal)	July 7, ,,
Exeter (Municipal)	Aug. 5, 1898	Stafford (Municipal)	Dec. 29, ,,
Glasgow (Municipal)	Sept. 1, 1899	Sunderland (Municipal)	July 28, ,,
Guildford (Company)	May 5, ,,	Taunton (Municipal)	June 16, ,,
Halifax (Municipal)	July 21, ,,	Tunbridge Wells (Mun.)	Sept. 1, ,,
Hammersmith (Vestry)	May 26, ,,	Wakefield (Municipal)	Dec. 1, ,,
Hampstead (Vestry)	Aug. 25, ,,	Walsall (Municipal)	June 23, ,,
Hanley (Municipal)	April 28, ,,	Wandsworth (Company)	Aug. 18, ,,
Harrogate (Municipal)	Oct. 20, ,,	Westminster (Company)	Feb. 24, ,,
Harrow (Company)	June 16, ,,	Whitehaven (Municipal)	July 28, ,,
Hast'gs & St. Leonards (Co.)	Feb. 2, 1900	Windsor (Company)	Dec. 22, ,,
H'use-to-H'use Co. (K'ns'gt'n)	Mar. 31, 1899	Woking (Company)	Dec. 22, ,,
Hove (Company)	Mar. 10, ,,	Wolverhampton (Municipal)	June 30, ,,
Huddersfield (Municipal)	Oct. 6, ,,	Woolwich (Company)	Jan. 13, ,,
Islington (Vestry)	Oct. 27, ,,	Worcester (Municipal)	April 7, ,,
Kens'gton & Knightsbr' (Co.)	Mar. 3, ,,	Yarmouth (Municipal)	Nov. 3, ,,
Kingston-upon-Hull (Mun.)	June 9, ,,		

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	ST. JAMES', LONDON.		LONDONDERRY.	
Undertaking Worked by	The St. James' and Pall Mall Electric Light [Co. (Limited.)		Londonderry Corporation.	
Date of Commencement of Supply	April, 1889.		May, 1894.	
System of Supply	Three-wire continuous-current.		Street lighting only; series continuous current.	
Chief Engineer	Sydney T. Dobson.		R. V. Macrory.	
YEAR ENDED	DEC. 31, **1898.**	DEC. 31, **1899.**	OCT. 31, **1897.**	OCT. 31, **1898.**
QUANTITIES—				
Units generated	3,847,204	4,686,192	224,007[a]	245,421[a]
,, **SOLD (TOTAL)**	3,448,853	4,201,104	—*	—*
,, sold to consumers	3,314,492	4,063,274	—	—
,, sold for public lighting, &c.	134,366	137,830	—	—
,, used on works	58,166	68,798	1,500[b]	1,500[b]
UNITS SOLD PER 8 C.P. LAMP CAPACITY	28·7	35·0	39·8*	43·6*
Maximum supply demanded	2,825 kilowat's	—	—	—
Number of public lamps	60 arc	60 arc	174 arc	174 arc
Number of consumers	1,394	1,500	—	—
Connections to mains in 8-c.p. lamps	142,783	169,400	2,720[c]	2,720[c]
CAPACITY OF PLANT IN 8-C.P. LAMPS	120,000	120,000	5 630	5,630
CAPACITY OF PLANT IN KILOWATTS	3,880	3,880	180	180
CAPITAL—	**Total.** / **Per kilowatt capacity.**	**Total.** / **Per kilowatt capacity.**	**Total.** / **Per kilowatt capacity.**	**Total.** / **Per kilowatt capacity.**
AUTHORISED (TOTAL)	£450,000 / £116	£450,000 / £116	£18,942 / £105	£18,942 / £105
Share	300,000 / 77·3	300,000 / 77·3	— / —	— / —
Loan (including Debenture charges)	150,000 / 38·7	150,000 / 38·7	18,942 / 105	18,942 / 105
RECEIVED (TOTAL)	310,000 / 79·9	283,935 / 73·2	18,942 / 105	18,942 / 105
Share	260,000 / 67·0	283,935 / 73·2	— / —	— / —
Loan (including Debenture charges)	50,000 / 12·9	nil / —	18,942 / 105	18,942 / 105
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	140,000 / 36·1	16,065 / 4·14	nil / —	nil / —
Share (unissued)	40,000 / 10·3	nil / —	— / —	— / —
Share (uncalled)	nil / —	16,065 / 4·14	— / —	— / —
Loan (including Debentures)	100,000 / 25·8	— / —	nil / —	nil / —
REPAID (TOTAL)	— / —	— / —	2,328 / 12·9	2,752 / 15·3
RESERVE OR SINKING FUND	15,000[a] / 3·87	49,523[i] / 12·7	— / —	— / —
DEPRECIATION FUND	— / —	— / —	— / —	— / —
EXPENDED (TOTAL)	263,046 / 67·8	317,283 / 81·8	19,786 / 110	19,786 / 110
Lands and buildings	101,774 / 26·2	154,189 / 39·7	— / —	— / —
Plant	86,427 / 22·3	85,048 / 21·9	— / —	— / —
Mains	69,557 / 17·9	73,153 / 18·8	— / —	— / —
Miscellaneous	5,289 / 1·36	4,893 / 1·26	— / —	— / —
BALANCE OF CAPITAL ACCOUNT	46,954 / 12·1	−33,348[j] / −8·60	−844[d] / −4·69	−844[d] / −4·69
REVENUE—	**Total.** / **Per unit sold**	**Total.** / **Per unit sold**	**Total.** / **Per unit sold.**	**Total.** / **Per unit sold.**
TOTAL	£70,285 / 4·890d.	£78,284 / 4·470d.	— / —	— / —
Revenue from supply	66,170 / 4·600d.	73,898 / 4·220d.	— / —	— / —
,, meters, &c.	1,761 / 0·123d.	2,016 / 0·115d.	— / —	— / —
,, public lighting	1,832 / 0·128d.	1,828 / 0·104d.	— / —	— / —
,, sale of lamps, &c.	— / —	128[k] / 0·007d.	— / —	— / —
,, miscellaneous sources	522[b] / 0·036d.	413[l] / 0·024d.	— / —	— / —
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	£28,381 / 1·976d.	£34,656 / 1·980d.	£1,935 / 2·104d.*	£1,847 / 1·806d.*
WORKS COSTS	17,757 / 1·236d.	23,482 / 1·342d.	1,681[e] / 1·804d.	1,565[e] / 1·530d.
Generation of electricity	*16,186[e] / 1·127d.*	*20,137[m] / 1·151d.*	*1,684[e] / 1·804d.*	*1,565[e] / 1·530d.*
Fuel (including cartage, &c.)	7,307 / 0·509d.	9,545 / 0·545d.	499 / 0·535d.	401 / 0·392d.
Oil, waste, water, stores	949 / 0·066d.	1,152 / 0·065d.	94 / 0·101d.	111 / 0·109d.
Wages at station	5,429[d] / 0·378d.	6,129[d] / 0·350d.	666 / 0·714d.	739 / 0·722d.
Repairs and maintenance at station	2,360 / 0·164d.	3,169 / 0·181d.	425 / 0·455d.	314 / 0·307d.
Distribution of electricity	— / —	— / —	— / —	— / —
Wages, &c.	—[d] / —	—[d] / —	— / —	— / —
Repairs, renewals of mains, &c.	1,149 / 0·080d.	2,951 / 0·1686d.	— / —	— / —
Public lighting	*422 / 0·029d.*	*394 / 0·023d.*	— / —	— / —
Attendance	422 / 0·029d.	394 / 0·023d.	— / —	— / —
Renewals			— / —	— / —
MANAGEMENT AND PROPERTY CHARGES	10,624 / 0·740d.	11,174 / 0·638d.	281 / 0·301d.	282 / 0·276d.
Royalties	— / —	— / —	— / —	— / —
Rent, rates, taxes	*2,809 / 0·196d.*	*3,028 / 0·173d.*	*75 / 0·080d.*	*72 / 0·070d.*
Management	*7,815 / 0·544d.*	*8,146 / 0·465d.*	*206 / 0·221d.*	*210 / 0·205d.*
Salaries	6,012 / 0·418d.	6,580 / 0·376d.	183 / 0·196d.	187 / 0·183d.
Stationery, &c.	208 / 0·015d.	218 / 0·012d.	— / —	— / —
Establishment charges	396 / 0·023d.	363 / 0·021d.	— / —	— / —
Law charges, &c.	1,199[e] / 0·084d.	985[n] / 0·056d.	23[f] / 0·025d.	23[f] / 0·023d.
FINANCIAL RESULTS—	**Total.** / **% to mean cap. exp'nded**	**Total.** / **% to mean cap. exp'nded**	**Total** / **% to mean cap. exp'nded**	**Total.** / **% to mean cap. exp'nded**
WORKING PROFIT FOR YEAR	£41,904 / 16·2%	£43,628 / 15·03%	— / —	— / —
Sum carried to Depreciation Fund	10,124 / 3·91%	12,281 / 4·23%	— / —	— / —
Sum carried to Reserve or Sinking Fund	— / —	— / —	— / —	— / —
Net interest on loans (incl. Debenture charges)	1,497 / 0·579%	487[o] / 0·168%	— / —	— / —
BALANCE FROM LAST ACCOUNT	384 / 0·148%	89 / 0·031%	— / —	— / —
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	30,274[f] / 11·7%	31,923 / 11·0%	— / —	— / —
Deficit	— / —	— / —	— / —	— / —
ORDINARY DIVIDEND PAID	14½%[g] / —	14½%[g] / —	— / —	— / —
PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE	40·4%	44·3%	—	—
Expenditure per kilowatt capacity	£7. 6s. 5d.	£8. 18s. 10d.	£17. 18s. 2d.	£19. 5s. 2d.
REVENUE PER KILOWATT CAPACITY	**£18. 2s. 0d.**	**£20. 3s. 5d.**	—	—
Expenditure per 8-c. lamp capacity	4s. 8¾d.	5s. 9¼d.	6s. 11¾d.	6s. 6¾d.
REVENUE PER 8-C.P. LAMP CAPACITY	**11s. 8½d.**	**13s. 0½d.**	—	—
REVENUE PER 8-C.P. LAMP CONNECTED	**9s. 10d.**	**9s. 2¾d.**	—	—
Price charged for lighting, per unit	6d. to 4d.[h]	6d. to 4d.[h]	—	—
Price charged for power, per unit	3d.	3d.	—	—
Price charged for public lighting	£30 per arc per ann.	£30 per arc per ann.	—	—

ST. JAMES', LONDON.—REMARKS—*a* Capital reserve fund by premium on preference shares. *b* Includes £169 from sale of steam, and £140 from rents. *c* Includes miscellaneous expenses £141. *d* Wages at distributing stations included in item "wages at station." *e* Includes £238 law expenses, £624 insurance, and £119 auditing. *f* After deducting £393 loss on sales of old plant. *g* Besides a dividend of 7 per cent. on preference shares. *h* By discounts. *i* Capital reserve fund; by founders' shares cancelled and premiums on other shares. *j* Over-expended. *k* From sale of steam. *l* Including rents £248, discounts on purchases £101, and transfer fees £49. *m* Includes "miscellaneous expenses" £142. *n* Includes auditing £144, law expenses £162, insurance £671. *o* This sum is the amount *received* on investments and advances *less* interest on banker's loans.

LONDONDERRY.—REMARKS—* In the analysis the units given as generated are assumed as the output sold. *a* These figures are stated by the engineer to have been arrived at by assuming that each arc lamp consumes half a B.O.T. unit per hour, no meters being used. *b* Approximately. *c* Assuming each arc lamp as being of a capacity of 600 watts. *d* Over-expended. *e* The items of generating costs apparently include distribution costs and charges for arc lamp attendance and renewals. *f* Insurance.

The Electrician.

The Oldest Electrical Journal (established as a weekly Journal 1861—1878

Published every Friday, Price Sixpence; Post Free, Sixpence-Halfpenny.
Editorial, Publishing and Printing Offices,

1, 2 & 3, SALISBURY COURT, FLEET ST., LONDON,

Telephone: 949 Holborn. *Telegrams:* "ELECTRICIAN NEWSPAPER LONDON."

All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher "THE ELECTRICIAN," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN" *Printing and Publishing Company, Limited, and be crossed* "*Coutts and Co.*"

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"THE ELECTRICIAN" *is published every Friday morning, in time for the morning mails. It is on sale at the railway bookstalls throughout the Kingdom on Friday morning, and can be obtained of all Booksellers and Newsvendors; or direct from the Publishing Offices, as above*

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THE ZIPERNOWSKY-DÉRI PATENT.

Messrs. ZIPERNOWSKY and DÉRI have taken out many patents, but the one which has had most attention drawn to it in this country is No. 3,379 of 1885, for it has been the basis of an action which, if successful, would have rendered all the companies and local authorities employing an alternating system of electrical distribution liable to pay heavy royalties to its owner. This patent for "Improvements in Distributing Electricity" described various methods of transformer distribution, one of which is, broadly, the parallel system employed to day in connection with all alternating-current electricity supply undertakings. Although the patent was filed in 1885, very shortly after which date several central stations were working on this system in England, no proceedings appear to have been taken against the alleged infringers until 1898, the year before the expiry of the patent. Then the owners of these undertakings were surprised one day to receive from Mr. MARTIN D. RÜCKER—a well-known specialist in bicycle finance, who had acquired the patent—applications for royalties. With a view to this claim, the patent in question had been most skilfully amended in April, 1897, all the redundant matter and descriptions of useless systems and devices being cut away so as to leave a clear and concise description of the present method of parallel distribution by means of transformers illustrated by a single diagram, and concluding with the single claim:—

> In the application of induction coils or transformers for alternating electric currents, the arrangement of several stations of second order as branch circuits of the main line, *i.e.*, connecting up the local centres with the main line in multiple arc, to which main line is supplied an alternating electric current of a tension as constant as possible, substantially as described and shown in the drawing.

Strange to say, only a very small group of the parties interested opposed this amendment, and this group withdrew its opposition on the award of a free licence under the patent. On royalties being claimed and proceedings threatened, however, all the other companies and local authorities interested joined hands, and a defence fund and committee was formed to support the London Electric Supply Corporation, against whom the action was brought. The case was heard by Lord Justice FARWELL from Jan. 22nd to Feb. 1st, and was

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reported in our issues of Jan. 26th and Feb. 2nd; and, on Monday last, judgment was delivered in favour of the defendants, the case being dismissed, with costs on the higher scale. The full text of the judgment will be found in another column of this issue.

Although the patent has already expired, so that the award in any case would have had no direct effect on the development of the electrical industry in this country, the result is of considerable importance, for, had it been in favour of the plaintiff, no doubt considerable sums would have had to be paid as retrospective royalties. Perhaps the chief interest, however, lies in the case itself rather than in its issue, for it affords an excellent lesson in electrical patent law given by the most eminent counsel and expert witnesses. There was no serious attempt to deny that the defendant's system was the system described in the patent, the real question to be decided being whether the patent was or was not valid—that is to say, whether the "invention" was novel or not at the date of the patent, for no argument was devoted to the question of disconformity between the provisional and complete specifications. In support of their contention that the invention was not novel, the defendants not only brought forward the testimony of witnesses not likely to err in such matters—viz., Lord Kelvin, Mr. Ferranti, and M. Fesquet (who was in charge of the famous Gaulard and Gibbs exhibit at the Royal Aquarium in 1883), and had other witnesses in reserve, but also produced documents to prove that the matter was "common knowledge" before Zipernowsky and Déri filed their patent in this country. An article, published in a number of the Austrian *Zeitschrift für Elektrotechnik*, which had been placed in the reading room of the Patent Office library two days before the filing of the patent, contained a description of the system, and was, in the judge's opinion, sufficient in itself to invalidate the patent. An interesting article in *The Times* of March 22, 1879, certainly described a system of distribution by means of transformers in parallel; but although this is evident with the light of present knowledge, it is doubtful whether the description was sufficiently explicit to convey all that was required at that early date. Two American patents, however (extracts from which and of *The Times* article appeared on p. 522 of our issue a fortnight ago) clearly indicate the same system as that of the Zipernowsky-Déri patent, and the only fault the plaintiff's experts could find in these was, it appears, that the self-evident proposition that the secondaries of the transformers should have low resistance was not mentioned. In his clearly-worded judgment Mr. Justice Farwell explains that parallel distribution at constant pressure, whether by continuous or alternating current, was known prior to 1885 (in fact, it is alluded to in the Electric Lighting Act of 1882), that the use of transformers and the "ratio of turns rule" was known, and that consequently there was nothing new in the invention described in the Zipernowsky-Déri patent. It may be objected that the precise system described was not in use in all its details prior to the date of the patent, but the answer to this is evidently that, although electrical engineers possessed a knowledge of its essential features, there was then no great demand for such a system. The distribution of electric light was at that time confined to small areas, only small units of generating plant had been constructed, and, although the advantages of high voltages were recognised, the latter were not considered indispensable or worth the risk involved until Ferranti started work at the Grosvenor Gallery station, and followed up his partial success there with the great scheme of transmitting electrical energy from Deptford to London at 10,000 volts. Before this, of course, the famous experiments were made with Gaulard and Gibbs transformers in series on the Metropolitan Railway, but these were at the most only experiments, although they led the way to the great development of transformer distribution.

In an industry which is dependent on scientific and engineering progress and invention there must of necessity be great master patents from time to time, such as those of the telephone and microphone, the incandescent lamp, and the three-wire patent; but equally great, if not greater, inventions are made by the steady evolution of ideas and the gradual extension of the application of scientific principles to practical purposes. Master patents are no blessing to an industry, but yet it is only fair that great inventors should at times obtain their due. Were Messrs. Zipernowsky and Déri themselves the plaintiffs in this action, one would feel some sympathy with them in the result, for these two energetic engineers were among the pioneers of alternating current electrical distribution. But with Mr. Rücker it is otherwise. He probably bought the patent in question at a low price as a speculation, after many had been offered it and had refused. He must have purchased it with a knowledge of its problematic value, just as he would have picked up cheaply some "written down" speculative shares liable to a "call." The investment has proved worthless, and he himself has to pay the call in the form of "costs on the higher scale."

PROF. OLIVER LODGE'S PRESIDENTIAL ADDRESS TO THE PHYSICAL SOCIETY.*

In taking the chair of this Society for a second year at the end of the nineteenth century, I propose to deal with the great physical discovery which heralded its birth—the discovery of the electric current by the illustrious Volta—a discovery introduced to this country by a letter to the President of the Royal Society on March 20, 1800, just a hundred years ago; a discovery commemorated by an important and interesting congress and celebration at Como—the birthplace of Volta—last autumn, a celebration which I deeply regret to say I was unable at the last moment to attend. It was assuredly no lack of admiration or enthusiasm for the great physicist and his epoch-making discovery that led to my absence, and I am glad to take this opportunity of testifying to Prof. Righi, Prof. Blaserna, and our other friends and co-workers in Italy our congratulation on the evident success and interest of the commemoration.

Strange that a discovery of this magnitude, and I may say also, in one sense, of this simplicity, should have been associated with a controversy which, arising in one form almost directly it was announced, has continued, with slight modifications and with temporary lulls, yet really without cessation, throughout the whole century. I hardly know of another instance of a question to which every physicist in the world must necessarily at some time or another have given his attention remaining so long unsettled: what is the seat of the chief E.M.F. in the voltaic pile? Or, if a reference to the actual current-producing battery is now archaic, what is the seat of the E.M.F. displayed in the corresponding electrostatic phenomenon also discovered and exhibited for the first time by Volta? To me the two questions are one and the same, but inasmuch as this may not be so for everyone, and as the second form of question suggests the controversy most active at the present time, I shall address myself chiefly if not entirely to that, and only to other phenomena of an electric circuit or physics or chemistry so far as they are connected with and throw light upon that.

Before entering upon the specific subject, however, there are some events of the past year on which I should like to make a few remarks. And first a respectful reference to our losses. We have lost two distinguished foreign members in the past year—Gustav Wiedemann, a man of extraordinary industry and encyclopædic learning, well known to many present; and the veteran Professor Bunsen, a teacher who was regarded with affection and veneration by his students, some of whom I see here present. They will recognise that it is not for me, who only once or twice when on a visit

* [Text of the opening remarks. The concluding portion is abstracted in our report of the meeting on another page.—Ed. *E.*]

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to Heidelberg heard Bunsen lecture, to attempt to do justice to the scientific eminence and the lovable human character of the man. Of Sir Edward Frankland I was myself, now many years ago, a pupil; but that, again, was at a period long subsequent to those discoveries in organic synthesis which established his fame. Nevertheless, his keen interest in and graphic representation of the constitution of organic molecules made a considerable impression on me, as upon all who learned chemistry about that time. Many of the things which he taught have since become commonplaces, only in turn to give way partially in time to still better and still more expressive modes of regarding the subject, a form of utilisation and replacement to which all our theories and ideas will in good time have to submit, thereby best serving their purpose.

And now quite recently we have lost D. E. Hughes, a man of inventive genius and handicraft skill; a man of the old type, who dabbled among phenomena and thought with his fingers—with his brain, too, of course, but best when aided by his hands—and thereby made many striking inventions and directed attention to several almost unexplored regions of physical science. His type printing machine was, I believe, the first of a long line of automatic electric typewriters, the last simplification of which we see in clubs and stock exchanges; and it involved mechanical combinations of remarkable ingenuity. His investigation into the self-induction and resistance of wires to rapidly alternating currents, being undominated by too familiar an acquaintance with text-book science, led to observations of great interest and to the opening of a neglected chapter in electrical science, of which only the title-page had been written by Clerk Maxwell. His induction balance and his microphone are too well known to need more than mention, but in connection with the microphone research it is clear to me that he was led, as Varley also was led at an early date, to an observation of the phenomenon of electrical cohesion; and Hughes also observed appearances, as Joseph Henry and Edison at very different dates also did, which anticipated to some extent some of the subordinate features of the facts permanently incorporated into the body of science by the masterly work of Hertz.

I will not stay to do more than just mention other names of fellows deceased: John Donaldson and S. O. Roberts and J. L. Howard; but as I personally knew the last named, knew him and highly valued him, since he acted as my demonstrator for twelve years, having been one of my students before that, I may be permitted to remind the Society that he was one of those who serve it so well on the staff of abstractors, and to deplore the loss of one so exceptionally learned, systematic, and industrious, at the age of 33.

Turning from the obituary, I see present a newcomer to London, one whom I hope we shall constantly see at our meetings, and whom we welcome to his quite recent appointment: I mean the director of the National Physical Laboratory, R. T. Glazebrook. He will have great opportunities of substantially benefiting science by his work, since nearly every problem which will be brought to his notice by the requirements of practical men will be replete with some form of scientific interest and importance.

I am glad to hear that Prof. R. W. Wood, of Wisconsin, is on his way to Europe—in fact, is now in London—and I trust that the secretaries will be able to persuade him to give to this Society the benefit of a discourse and demonstration of some of the remarkable optical researches of which we have read from time to time recently in the pages of the *Philosophic Magazine*.

Of the work which has gone on in this country, none has struck me as more remarkable or likely to prove of more abiding interest than the brilliant series of researches conducted in that laboratory which we owe to the wise liberality of the late Duke of Devonshire, and to the initiation of the first professor of experimental physics at Cambridge, Clerk Maxwell. It is appropriate that Cambridge, which has in many ways been the mother of physics in this country, should still take the lead, as I think it is doing, in both mathematical and experimental physical research. It attracts good workers from all parts of the British Empire, notably from the Colonies, and they are admirably guided by its present professor, J. J. Thomson. The way in which the researches now going on are beginning to confirm in many respects the suggestive speculations of Dr. Johnstone Stoney and the profound mathematical work of Dr. J. Larmor, president elect of Section A this year at Bradford, is intensely interesting.

Clerk Maxwell indicated in his book that in his opinion the most likely avenue to fruitful discovery lay in the direction of the discharge of electricity through gases; and this avenue is being most admirably explored by his present successor. The ultimate atom, so called, is beginning to give way under the scrutiny and to break up into several hundred or thousand similar fragments; the atomic doctrine of electricity, once guessed at by Helmholtz, is beginning to put on some sort of reality and shape; and the whole of our ideas of matter and electricity seem likely to be revolutionised and in the end rendered much more definite and precise. If all this, or anything like it, turns out true as investigation proceeds, not only will the facts have a profound bearing on the whole of physics and chemistry, but they will lead to a unification of knowledge of the highest philosophical interest.

PHYSICAL SOCIETY.

At the annual general meeting, held Feb. 9, Prof. Lodge, F.R.S., President, in the chair, the following officers were elected to form the council:—

President: Prof. Lodge. Vice-Presidents (who have filled the office of President): Dr. Gladstone, Prof. Carey Foster, Prof. Adams, Lord Kelvin, Prof. Clifton, Prof. Reinold, Prof. Ayrton, Prof. Fitzgerald, Prof. Rucker, Sir W. Abney, Mr. Shelford Bidwell. Vice-Presidents: Mr. Blakesley, Mr. Boys, Prof. Everett, Mr. Griffith. Secretaries: Messrs. H. M. Elder and W. Watson. Foreign secretary: Prof. S. P. Thompson. Librarian: Mr. W. Watson. Treasurer: Prof. Callendar. Other members of council: Prof. Armstrong, Dr. Atkinson, Mr. W. Baily, Prof. Glazebrook, Mr. E. H. Griffiths, Mr. S. Lupton, Prof. Perry, Mr. Swinburne, Prof. Threlfall, and Mr. J. Walker.

Mr. ADDENBROOKE asked if the *Proceedings* of the Society could be published with less delay. The Chairman promised to try and have them printed sooner.

Prof. LODGE then delivered his presidential address on

"The Controversy concerning Volta's Contact Force."

Those who take a metallic view of the Volta contact force are accustomed to deny that the Peltier evolution of heat measures the local E.M.F. existing at a junction; they assert that it measures the rate at which that same E.M.F. varies with temperature. In the thermodynamic equation connecting the Peltier effect with the variation of E with temperature the E which varies is not necessarily that at the junction considered, but is the total E.M.F. of the circuit. The reversible heat at a specified junction is a measure of the metallic E.M.F. located there: those who say it is a temperature variation of the E.M.F. beg the question by locating the whole E.M.F. of the circuit at the particular junction they are considering, usually an interface of zinc and copper. At a chemical junction the E.M.F. is not purely thermal, and hence is not measured by the Peltier effect. It is chiefly of chemical origin, and is calculable from the energy of combination of the materials on either side of the boundary. At a metallic junction there is no such chemical potentiality. A strong current may be passed across a zinc-copper junction for years and no brass is formed. It is therefore improbable that the chemical affinity of zinc for copper is the propelling influence which causes the E.M.F. located at such a junction. In showing the Volta effect experimentally a trace of liquid can act detrimentally by forming a conducting bridge between the plates, across which the bulk of the electricity passes as the metals are being separated. The safest and clearest mode of expressing the Volta effect is that it consists in an opposite charge acquired by dry zinc and copper while in metallic contact—a charge which results from an E.M.F. of fixed value and is controlled solely by this E.M.F. and electrostatic capacity. It is undeniable that the order of the Volta force can be calculated from the differential heats of combination of the metals for oxygen, although it is doubtful whether it can be calculated from the heat of formation of brass.

The opposing sides of the old controversy used to be called contact theorists and chemical theorists. Now the opposite sides are involved both in contact and both in chemical views. It is a question of which of several contacts is the effective one, and what kind of chemical action or affinity is the active cause. Is it the contact and chemical affinity across the metal-metal junctions, or across the metal-air junctions? The opposite sides are thus metallic and dielectric. The metal-air force is of the order volts, the metal-metal force is of the order millivolts.

When a piece of zinc is put in contact with a piece of copper, the oxygen atoms which surround these bodies move slightly away from the copper and approach slightly nearer to the zinc. These slight motions produce the whole Volta effect. All that is necessary for the Volta effect is the inherent film on the surface; all the rest of the gas is mere dielectric, and might be substituted by a vacuum.

It was proposed by Prof. Perry and seconded by Prof. Armstrong that a meeting should be held to discuss the address.

The meeting then adjourned until February 23.

Utilisation of Water Power in Queensland.—Application has been made to the Queensland Legislative Assembly for permission to divert from a point above the Barron Falls, Queensland, situated about 16 miles from Mareeba, sufficient water to develop 10,000 H.P. This power is to be utilised to supply energy for the electrolytic works required to treat the Chillagoe ores. It is not proposed to use more than 3,000 H.P. at present. It is understood that the concession has been granted by the Government for a term of years, for a consideration of £1,000 per annum.

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KINLOCH TELEPHONE SYSTEM IN ST. LOUIS.*

The Kinloch Telephone Co. was organised in the year 1897, for the purpose of constructing an independent telephone exchange in the city of St. Louis. All the cash capital necessary for the construction and installation of a telephone exchange of the highest class throughout, with an immediate capacity of over 6,000 lines in actual operation and conduits and other construction which would provide ultimately for about 15,000 lines, was obtained, and was in bank at the disposal of the company before any work of construction was undertaken. The company was fortunate in the selection of its engineer, Mr. Charles H. Ledlie, a civil and electrical engineer of high standing and attainments. Under Mr. Ledlie's guidance the system of exchange operation was determined on and the work of construction was laid out and carried to a successful completion.

Divided-Exchange Multiple Switchboard System.

The Kinloch exchange employs a switchboard system which is said to be equal to the task of connecting 20,000 lines in one exchange, thus doing away with branch exchanges up to that number. The Kellogg divided exchange multiple-switchboard system which was adopted for the Kinloch exchange, and which is now in successful operation there, is a development of the multiple-switchboard system. But it practically increases about fourfold the scope of the multiple switchboard as now in use. In other words, the multiple switchboard as now generally in use is practically limited in its capacity to about 5,000 or 6,000 lines in one exchange centre, whereas the Kellogg divided-exchange multiple system secures practically all the advantages of the multiple-switchboard system of operation to exchanges of more than 20,000 lines. In the Kellogg divided-exchange system, as installed in St. Louis, all the subscribers' lines of the city are brought into one central office. The lines are divided into four equal divisions, and are designated as lines A, B, C, and D respectively. The multiple-switchboard sections are also divided into four divisions, also designated A, B, C, and D. Each line of division A of the lines has a spring-jack on each section of division A of the board. Each line of division B of lines has a spring-jack on each section of division B of the board, and similarly with divisions C and D. These spring-jacks thus multiplied are called the "multiple jacks" or "outgoing-call jacks" of the lines.

Each of the lines of the exchange has also four other spring-jacks, which are located at sections in the four divisions A, B, C and D of the board, one in each division. These jacks are distributed equally among the sections of their respective divisions, and are called the "answering" or "incoming-call" jacks of the lines. Each line of the exchange has four polarised annunciators or drops so constructed that each will indicate a call when a current of one polarity passes through it in a given direction, and will not indicate when a current of the opposite polarity passes. These polarised drops of each line are located one in each division of the switchboard and each at a section in which the line has also an "answering" or "incoming-call" jack.

The subscribers' station apparatus of each line has current-generating apparatus, and has also four keys, with commutator springs and connections whereby current of either polarity alone may, on the depression of one or the other of two of the keys, be sent from the subscribers' ground over one side of the metallic-circuit line which is normally grounded through two of the polarised drops, and these drops are so connected into the circuit that one responds to a current of one polarity, and only that, and the other responds to a current of the other polarity, and only that. The other two keys will, on depression, send a current, one of one polarity and the other of the other polarity, over the circuit of the two sides of the line; and the two other polarised drops, which are normally bridged between the two sides of the line, are so connected into the circuit that one responds to a current of one polarity and the other to a current of the other polarity. These four keys are marked A, B, C, and D respectively, to indicate the division of the switchboard in which is located the drop of the line which will respond when the particular key is depressed. By pressing on one or another of the four calling keys the subscriber may thus cause either of the four drops of his line to indicate a call, and may therefore call at will an operator in either of the four divisions of the switchboard.

Each section of the switchboard has three operator's positions and 30 pairs of switch plugs with their cords, with calling and listening keys and connections, whereby either one, two, or three operators may operate at a section and connect any "answering" jack at the section with any "multiple" jack located there, by the mere act of placing one switch plug into the "answering" jack of one line and its mate into the "multiple" jack of another line. Thus the operator can connect any line which has an answering jack at her section with any line which has a multiple jack at her section.

The operation of the system is as follows: Any subscriber who wishes a connection with the line of any other subscriber finds out from the exchange directory the number of the line wanted, with its alphabetical designation. He then calls the operator at the division at which the line wanted has its multiple jack, by pressing on the corresponding key and thereby causing the drop of the line at that division to indicate. The operator, on observing the call, places a switch plug in the "answering" jack which corresponds with the drop of the line calling, and after finding out what line is wanted, places the mate to the plug in the "multiple" jack of the line wanted, thereby connecting the two lines together.

In the Kinloch switchboard, as at present installed, there are multiple jacks for 2,200 lines in each of the four divisions, or for 8,800 lines altogether. Each division has ten sections, at each of which its 2,200 lines have multiple jacks. There are therefore 40 sections. Each subscriber, being able to call to each of the four divisions, can obtain a connection at that division with each of the 2,200 lines of the division, or by calling to the four divisions can obtain connections with 8,800 lines altogether, without any necessity of trunking. The ultimate capacity of the sections is such that multiple jacks for 5,035 lines may be placed in each division. Additional switchboard sections may therefore be added, and at the same time multiple jacks placed in the old sections for the new lines until each division is equipped for 5,035 lines; and the whole exchange will then have a capacity for 20,140 lines. Thus, at St. Louis, at some time in the future, over 20,000 lines will be operated in the exchange; and no connection whatever will require the service of two operators. It seems apparent, therefore, that for as many as 20,000 lines in one exchange all the advantages of cheapness and efficiency of operation are obtained which are found with the pure multiple switchboard without branch exchanges and trunking between them.

The Kinloch Co. began its pay service about April, 1899. By the end of the year 1899 its number of actual subscribers approximated 6,000, and its list is steadily growing. It is to-day the largest independent telephone exchange in the country, and it is believed that it is the largest exchange in the world in which each connection is completed by a single operator without trunking. It is also claimed by the officers of the company that its cost of operation is less per line than that of the exchange system in any large city of the country.

Underground Construction.

In the underground construction multiple-duct vitrified terra-cotta conduit is used. It was made by John T. McRoy, of Chicago, and is principally of the four-duct size, although two-duct, three-duct, and six-duct sizes were put in where possible. In all there is about 560,000 duct feet. This conduit comes in sections 6ft. long, and is made of shale burned quite hard, with an exterior and interior salt glazing: it has openings of a diameter slightly greater than 3in., rectangular cross-section, with curved corners, and it joints together by means of a steel dowel pin. It was laid in a most thorough manner in concrete of the usual mixture, one part cement, three of sand, and six of crushed stone, to a depth of 3in. on the sides and bottom and 4in. on top, and so good was the alignment that not a single case of trouble developed when the cables were pulled in. For very sharp curves and outlets to laterals a 3in. iron pipe was used. The manholes were built of vitrified paving brick with 13in. walls, concrete floors 12in. thick, with sewer connections where possible and necessary, and concrete and I-beam roofs. They range in size from 3½ft. square to 5ft. square, the intermediate size, 4ft. square, predominating. The manhole cover is a solid steel casting weighing about 400lb., circular in shape, 36in. in diameter, and resting on a 900lb. iron frame. In all about 300 manholes were put in.

In these ducts were installed lead-covered cables supplied by the Standard Underground Cable Co. of Pittsburg, Pa., and made in accordance with rigid specifications. Of the underground cables there was in all about 350,000ft. of different sizes installed. The principal sizes put in were 100, 75, 50, 25, 15, and 10-pair, although later on some 200-pair cable (about 20,000ft) was put in to provide for additional subscribers.

In installing the cable a manhole capstan, built for the purpose, was employed, and an average of 3,500ft. a day of 100-pair cable was put in. This capstan consisted of an 18in. drum on a 12ft. steel shaft, with a key and nut, so that its height could be regulated to bring the middle of the drum opposite the duct into which the cable was to be pulled. The shaft fitted into a socket in a bottom board braced against the sides of the manhole, and ran through an iron guide on the surface, the guide consisting of two cross-pieces of flat iron, long enough to span the manhole frame, and having holes in them by which it could be securely pinned to the street. A collar with protruding spokes is slipped over the top, and the height regulated by a key and bolt, and iron-pipe handles are slipped on to the spokes and serve as capstan bars for the men to push on. This apparatus is easily moved, and was found most serviceable, especially where small manholes were encountered. It was with such an apparatus and an ordinary gang of nine labourers and a foreman that what is believed to be a record run was made—over 7,500ft. of 100-pair cable and larger size in 8½ hours. In order to accomplish this the conditions must be perfect—long, straight runs,

* Abstract from the *Western Electrician* of Chicago.

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not too frequent changing of the capstan, and, above all, a well-drilled force, every man of which knows what he has to do and does it without being told. Such conditions do not often arise, so that a daily average of 2,500ft. to 3,000ft. of 100-pair cable is considered very creditable. The installation of the cables was begun in the autumn and carried through the winter, the jointing gang following up the pulling-in gang as closely as possible. On account of the sheath of the cables being soft, great care had to be taken to keep them from kinking; but, on the other hand, it was possible to bend them properly around the walls of the manholes, even when the manholes were quite small, and in a number of cases cables were put in when they had to make a right-angle turn, no splice being made. The pliability of the cables also enabled their being pulled through intervening manholes when the distances were short and the difference in level and alignment of the ducts was not too great.

The splicing was done in the usual manner, except that where the 100-pair mains branched off into smaller subsidiary cables it was sometimes necessary to make three-way, four-way, and even five-way splices. These subsidiary cables ended in a terminal, either at a pole or in an alley, or else in the basement of a building, so that all the laterals were comparatively short. Where the terminal was in an alley, the house connection was made by means of Marsh duplex wire, which consists of two No. 14 B. & S. conductors of hard-drawn copper, one insulated with rubber compound and the other with high-grade weatherproof insulation, and the two twisted together. When the terminal was located in the basement of a building, rubber-covered braided wire was used for connection to the instruments. For all sizes smaller than 10 pair the terminals used were of the tubular hard-rubber type, but for 10-pair and larger sizes they were of the well-known iron, double-row, lock-nut, "Conference" style, such as are universally used by the telephone, telegraph, and fire-alarm companies. In both styles the cable is connected to binding posts on the inside of the terminal by means of a lock-nut connection, and the line wires to the same binding posts on the outside of the terminal, the terminal in any event being enclosed in a weather-proof box. As a further precaution against moisture, all the small tubular terminals, after they were connected up and the end of the lines tested, were filled with insulating compound.

Overhead Construction.

The cables for the overhead lines were also furnished by the Standard Underground Cable Co., but were installed by the St. Louis Electric Construction Co., which also built the conduit system, and which put in a system that it would be hard to surpass anywhere in the United States. The poles are of well-seasoned white cedar, averaging 48ft. in height, with 6ft. in the ground, and have a minimum diameter of 7in. at the top. They were furnished by Naugle, Holcomb and Co., of Chicago, and were painted white, with red butts. The cable cross-arms are of 3in. angle iron, placed low upon the poles, and hold the iron messenger wire by means of U-bolts. The diameter of this messenger wire varies with the size of cable to be suspended, ranging from ½in. for 100-pair to $\frac{5}{16}$in. for 25-pair cable. On account of the rigid inspection to which the poles were subjected before being accepted and the care with which they were placed in the ground, their overhead lines are about perfect as regard alignment and uniformity, the lines being straight, of an even height, and as taut as desirable. The poles are braced in all directions against strains by means of galvanised iron guy wires and sunken stubs.

The ordinary lines are of hard-drawn bare copper wire of No. 12 B. and S. gauge, erected and insulated in the usual manner, and of which about 3,800 miles has been strung. The overhead cables are similar in all respects to those put in underground, except that they are made of No. 20 B. and S. conductors instead of No. 19 B. and S., and the thickness of the lead sheath is slightly reduced, both of these changes being made in order to lessen the weight. They are required to fulfil the electrical requirements and tests specified for the underground cables. Only four sizes are made use of—100-pair, 75-pair, 50-pair, and 25-pair—and of the four about 499,000ft. in all has been strung, including the lines crossing the river and those in East St. Louis, Ill.

Terminals and Testing Outfit.

The terminal room, in which the underground cables end, is located under the sidewalk, the cables entering it by means of two cable vaults. It is a well-lighted and ventilated room, containing the testing instruments and cable terminals, and especially constructed for the purpose. The testing outfit is about as complete as it can be made, and no expense has been spared in its equipment: the galvanometer is mounted on a separate stone-and-brick foundation, so that it is free from the vibrations of the building. The Wheatstone bridge, a very large one, is in a quartered oak drawer, so that it can be easily put in use when wanted and is out of the way at other times. The condenser, resistance box, shunt, charging and discharging key, and all kindred apparatus are conveniently at hand, and can be used by the tester without changing his position; when not in use all instruments are covered by oak cases to protect them from dust. The battery used consists of 100 cells of the Leclanché type, giving a constant voltage of 160 volts when all are in service, or any fraction of that as desired, the change being effected by a switch. These cells are tested frequently, so that constant voltage is assured, and are placed in a shelf or cupboard out of the way.

The terminals installed were purchased from Mr. F. B. Cook, of Chicago, and are what are commonly known as "Conference terminals" for 100 pairs of conductors. They contain a double row of 102 binding posts on each side (51 pairs), the two extra posts being for spare wires, and are numbered from 1 to 51 on the left side, beginning at the top, and 52 to 102 on the right side, a number appearing between two posts. The posts are slightly staggered, and the upper one of each number is always used for the same side of a pair. In this system the upper wire is called positive, and as each pair consists of wires with two colours of insulation, magenta and blue, the magenta wire is called the positive of the pair and the blue the negative, so that in soldering in the formed cable the magenta insulated conductor is always put into the top binding post of the pair. The first row of binding posts is for the underground cable, which comes in at the bottom; the second row for the cable going to the distributing board, which comes in from the top of the terminal, and both are formed, laced, and soldered in precisely the same manner, except that the distributing-board cable begins at the top and gradually tapers off as it goes down, whereas the underground cable begins at the bottom and goes up.

The body of the terminal is a cast-iron box, in which are the binding posts, those containing the wires of the underground cable or line being connected to those containing the wires going to the distributing board through a heating coil and a lightning arrester. The heating coil connects two springs, so that when a small current is in the circuit the coil fuses after a short time and releases these springs, one of which grounds the underground line and the other opens the line to the distributing board. Whenever a line becomes grounded in the terminal room, through the fusing of the heating coil, it rings a call bell, notifying the attendant there of the fact, and also registers the number of the terminal by means of an ordinary annunciator board, so that the trouble is readily found and fixed. Attached to one of the springs of the heating coil, but not in the circuit, is a lightning arrester consisting of two carbon plates with a sheet of thin piled silk between them. When a discharge occurs the silk becomes charred, which grounds the line, and as the heating coil fuses at the same time, both are replaced at once and the line is again ready for service. Both the lightning arresters and heating coils are on the outside of the terminal, where they are readily accessible.

THE STANDARDISATION OF ELECTRICAL ENGINEERING PLANT.

The following is an abstract of the discussion at the Institution of Electrical Engineers, in connection with Mr. R. Percy Sellon's Paper on this subject. This Paper was reprinted in our issue last week.

Thursday, February 8.

Mr. R. E. B. CROMPTON said that they all thanked Mr. Sellon for bringing before them a subject of such great importance both to manufacturers and users. It was a Paper of arguments, and they were so thoroughly in agreement with nearly every argument that it was not easy for the Paper to be effectually criticised. They agreed with Mr. Sellon, and they must all try to help him to carry out the suggestions contained in the last paragraph of his Paper; that the Institution should encourage the submission of Papers suggestive of standards, and that the Uniformity Committee of the Institution should be strengthened. This could be very easily done. Mr. Sellon had commenced by pointing out that there were disadvantages in introducing standards into any industry at too early a stage, and this was undoubtedly the case. He thought that up to the present, in England, the manufacturers were the people who had suffered from the vagaries of the consulting engineer by not being allowed to adopt a greater degree of standardisation than had been the case. Probably a greater degree of harm would have followed if standardisation of manufacture had been carried out much earlier. Mr. Sellon had given a list of central stations with a view to showing what wide variations of practice existed in all classes of generating plant. That list proved that the consulting engineers who had been responsible for station supply had not varied very much. The 100 volts for continuous-current supply was fixed upon practically by the lamp manufacturers. This voltage was supposed to be, for many years, the limit at which a suitable lamp could be manufactured, and it was varied to the extent of 10 per cent. to suit burning two arc lamps in series on the same circuit, making the pressure from 100 to 110 volts. After several years of use with lamps of this voltage, it was discovered that lamp manufacturers could make lamps of a much higher voltage, but the tendency to make lamps for voltages such as 150 or 160 was very wisely resisted by engineers, and there were very few cases of attempts to utilise these lamps, which would have considerably reduced the cost of copper under the conditions at the time. It was only when lamp manufacture was so far improved that it was possible to get lamps of double voltage that these double voltages began to be used. Then they came to the

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question of the variations in the periods of alternating currents. They would all remember the very strong controversies that had taken place in regard to the proper periodicity for alternate currents in order to get the best possible effect, and there was no doubt that the great variety in periodicities had pressed very hardly on the manufacturers. Only those who had to deal with the manufacturing of alternate-current motors, alternate-current arc lamps, and other means of utilising alternate energy, knew what trouble and what anxiety had been introduced into the industry by the great variety of periodicities which existed. However, this seemed to be in a fair way to be overcome. They must all agree with Mr. Sellon that the advantages of standardisation would come, in the end, just as much to the user as to the producer. In engineering matters perhaps the only standardisations that had taken place had been in the small machinery for domestic use—sewing machines and articles of that kind—but he thought it was about time that the motors that they intended to largely use in their houses should be classed with articles of domestic use. It was only when they were so standardised that they could be produced in any large quantities, thus letting the user have them at a price he was prepared to pay. He was glad to say that quite recently developments had taken place in the use of electric motors which bid fair to increase their use very largely indeed. He referred to motors of $\frac{1}{8}$ H.P. or $\frac{1}{4}$ H.P., such as would be used in houses either for small domestic power purposes, ventilation, or cooling rooms. It was in these directions that a trade had been stirred up and of course had introduced standardisation, with a consequent reduction in cost. He thought the next degree of standardisation would be in the supply of motors for the working of tools which took a definite amount of power. There were a large number of tools used in workshops in which the power was from $\frac{1}{4}$ H.P. which could be grouped together and motors supplied to be fitted direct on to them. In this direction they were quite certain to have standardisation at once, so that it was evident that, by a natural law of commencing with the smallest motors, they would gradually standardise all, and from year to year get up to the larger sizes, quite apart from any special effort that the Institution might make. This would be the natural economic law that would be followed, but the Institution could assist that law by calling the attention to the enormous advantages to be obtained through adopting the standards of the manufacturers themselves, and this was really the best way to get at the end they all desired.

Mr. A. B. BLACKBURN said they were all agreed as to the desirability of standardisation, and the chief thing to consider was the limit to which they could go. He thought each manufacturer should begin at home. The manufacturer should make standards, as far as he could, in his own types of machinery, and then try and convince the user that he had good reason for having done so. By that means the manufacturer would commence, as far as he himself was concerned, a fair measure of standardisation; and if every manufacturer did this, they would be able to come to some understanding amongst themselves as to what were the best types. There was no doubt that the user could assist them very greatly by pointing out, from his actual experience, what were the conditions which required to be fulfilled in the machinery he used; and if he would, as Mr. Sellon had remarked, state the ends, then the manufacturer would find the means. As regards dynamos and alternate-current machinery, in which he was chiefly interested, he thought they had already to some extent arrived at a basis. In alternate-current working there had been a very great diversity of periodicities, which had blocked the way to standardisation. There was a consensus now, however, leading to a definite periodicity which, except in the case of stations already existing—and which of course would be tied for a number of year to the present periodicity—would very considerably lighten the task of the manufacturer. The same with regard to continuous-current working. They were settling down very much. In Mr. Sellon's tables it was seen that a very large proportion of the stations were now between 400 and 500 volts, which was very satisfactory to the dynamo makers, and he hoped that the engine makers would help them. At present, in tendering, they generally found a considerable diversity of speeds, and this very frequently involved getting out tenders with three or four different sizes of dynamos to accommodate the different engine makers. If the engine builders could arrive at a definite standard of speed, it would help matters considerably. As regards American competition, he thought that standardisation in these goods had arisen very much from the large quantity used, and not the quantity from the standardisation.

Mr. J. SLATER LEWIS thought the first question to be asked was how were they to meet this foreign competition? That this country was being invaded at present by Germans and Americans was a question beyond doubt, and it was giving manufacturers here great trouble at the present time to know how they could meet this. He asked them to imagine a dynamo manufacturer who built machines of one size and one type only. Anybody who had had experience in this class of work would see that the establishment or fixed charges in such a shop would fall enormously. He had made some very careful calculations as to what could be done by standardisation on these lines—viz., building one type of machine in one shop—and he was perfectly convinced that if this were done the establishment charges would fall at least by 60 per cent. The establishment charges in an electrical shop at the present moment were very much higher than with any other class of machinery, and this state of things was entirely brought about by the fact that in England there were one or two large shops doing all classes of work, from little things as big as a man's hat to a machine 15ft. or 16ft. in diameter. He was perfectly certain, if we were to do any good in this country, we must make up our minds that we must standardise. Unless this was done we should go on in the old way building shops that were not suitable for the class of work, and we should be unable to met foreign competition. His own opinion was that if some committee could be formed with a view to suggesting certain sizes of motors and dynamos, it would be possible to arrive at something fairly satisfactory. He was inclined to think that Mr. Crompton was wrong in saying that these matters would right themselves automatically. He did not believe in this at all. He believed we were now standing face to face with a very serious problem, and the sooner it was attacked in a practical sort of way the better. His firm had been engaged for some considerable time in standardising a series of motors. They had already commenced operations with these motors, and he could only say that the results had been eminently satisfactory; and they hoped in a very short space of time to sell everything to a standard, and under no circumstances would they depart from that line of business. It was the only way to meet this foreign competition, and they must be supported by the consulting engineers. Dynamo manufacturers who had to supply Corporations were suffering very seriously from the fact that all sorts of details were imposed upon them, and this involved the alteration of patterns and drawings and all that sort of thing. They all knew what a conglomeration of patterns and sizes was to be found in almost every dynamo manufacturer's in this country, and until they could reduce this to a minimum they would never do any good.

Mr. E. JOHNSON had had a good deal to do with standardisation of electrical apparatus, but not exactly in the direction that Mr. Sellon had put the subject before them. His efforts had been to standardise the apparatus as near as possible in its constructional detail. He thought the trouble experienced in England in this direction was due to the fact that for each order there was a different engineer specifying the details, instead of allowing the manufacturer to supply what he knew would do the work. In America, if a traction company wanted so many dynamos to give so many H.P., and so many motors to drive so many tramcars, it called for that and nothing else. The manufacturer had only to supply that, and the result was that he soon had them in stock.

Mr. J. S. RAWORTH said the very hearty reception that had been given to this Paper must have made Mr. Sellon sorry that he had never submitted a Paper to the Institution before. Mr. Sellon had read a great many at other institutions, and he noticed that he had done what every practical writer of a Paper did, and that was to throw down upon the floor what he might call the "bone of contention." It did not matter what sort of a bone this was, so long as it was long enough for two dogs to get hold of it at the same time. Mr. Sellon had given them a Paper which provided plenty of scope for discussion, and he had also given it a title that did not fit. They could discuss the title as much as they could the Paper. In order to get them to appreciate this point about the title, he asked them to consider the meaning of the word "plant"; and he did so because there were a great many young men present who, if they did not thoroughly appreciate the meaning of this word, would go through many of the throes and troubles in their future life that he had already gone through. The reason of this was that the word "plant" was used in legal documents; it had a legal meaning, and in these documents they never found a single word of explanation as to the meaning of that word. What was plant? They sometimes heard people talk about two plants or three plants, but a man could not have two plants any more than he could have two wives. Plant was the machinery, tools, and utensils used in carrying on any particular trade. When they saw plant spoken of in specifications, it did not mean the engines and dynamos that the producer was producing and supplying to the consumer; it meant all his tools and machinery for the purpose of producing these things. He had known town clerks and others try to make out that the clauses with reference to plant actually referred to the machinery that he was supplying to them under contract. While the machinery was in process of construction it was not plant; but as soon as the engineer's signed certificate was obtained it became the "plant" of the business of the purchaser. When they therefore turned to the title and saw "The Standardisation of Electrical Engineering Plant" it meant the standardisation of the lathes, drilling machines, screw-drivers, and all these things that formed part of the tools with which the electrical engineer conducted his business. If they took the analogy of a railway, he should call the gauge the principal governing factor; and it was because engineers in the early days did not fully recognise the importance of this that they began specifying gauges that were not all alike, and consequently gave a great deal of trouble and cost the country a great amount of money to bring them into uniformity. Taking this analogy, the equivalent of the gauge was the periodicity and pressure, and in Mr. Sellon's list at the end it was seen that some considerable effort had been made to get at standardisation. They would find there were 20 stations which had a periodicity of 100. It had been proved later that a periodicity of 50 gives better results, and now they found that no less than 20 stations, in a very much shorter period of time, had been standardised to a periodicity of 50. This was a very satisfactory result, and he thought it went to show that the consulting engineer after all was coming very much nearer to Mr. Sellon's standard than he was aware of. Coming to the standardisation of details, he quite agreed with Mr. Crompton and Mr. Blackburn that this had a very much stronger effect upon the cost of production than most people were aware of—a far stronger effect than the standardisation of pressure and periodicity. He had been connected with a company that had done a very great deal towards standardisation. It had passed resolutions at board meetings; it had given instructions to managers; it had written innumerable memoranda and it had exerted itself to an enormous extent to get *standardisation*, but they did not get it. The ordinary commercial draughtsman could upset all the calculations of a board, or of a manager, by the simple expedient of altering things as he went along, without anybody finding it out. On one occasion he wanted a new valve spindle for an engine, and ordered it from the original maker. When it came he found the draughtsman had made his drawing $\frac{1}{32}$in. smaller than the previous one, with the result that the spindle was no use. He thought Mr. Sellon would be well advised if he were to carry out this suggestion—viz., that anybody who wants to standardise satisfactorily must get a cauldron of boiling oil and keep the draughtsman in it with a ticket round his neck saying that "This is the man who dared to alter our standards."

(To be concluded.)

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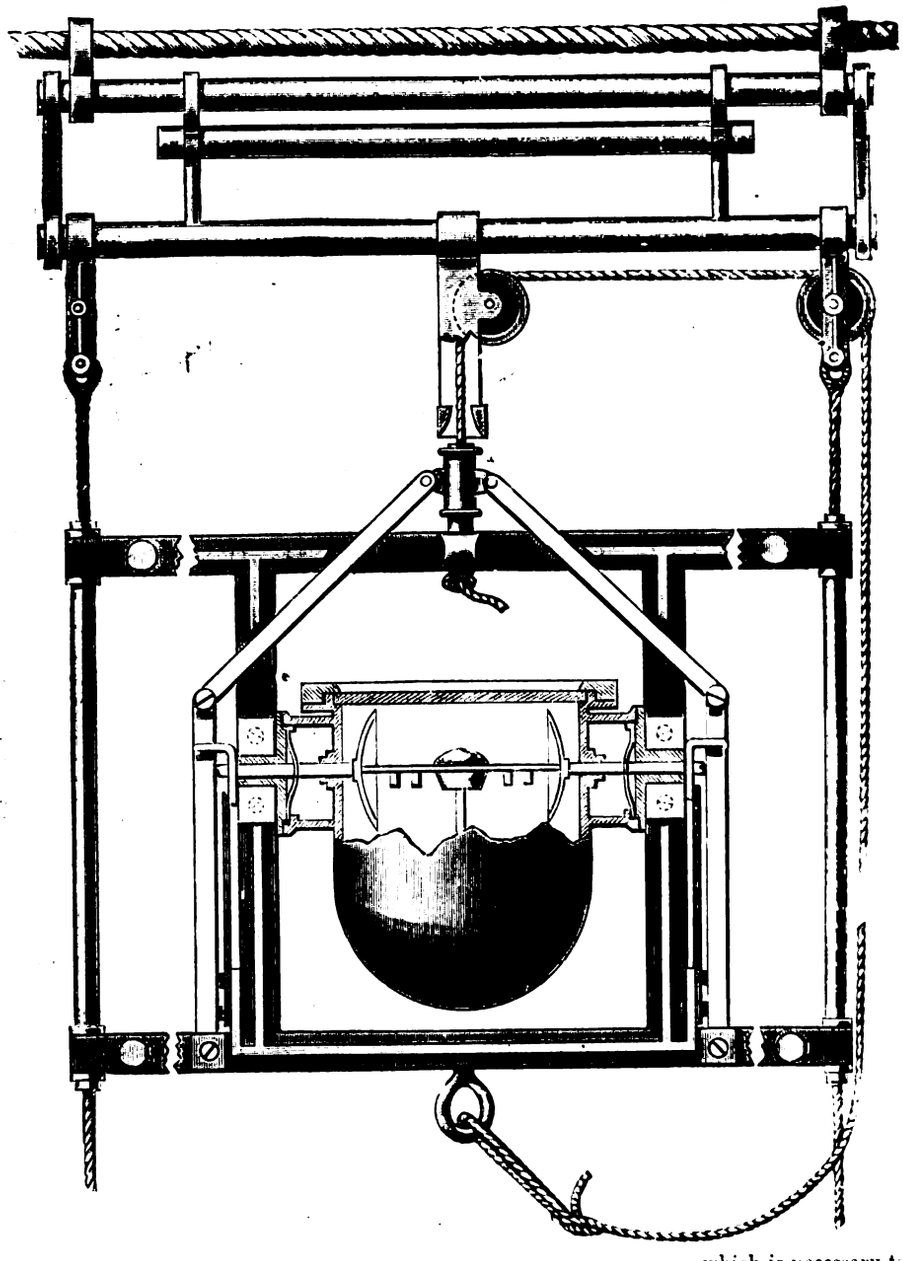
CORRECTING THE DEVIATION OF THE SHIP'S COMPASS.

The importance of the compass, in enabling the mariner to steer his ship with every confidence and certainty of his bearing, is very well known. It is not so generally known, however, that this confidence and this certainty are rendered possible only by the successful elimination of a large number of extraneous influences which tend to deflect the compass very considerably from its true position. These deviations, as they are called, would in many instances amount to 30deg. or 40deg., and this where an error of even half a point—when steering, say, through a narrow channel—might prove disastrous.



These sources of error are due mainly to the large quantity of iron and steel used in the construction of a modern ship. The keel, cross-beams, spars, and masts are generally made of steel, which in the course of the building, and owing to the hammering to which they are then subjected in the earth's field, become strongly magnetised. These produce a source of error partly permanent and partly sub-permanent. As the vessel changes her course or her latitude, there is introduced another error, due to the varying magnetisation induced by the terrestrial field in the iron of the ship, known as the error due to transient magnetism. These errors can be, and in fact are, corrected by various devices, and there remains only the serious influences of magnetic storms, which no compensation or correction can anticipate.

Many methods have been employed during the present century to calculate, or to compensate for, the errors due to the above-mentioned causes. Of the former we may refer to the methods connected with the names of Poisson, Napier, Airy, and Archibald Smith, whose corrections were, though fairly accurate and sufficient, somewhat laborious in their application; of the latter, we need only mention Lord Kelvin's mariner's compass, patented in 1874, now universally employed. Even in this case the compensation cannot be absolutely relied on to remain constant, as evidenced by the Admiralty regulations, which require the commander of every vessel to frequently compare the indications of his compass with that calculated from his "dead-reckoning," or from solar or stellar observations. The corrections thus involved are again somewhat troublesome to carry out.

The need has thus been felt for a compass which would read correctly in all circumstances and conditions, involving no troublesome compensations or corrections. Dr. Scoresby, the famous Arctic explorer, so long ago as 1854 suggested the fixing of the compass right aloft, up among the rigging and away from the disturbing influences of the iron in the ship's hull and hold. This suggestion has been, curiously enough, only recently taken up, and is exhibited in the Evoy patent compass, just put on the market. We have recently had an opportunity of inspecting it. As compass readings cannot conveniently be taken with the compass up in the rigging, Mr. Evoy very ingeniously devised a mechanism which would automatically lock the card as soon as it is hauled away from the jumper stay to which it is usually attached. The method by which this is accomplished is sufficiently clearly indicated in the accompanying illustration. The bowl of the compass, which in all respects is similar to the ordinary Kelvin compass, is suspended on a carrying frame by trunnion-like axles through which plunger rods pass, having their inner ends provided with discs or stops. The plunger rods have liquid-tight diaphragms, and their outer ends project so as to be pressed in by vertical levers controlled by springs, which tend to keep the levers inwards, the card thus becoming locked or held by the two cups until released in the following manner: The upper ends of the levers are jointed to links connecting them to a sliding cup centrally fitted on a stem at the upper part of the bowl framework. The carrying frame has a system of cords and pulleys for the purpose of maintaining the bowl in proper position and hauling it up and down as required. When hauled up two hemispherical projections are engaged in corresponding cavities, thus fixing the frame and liberating the card simultaneously. After a minute or two the compass is hauled down, the card becoming locked at the instant it begins to descend, and the reading is taken on deck.

It remains to be seen if the Evoy compass will find a useful application in practice as an auxiliary to check the reading of the "standard compass." A difficulty may occur, however, in the case of vessels with steel masts, for the disturbing influences of these on a compass fixed up aloft would probably be even greater than on deck. As this error would in general be approximately constant, compensation might successfully overcome this difficulty. A possible drawback, which would be of more serious nature, might be occasioned by the swaying of the jumper stay, which would in general bring the lubber-line and centre of the needle out of the same plane with the keel of the ship. Another possible objection is that the wrench which is necessary to pull the compass away from above might cause the card to swing round somewhat and become locked away from its natural position. It is to be presumed that these difficulties have been foreseen and have been successfully met, for we are informed that 300 of these compasses are now in use and are giving the greatest satisfaction to the commanders of vessels employing them.

Discontinuance of Trailer Cars at Hull.—It is an unusual and somewhat curious fact that trailer cars have not been popular at Hull, as they generally are on electric tramways. It is intended to discontinue the use of this class of car, the disfavour arising on account of the delay caused by connecting them at the termini to the motor car.

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LEGAL INTELLIGENCE.

Rucker v. the London Electric Supply Corporation (Ltd.).

JUDGMENT.

Mr. Justice Farwell delivered judgment in this action on Monday. (The evidence was very fully reported in *The Electrician* of Jan. 26 and Feb. 2.)

His LORDSHIP said: The plaintiff claims, by assignment, letters patent of March 16, 1885, for an invention for improvements in distributing electricity communicated by Zipernowsky and Déri, of Buda Pesth, and by his writ dated July 1, 1898, seeks for an injunction and an account of profits or damages against the defendants for breach of his patent. As his patent has expired since the date of the writ, he can of course obtain no injunction; but this does not affect his claim for an account or damages for breaches during the existence of the patent. The defences raised are that there is no patentable invention in the plaintiff's specification, prior publication, and want of novelty. The first issue that I have to determine is the state of knowledge of electricians with reference to lighting by electricity at the date of the patent. Since 1870 electricity had been applied for lighting purposes, and various advances had from time to time been made in the means adopted for that purpose. The first lamp used was the single arc lamp with a dynamo of its own. Then Jablochkoff showed the possibility of subdividing the electric light by putting several lamps in series on one circuit, and by connecting several circuits to one dynamo. Then the arc lamp was replaced by incandescent lamps, which were run in parallel and required constant potential, a requirement which entailed considerable practical difficulties. The desideratum was to obtain a constant pressure on the lamps and the smallest possible amount of copper in the mains; and this involves sending out from the station at high pressure and using the power at the lamps at low pressure. Both continuous and alternating currents were used. I find that the following facts existed in March, 1885:—

1. The parallel system of distribution, giving on each consumer's premises a supply of electric energy at constant potential, to be drawn off in multiple arc both for continuous and alternating currents, was well known.

2. Transformers or induction coils were well known as machines by which the electrician could transform up or down—viz., multiply or divide—the tension on the primary.

3. It was also known that the E.M.F.s of the two coils bore a constant ratio to one another depending upon the number of turns of wire on the primary and on the secondary. The question of the ratio of turns is well put in an article in *La Lumière Electrique*, where M. Marcel Deprez, referring to Gaulard and Gibbs' secondary generators, writes in 1884 as follows: "In substance these generators are composed of a series of solenoids of little height and large diameter traversed by an altenating (so-called primary) current, taken from any source: this alternating current generates by induction in a second series of solenoids situated at a very short distance from the first solenoids, and moreover interpolated between them an induced (so-called secondary) current, the tension of which depends on the proportion of the number of the inducing spires to the number of the induced spires, and also on their grouping." Moreover, both Mr. Fesquet and Mr. Ferranti told me that they knew this themselves prior to 1885. I have mentioned this because there is some conflict of testimony on this point between the plaintiff's and the defendants' witnesses, and I desire to say that I accept the defendants' witnesses as more accurate in this respect than the plaintiff's. I think that Mr. Swinburne does less than justice to the electrical knowledge of himself and his fellows in 1885.

4. The excitation of an induction coil by a machine for the purpose of utilising the secondary current was not novel.

5. Putting machines in parallel on secondaries of an induction coil was not novel.

6. The positive and negative poles in the consumer's house which are connected with the double series of mains required in the parallel system are the equivalent of a dynamo producing a constant current.

In the year 1882 the Electric Lighting Act was passed, and in that and subsequent years many Acts have been passed confirming provisional orders under the Act. The basis of the legislation was that it was feasible to generate electricity at central stations and supply it to consumers in much the same way as water is supplied. The powers of the supplying body, however, ceased at the two poles in the consumer's house referred to: abroad the consumer took his supply by "straddling" the mains at those two poles—viz., by putting the transformers on the poles in parallel on the secondary circuit—and, as Mr. Swinburne told me, the consumer can himself put on the transformers in parallel on an ordinary parallel system. The customer was at liberty to use the current which he so obtained for any purpose that he thought fit. I should add that the Acts extend both to continuous and alternating currents, and both to the parallel and the series system.

Before considering the various documents referred to in the defendant's particulars, I will consider the construction of the patent. The claim of the patent is as follows: "In the application of induction coils or transformers for alternating electric currents, the arrangement of several stations of second order as branch circuits of the main line (*i.e.*, connecting up the local centres with the main line in multiple arc), to which main line is supplied an alternating current of a tension as constant as possible, substantially as described and shown in the drawing." In my opinion this is a claim for arrangement, and for arrangement only; it is merely a combination in a particular way of old well-known methods. The difficulty of construing this patent is increased by the fact that the patentee amended it some time ago by striking out claims for a means of maintaining an invariable tension at the points where the primary current enters the local centres. On the unamended patent, I should have been of opinion that the words "substantially as described" referred to the means of keeping the tension as constant as possible, but I cannot so read them now that the provisions relating thereto have been struck out. In my opinion, therefore, the words must be read "the arrangement substantially as described." I have therefore to consider if there is anything in the body of the specification affecting that claim in any way. Now, the specification commences by a historical statement, followed by a reference to the inefficient modes of distribution then in use, and states that the object of the invention is to make all individual points of consumption of electrical energy quite independent from one another; and it goes on to state in general terms the mode of doing this, which is in effect what is stated in the claim that I have already read. The inventor then states that "the distinctive feature of our system of distribution is that each group of induction coils or transformers of the several stations of second order shall merely constitute branch circuits of the main line for the primary current—*i.e.*, that primary circuits of the several local centres, any one of these being taken as a whole, are connected in multiple arc. In this manner we have conductors distributing the primary high-tension current in as many branch circuits as there are local centres, and any desirable number of secondary (low-tension) circuits." I pause to observe that there is nothing here as to the form of the transformer to be used, but that the patentee says that the distinctive feature of his invention is the arrangement in parallel arc. It appears to me that he believed himself to have discovered the use of transformers in parallel arc on secondary circuits, and this seems to have been to some extent the view of Mr. Swinburne when, in answering Mr. Moulton's question, "In what respect do the defendants infringe?" he replied: "In that you have a system of distribution with alternating-current transformers with high tension in primaries of 2,400 volts, and secondaries supplying lamps in parallel at 100 volts," and he said also that he considered the high tension and the low tension of the mains both essential. Pausing here, I am of opinion that no patentable invention is disclosed by this part of the patent if this be the essential feature of it. Mr. Swinburne a short time before had admitted that as early as 1882 the advantages of high tension and low tension were well known; and, further, that high tension and low tension are mere descriptive epithets, having no technical meaning. I hold as a matter of construction that high and low tension are not within the plaintiff's claim—*i.e.*, that the words are merely descriptive, and express nothing beyond the fact that the primaries are of high tension in comparison with the secondaries. The next four lines of the specification, as I have already stated, have given rise to some conflict of testimony. They are as follows: "Now, the electromotive forces of the two coils of the transformer bear a constant ratio to one another; therefore, if the internal resistance of such an apparatus is very low, the secondary tension will remain almost unaltered if we only have a constant difference of potential at the terminals of the primary coil." I have already found that the various statements in these lines were and were intended to be mere statements of well-known facts, and that this was intended to be so as a matter of construction is made clear to my mind by reference to the unamended specification, which I am entitled to look at for this purpose according to Lord Watson's statement in the House of Lords. It is to my mind plain, on the original specification, that these lines were statements of fact leading up to and emphasising the value of the means for maintaining an invariable tension which formed part of the original specification. Some argument was used on the advantage of keeping the resistance as low as possible; but this seems to me to be a mere truism, amounting simply to a statement that it is desirable to avoid useless waste, because excessive resistance exhausts the energy that is wanted for lighting by turning it into heat. Passing over some paragraphs in the specification, I come to the following statement on the last page: "We desire it distinctly to be understood that the form of induction apparatus or transformers may be of any kind whatever, without departing from the principle of our invention." That is a claim extending to all transformers of every sort; but transformers were well known and were in common use before the date of the patent. Lord Kelvin told me that no practical man would have been afraid to put induction coils straddling across mains of a high-pressure alternating-current circuit, and that there was absolutely nothing novel in it. Mr. Swinburne put the plaintiff's case very neatly when he said, "Everybody knew that we wanted a high pressure from the station and a low pressure in parallel distribution in houses. They—Zipernowsky and Déri—came, and they realised that a transformer arranged in a particular way which was not the usual way of arranging them gave them the key to the solution of the problem." Assume that it was not "the usual way," as he says: it was, however, a well-known way, and I am wholly unable to discover any invention in it. Authorities on different specifications are of little value in questions of construction, but I think the case of Gaulard and Gibbs gives a useful illustration of the application of the principles upon which the Court acts. To my mind, this specification contains at the utmost good advice, and is very far removed from invention. It recommends one of two well known modes of procedure as most suitable for conducing to a particular result. I should add that all transformers are said to be within the arrangement claimed; but as a fact all are not suitable. The plaintiff, however, can get no benefit from this, for he certainly does not point out any particular form of transformer as the appropriate one, or give any guidance whatever in this direction.

I will now proceed to consider briefly the defendants' particulars of objections. The most important document, to my mind, is the article in the *Zeitschrift für Electrotechnik*. It was proved that this document was sent over to the Patent Office here, and was laid on the table of the public reading room two days prior to the plaintiff's patent, and it is

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admitted that it is a description of the plaintiff's arrangement. If, then, this document contains sufficient information of the details of the plaintiff's arrangement to enable a practical electrician to put in operation the plaintiff's arrangement, the case would fail even if (contrary to the opinion that I have already expressed) the plaintiff's arrangement was a patentable invention. In my opinion the article does contain all such information. I have come to this conclusion both as a question of fact, after weighing the evidence of the witnesses, and also as a question of construction, treating myself as far as possible as possessed of the knowledge of the subject which a competent electrician would have had in 1885. On construction, I am of opinion that the article indicates with sufficient precision that there was a parallel distribution, and that the consumer was to take his supply by transforming down from high-tension primaries. Lord Kelvin was clear about this, and I do not consider that his testimony was at all shaken by the cross-examination, although he for the moment forgot the statement in the last paragraph but one of the article, namely, "Currents of respectively 6 and 7 amperes at the maximum flowed through the primary conductors." He set this right in re-examination, pointing out that these words clinched it; and as a matter of construction I agree with him and with Mr. Fesquet and Mr. Ferranti; and further, I do not think that Mr. Swinburne really differed, judging from his manner and tone in answering one of the questions addressed to him on this point. It is needless to say that Mr. Swinburne is not only a most competent, but a most straightforward and candid witness. I think that he meant that he agreed with Mr. Moulton and the construction that he put upon the sentence that I have just read. In view of the opinion that I have expressed, it is not necessary for me to consider the other documents mentioned in the defendants' objections in any great detail. They are important as showing the general state of knowledge prior to the plaintiff's patent, and they confirm me in the view that I have already expressed. The first is Brush. In this specification the defendants rely on a drawing only—viz., Fig. 9. This figure does, in my opinion, show diagrammatically the system of distribution by parallel mains, and of drawing off by transforming and using secondary circuits. As Mr. Swinburne put it, "Fig. 9 is the diagrammatic method of representing transformers in parallel on parallel mains—that is, with their primaries on parallel mains." Again, Lord Kelvin said that "Fig. 9 shows diagrammatically with perfect clearness five transformers placed in parallel on the mains of an alternating-current dynamo machine. The diagram alone, with the statement that this applies to transformers in alternating-current machines, is unmistakable." And as Lord Kelvin said, "The problem of distribution is represented in Fig. 9, although the problem as to the size of dynamos or the method of getting electricity over a large area is not dealt with." But I cannot see that this affects the question when you have once arrived at the fact that parallel distribution was well known before 1885. I agree with Lord Kelvin that, given that knowledge, there was no invention in proposing to do at 20 places what was done in one. I will pass by the article in *The Times* referring to Fuller's patent with the remark that I hold that the statement there is a statement of parallel distribution, but that, if that article stood alone, I should have had some difficulty in thinking it sufficiently explicit. The next document is Edison's patent of 1883. This is very remarkable, because on the evidence before me I find that Mr. Edison has the whole of the plaintiff's arrangement and something over and above and quite independent of the arrangement, and that Mr. Edison—I say it with hesitation of so eminent an inventor—apparently failed to appreciate the full advantage of his own invention, but to have been led away by his desire to secure continuous current. As Lord Kelvin said, "Edison's arrangement without the commutators is the plaintiff's arrangement," and the only object of the commutators was to convert the continuous current into an alternating current of high tension, which then passed through the transformers and came out as an alternating low-tension current to another commutator, the object of which was to deliver a continuous low-tension current, but no alteration was effected either in the tension or the quantity. Mr. Swinburne did not really disagree with this view, for he said that if you remove the whole of the commutators and substitute alternating currents you have the Zipernowsky system, and the only objection that he suggested to Edison's system had reference to the commutators—namely, that there would be such serious sparking at the commutators that they would not work. The only other matter to which I need refer is the installation under the Gaulard and Gibbs system. I accept Mr. Fesquet's testimony with regard to the exhibition at the Aquarium in 1883. I make no sort of reflection of course on Mr. Mackenzie; but he had for some years ceased to be employed in electrical engineering, and I am convinced that he had no really accurate recollection on which I could rely. I find that in 1883 Fesquet coupled the primaries in parallel as well as in series many times, and that the lamps were placed in parallel on the secondary wires; and further, that in 1881 there was an installation on the Metropolitan Railway running for some months, in which alternating high-tension currents were transformed down, and that the lamps were in parallel. I mention this because I desire to say that in my judgment Mr. Ferranti was a competent and trustworthy witness, on whose evidence reliance can be placed. I think that it is unnecessary for me to refer in detail to the Imray specification or to Rankin Kennedy's article, the last sentence of which is certainly remarkable.

The result is that the plaintiff's action fails, and must be dismissed, with costs.

Mr. CRIPPS (for defendants) asked for costs on the higher scale. Such an order was made in such complicated cases as this.

Mr. WALTER submitted that in this case no experimental work had been required. It was only examination and construction of documents. It was a pure question of argument on the construction of documents.

Mr. CRIPPS said that in this case they had had necessarily on both sides the most eminent men.

His LORDSHIP then dismissed the action, with costs on the higher scale.

TRADE NOTES AND NOTICES.

[Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.]

NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers, or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London:—

READY.

(Price 12s. 6d., by post, 13s. 3d.; Colonies, 14s.; abroad, 14s. 6d. (United States, 15s.)

"The Electrician" Electrical Trades' Directory and Handbook for 1900 (corrected to January 31st, 1900).—In addition to the well-known features of this Directory and Handbook (all of which have been carefully revised and brought quite up to date), a large addition has been made to the Handbook Division, including a Digest of the Law of the Telegraph and Telephone, for the use of municipalities and companies contemplating applying to the Postmaster-General for a Telephone Licence. This section of the book now includes the new model form of Licence issued by the Postmaster-General in January, the Telegraph Acts and Orders passed by Parliament in 1899, and other information in connection with this the latest development of electrical enterprise. The huge sheet tables of Electric Light and Power and Electric Railway and Tramway undertakings of the United Kingdom have been made complete up to the 31st January. These sheets form a most complete record of electrical engineering progress in connection with electricity supply and power and traction applications. The Directory Division has been carefully extended and corrected up to Feb. 2. A number of additional interesting sketches of the careers of well-known electrical experts have been added to the Biographical Division, together with many new portraits. The new volume is, we claim, the most complete and correct book of its kind ever published in any language. An analytical digest of the contents of this volume is in preparation.

"Practical Notes for Electrical Students."—By Messrs. A. E. Kennelly and H. D. Wilkinson. Price 6s. 6d., post free. The authors give in a clear and concise manner a good summary of the general principles of electrical science.

"The Incandescent Lamp and its Manufacture."—By Gilbert S. Ram. Price 7s. 6d., post free. The principles underlying the manufacture of the incandescent lamp are carefully and fully dealt with in this volume.

"The Centenary of the Electric Current, 1799-1899."—By Dr. J. A. Fleming. Price, paper covers, 1s. net, post free 1s. 3d.; strong cloth, 2s. 6d., post free.

"Localisation of Faults in Electric Light Mains."—By F. C. Raphael. Price 5s., post free. The book deals with the important subject of localising faults in electric light and power cables; and the various methods of insulation testing are here collected and discussed.

"Motive Power and Gearing for Electrical Machinery."—By E. Tremlett Carter, C.E., M.I.E.E. Price 12s. 6d., post free. In this comprehensive work an account is given of the scientific principles and modern practice in the use of engines for dynamo driving, not only for isolated power plants, but also for public electric lighting and power stations. The various forms of gearing in the power station and for electric motors are also dealt with; and the book contains, in addition, numerous tables giving exact data of the equipment and working of electric power stations.

"The Manufacture of Carbons for all Electrical Purposes."—by Francis Jehl. 10s. 6d., post free. This is a practical handbook, giving a complete description of the art of making carbons for electric lighting, electrodes, &c., with particulars of the various gas generators and furnaces used in carbonising. The work also contains particulars of the cost, &c. of erecting and working carbon works, and plans of a model factory.

"Wireless Telegraphy: Signalling across Space without Wires by Electric Waves." A Review of the Work of Hertz and his Successors.—By Dr. O. J. Lodge, with a large number of illustrations. New and Enlarged Edition, 5s. nett. *Now ready.*

"Electromagnetic Theory."—By Oliver Heaviside. *Vol. I.*, 12s. 6d. *Vol. II.*, 12s. 6d.

"Electric Motive Power," by Albion T. Snell, contains the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. Price 10s. 6d., post free; abroad, 11s.

"Electrical Testing for Telegraph Engineers."—By J. Elton Young, M.I.E.E. The scope of the book aims at furnishing a fuller treatment of the subject, from the standpoint of the Telegraph Engineer, than it has hitherto received, whilst it endeavours to facilitate a thorough comprehension of the theory of testing as applied to electrical lines in general. Demy 8vo, fully illustrated. 10s. 6d., post free.

"Electric Lamps and Electric Lighting," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is handsomely bound, and full of original illustrations, designs, initials, &c. *New and Cheaper Edition now ready.* **6s., post free.**

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"Submarine Cable-Laying and Repairing."—By H. D. Wilkinson M.I.E.E., &c., fully illustrated; price 12s. 6d. This work gives a detailed technical summary of modern practice in manufacturing, laying, testing, and repairing submarine telegraph cables.

"Magnetic Induction in Iron and other Metals."—By Prof. J. A. Ewing. Price 10s. 6d., post free. *New Edition nearly ready.*

"The Steam Engine Indicator and Indicator Diagrams."—Edited and enlarged by W. Worby Beaumont. Price 3s. 6d., post free. This work is a concise guide to the objects, construction, and use of the steam engine indicator and to the interpretation of indicator diagrams.

"The Art of Electrolytic Separation of Metals."—A second issue of Dr. Gore's book is now ready, price 10s. 6d., post free. The author treats fully both the theoretical principles of the art of electrolytic separation of metals and the practical rules and details of technical application on a commercial scale. The work is adapted to the use of the manufacturer as well as the student.

TENDERS INVITED.

The New Tramways committee of the *Newcastle-upon-Tyne* Corporation require tenders for the supply of 130 car bodies, trucks for same, and for electrical equipment. Further particulars are set out in an advertisement, and general particulars and conditions of contract may be obtained from the consulting engineer, Mr. Charles Hopkinson (Messrs. Hopkinsons and Talbot), 26, Victoria-street, London, S.W. Tenders must be lodged at the office of the town clerk (Mr. Hill Motum), Town Hall, Newcastle-upon-Tyne, not later than March 2.

The *Keighley* Corporation invite tenders for the supply and erection of the following plant at their electricity works: Switchboard and balancer, 10-ton overhead traveller, storage battery, mains, conduits, arc lamps and posts, ejector condensers, exhaust pipes and tanks, main, steam, and feed water pipes. An advertisement gives further particulars, and specifications, &c., may be obtained from the borough electrical engineer (Mr. J. M. Smyth). Tenders, addressed chairman of the Electricity committee, Bridge street, Keighley, to be in by 10 a.m. March 1.

The *Sunderland* Corporation require tenders for the supply of (*a*) steam exhaust, feed, and other pipes, and (*b*) two steam-driven induced draught fans and accessories. An advertisement gives further particulars, and specifications, &c., may be obtained from the borough electrical engineer (Mr. J. F. C. Snell), Dunning-street, Sunderland. Tenders, addressed chairman of Lighting committee, Town Hall, Sunderland, to be delivered at the office of the town clerk (Mr. Fras. M. Bowey) by noon March 2.)

The Corporation of *Durban* (Natal) invite tenders for the supply and delivery at Durban of: 1,900 tons steel girder rails, 64 tons fish plates, the necessary fish bolts, nuts, tie bars, and electric bonds; 407 lots Australian hardwood stringers, with the necessary dog spikes. An advertisement contains further particulars, and specifications, &c., can be obtained on application to the agents to the Corporation (Messrs. Webster, Steel and Co.), 5, East India-avenue, Leadenhall-street, London, E.C. Sealed tenders (in duplicate) must be delivered to Messrs. Webster, Steel and Co., by Thursday, March 8, or to the town clerk, Durban, by mail delivery, on or about Monday, April 2.

The *Wigan* Electric Light and Tramway department invite tenders for the supply and delivery of 3,000ft. of 2in. and 3,000ft. of 1½in. gas barrel. Tenders must be addressed to the chief electrical engineer (Mr. H. Collings Bishop), Bradford-place, Wigan, by Saturday, 24th inst.

The *Poplar* (London) District Board of Works invite proposals for the fitting up of consumers' premises for the electric light free of initial cost to the board or the consumer. Some particulars are set out in an advertisement, and all further information can be obtained from the electrical engineer (Mr. Alfred Blackman), Electricity Works, Glaucus-street, Bromley-by-Bow, London, E. Schemes must be lodged with the clerk to the board (Mr. Leonard Potts), 117, High-street, Poplar, London, E., by March 1.

The *Farnworth* Urban District Council invite tenders for the supply and erection of (1) Lancashire boilers, economisers, condensing plant, feed pumps, steam exhaust pipes, &c.; (2) three 120-kw. steam dynamos; (3) lighting switchboard; (4) traction switchboard; (5) accumulators; (6) underground cables; (7) travelling crane; (8) re-cooling tower. Specification, &c., can be obtained from the consulting engineers (Messrs. Lacey, Clirehugh and Sillar), 2, Queen Anne's gate, Westminster, S.W., and 78, King-street, Manchester. An advertisement gives further particulars, and tenders must be delivered to the clerk (Mr. David Crossley), Council Offices, Farnworth, Lancs, by March 7.

The *Blackburn* Corporation invite tenders for the supply and delivery of feeder cables. Specification, &c., can be obtained at the offices of the consulting engineers (Messrs. Lacey, Clirehugh and Sillar), 2, Queen Anne's-gate, Westminster, S.W., and 78, King-street, Manchester, after 17th inst. Further particulars are given in an advertisement, and tenders must be delivered to the town clerk (Mr. Robert E. Fox), Town Hall, Blackburn, not later than 28th inst.

Newcastle-upon-Tyne New Tramways committee invite tenders for a 50 ton, a 25 ton, a 6 ton, and a 2 ton electric crane. Tenders to town clerk by noon, March 5.

The *Manchester* Tramways committee invite tenders for the supply and erection of steel roof trusses and girders, cast-iron columns, and other metal work at their electric car shed at Cheetham. Tenders to chairman of committee by 24th inst.

The Electric Light committee of the Vestry of *St. Mary, Newington* (London), require tenders for the supply and erection of two water-tube boilers, feed pump, and sundry extensions to the steam and water mains for the electricity works at Penrose-street. Tenders to clerk, Vestry Hall, Walworth-road, London, S.E., by 20th inst.

The Vestry of *Shoreditch* (London) invite tenders for stores for the electricity department, including electric cables and sundries, engineers' stores, ironmongery, tools, &c., wiring and fittings materials. Tenders to Dr. H. Mansfield Robinson, Town Hall, Old-street, London, E.C., before 3 p.m. 27th inst.

The *Salford* Corporation invite tenders for the supply and erection of electrically-driven mechanical stokers, economisers and fittings, jet condensers and pumps with steam exhaust and water pipes, electrically-driven feed pumps and feed pipes, and travelling crane. Tenders to town clerk (Mr. L. C. Evans) by 10 a.m. 28th inst.

Tenders are invited for the supply of electrical fittings, &c., for the *Norfolk County Asylum*, Thorpe. Tenders to clerk (Mr. P. E. Hansell), The Close, Norwich, by 27th inst.

The *Bournemouth* Corporation require tenders for cables, arc lamps, wiring, &c., for the electric lighting of the pleasure grounds. Tenders by March 3.

The *Aberdeen* Tramways committee invite tenders for the supply of four electrically-equipped tramcars and other material. Tenders to town clerk, Town House, Aberdeen, by noon 28th inst.

The *Gloucester* Corporation invite tenders for wiring the Guildhall, public baths and electricity works, and for supplying the necessary fittings. Tenders to Mr. G. Sheffield Blakeway, Guildhall, Gloucester, by Feb. 27.

The *Rochdale* Corporation invite tenders for the supply and delivery of electricity meters. Tenders to town clerk by 26th inst.

The *Kingston-upon-Hull* Corporation invite tenders for the supply of 35 double motor equipments and 10 car bodies (double-decked) to seat about 51 passengers. Tenders by Feb. 19.

The *Walthamstow* District Council invite tenders for plant for electric lighting of their Isolation Hospital at Chingford. Tenders to clerk by 23rd inst.

The *Birkenhead* Corporation require tenders for feeder and distribution mains. Tenders by March 1.

St. Annes-on-Sea Council require tenders for battery and accessories, meters and demand indicators. Tenders to clerk by 26th inst.

The *Wimbledon* District Council require tenders for 25 incandescent electric lampposts. Tenders to clerk by 26th inst.

The *Prussian* State Railway Authorities invite tenders until the 28th inst. for the supply of 224 tons of telegraph wire, 27,000 insulators, and 4 tons of insulated wire. Particulars from and tenders to Die Königliche Eisenbahn Direction, 7 Joachimstrasse, Hanover.

TENDERS RECEIVED AND ACCEPTED.

The tender of Macartney, McElroy and Co. has been accepted by the Bradford Corporation for the electrical overhead equipment of Listerhills, Stanningley, Whetley Hill and Thornton tramway sections (about 8 miles), at £12,064. 15s. 2d.

The Tunbridge Wells Town Council have accepted the following tenders for the supply of additional plant at the electricity works:—

S. Z. de Ferranti (Ltd.) (400 kw. steam alternator)	£4,677
Klein Engineering Co. (condensing plant)	4,621
Tinkers (Ltd.) (two Lancashire boilers)	3,060

A full list of the tenders sent in appeared in our last issue.

The following tenders have been accepted by the Edinburgh Town Council for the supply of additional generating plant for the McDonald-road station:—

Mather and Platt (steam dynamos)	£12,319
George Sinclair (boilers)	4,800

The tender of Messrs. J. W. Singer & Sons has been accepted for supplying and fixing electric light fittings at St. Mary's Hall, Coventry, at £250. 2s. 6d.

The tender of the British Insulated Wire Co. for the laying of mains has been accepted by the St. Anne's-on-Sea District Council. The tender of Messrs. Crompton and Co. for street arc lighting has also been accepted.

The tender of Messrs. Hughes and Sterling has been accepted by the Morecambe Council for the erection of a refuse destructor.

The tender of the British Thomson-Houston Co. has been accepted by the Croydon Corporation for the supply of a 500 kw. steam alternator.

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The Glasgow Corporation has accepted the tender of the Electric Construction Co. for the supply of electric motors for the elevators on the Pollokshaws-road station at £170. 15s. each.

APPOINTMENTS VACANT AND FILLED.

The Pembroke (Dublin) Urban District Council invite applications for the position of resident engineer to take charge of their electric lighting and refuse destructor works, at a commencing salary of £150 per annum. An advertisement gives further particulars, and applications must be sent to the clerk to the council (Mr. J. C. Manly), Town Hall, Ball's Bridge, Dublin, by 3rd prox.

An assistant is required for the electrical engineering department of the City and Guilds Central Technical College, Exhibition-road, London, S.W. Commencing salary £150, rising to £200 per annum. Applications to Prof. W. E. Ayrton. See advertisement.

A working electrical engineer is required to look after an installation of from 600 to 700 lamps, including about 30 arc lamps and three gas engines. Particulars will be found in an advertisement, and applications have to be sent in to the town clerk, Brighouse, not later than the 27th inst.

Two station assistants, to take charge of shifts, are required for the Leicester Corporation electric lighting department. An advertisement contains further particulars, and applications must be sent to the engineer and manager (Mr. Alfred Colson), Gas Offices, Leicester.

An assistant demonstrator is required for the physical laboratory of the East London Technical College. Applications to treasurer.

A temporary architectural assistant, with experience in the preparation of plans for electric power and tramway stations, is required at Southend-on-Sea. Applications to borough engineer.

The Shoreditch Electric Lighting committee require a clerk of works to superintend the construction of two sub-stations. Applications to surveyor, Town Hall, Old-street, London, E.C., by Feb. 19.

A first-class electrical engineer is required for the Glasgow Corporation tramways. Applications to manager of tramways department (Mr. John Young), 88, Renfield street, Glasgow, before Feb. 24.

The Manchester Tramways committee require an assistant permanent way engineer. Applications (addressed chairman of committee, Town Hall, Manchester) by Feb. 24.

Barrow-in-Furness requires a mains superintendent. Applications to chairman of Electric Lighting committee by noon Mar. 7.

The Brush Electrical Engineering Co. (Ltd.) announce the following appointments:—Mr. C. S. Thomson to be superintending engineer in charge of lighting and power contracts; Mr. E. H. Tyler to be traction engineer in charge of traction contracts; and Mr. A. P. Hasham to be in charge of the estimating department.

Mr. W. Y. Legge has been appointed electrician-in-charge at the Southport Corporation electricity works. Mr. Legge has been for five years with the Halifax Corporation.

Mr. George F. Pilditch has been appointed by the Council chief engineer of the Rathmines electricity works. From the commencement of the work Mr. Pilditch has acted as superintendent on behalf of Mr. Robert Hammond, the consulting engineer.

Mr. K. O. Hole has been appointed architectural and engineering draughtsman in the electrical engineers' department, Bristol, at a salary of £200, rising by annual increments of £30 to £290 per annum.

BUSINESS NOTICES.

Messrs. Frank Monkhouse and Thompson Gradon, the younger, electrical and general engineers, 118, Pilgrim-street, Newcastle-on-Tyne, have dissolved partnership. Debts by Mr. Gradon, who continues.

The Preston Electric Co. notify that, after March 25, their business will be removed to 12, Seymour street, Belgrave-street, Birmingham.

BANKRUPTCIES, LIQUIDATIONS, &c.

W. P. Durtnall, 24, Kingston-road, Ilford, E. R. H. Gudgeon, 72, Dundonald-road, Wimbledon, and Hubert Sadler, King's Arms Hotel, Kew Gardens, trading as electrical engineers at 85, Finsbury-pavement, London, E.C., under the style of E. H. Gudgeon and Co., have executed a deed of arrangement. Mr. P. Mason, 64, Gresham-street, London, E.C., is trustee. Liabilities £599. 5s. 3d., assets £677. 11s. 7d.

It has been resolved to wind up Cuttriss, Walliss and Co. (Ltd.) voluntarily. Mr. J. W. Close, 7, Greek-street, Leeds, is liquidator.

Application for the discharge in bankruptcy of E. L. Joseph, electrical engineer, Northampton Works, Northampton-grove, London, N., will be heard on March 1, at Bankruptcy-buildings, London, W.C.

J. H. Douglas Willan was examined at the London Bankruptcy Court last week. Debtor is described as of 16, St. Helen's place, London, E.C., and to be interested in the Stern and Bowen electric lamp patents, one of which has run out. Debtor describes the remaining patent (the Bowen) as being worth £500,000. and his share as one-fifth interest therein. Liabilities £12,000 Examination adjourned.

A first and final dividend of 5d. is payable by the trustee (Mr. E. H. Hawkins), 3, Barbican, E.C., on 16th inst. in the failure of A. G. Inrig, electrical engineer, lately trading at White Post-lane, Victoria Park, London, E., as the Globe Electrical Co.

A first and final dividend of 11½d. is payable on 19th inst., at 174, Corporation-street, Birmingham, in the bankruptcy of Thomas Ford (trading as Thomas Ford and Co.), electric fittings manufacturer, &c., Victoria Works, Emily-street, Birmingham.

Sale by Auction.—Particulars will be found in an advertisement of an unreserved sale by auction by Mr. J. A. Y. Matthews, on Wednesday and Thursday, March 7 and 8, of the valuable nearly new fixed plant and machinery at the North Wilts Engineering and Electrical Works, Swindon, Wilts. The plant, in addition to a large stock of engineers' tools, includes a quantity of electric lighting appliances and other machinery and apparatus, a portion of which is detailed in the advertisement. All further information and copies of the catalogue (which will be ready shortly, price 6d.) can be obtained from Messrs. Townsend, Jones and Wood, solicitors, Swindon, or at the auctioneer's offices, Park House, Swindon. The sale commences each day at 11 a.m.

Plant for Sale.—Messrs. Albright and Wilson (Ltd.), Oldbury, near Birmingham, have for sale three Babcock-Wilcox boilers and a Crompton steam dynamo. See advertisement.

Patent Amendment.—Mr. William Ernest Burnand, Club Garden Walk, Highfield, Sheffield, has applied for leave to amend specification of letters patent 26,723 (1898) for "New or improved device for indicating the frequency of an electric current or currents, &c." Particulars of the proposed amendment are set out in the *Illustrated Official Journal (Patents)* of 7th inst., and notice of opposition must be given within one calendar month from that date.

Parcels Post to America.—Truly American enterprise is phenomenal. It is announced that there is an outside possibility that the United States will enter into a parcels post arrangement with this country shortly, the correspondence on this subject having extended over a period of no less than 14 years. At the present time the United States shares with Corea the honour of being the only place in the civilised world to which the parcels post is not available.

Presentation.—On Friday last Mr. J. S. Highfield, chief engineer of the St. Helens Corporation lighting and traction station, was presented by the staff with a handsome tantalus as a token of esteem and good wishes on the occasion of his marriage. The presentation was made by the chief assistant (Mr. E. M. Holingsworth).

The "Journal."—Part 142 of the *Journal* of the Institution of Electrical Engineers is now ready, price 3s. 6d. The contents are set out in an advertisement.

Hart Accumulators.—A very complete battery catalogue is issued by the Hart Accumulator Co. (Ltd.), of Stratford, London, E. The information given includes complete instructions for erecting Hart batteries, a general plan of the arrangement of batteries and connections, and the price of the various types supplied by the company. The particulars given apply to both lighting and traction cells, and the whole forms a useful and compact handbook for the use of contractors and users of this class of apparatus. A special list of complete batteries capable of maintaining a small number of lamps for different periods of time is given on p. 18 of the list.

"Willing's Press Guide."—Messrs. James Willing (Ltd.), of 125, Strand, London, W.C., forward the 1900 edition of "Willing's Press Guide." We have in past years favourably reviewed this annual publication, and it is only necessary on this occasion to say that we regard it as the handiest and most complete directory published to the press of the United Kingdom. The published price is 1s., and certainly no office library is complete without it.

Fire Risks.—In the forthcoming revised edition of the fire risk rules and regulations of the Liverpool and London and Globe Insurance Co. it is prominently announced that in all ordinary, non-hazardous risks (such as office premises, dwelling houses, and the like), installations which have been fitted to conform to the general rules of the Institution of Electrical Engineers, or to the detailed regulations of electrical supply authorities, will be allowed by the company, without alterations being required, at current rates. The following are indicated as the principal sources of fire loss, according to the company's experience:—

1. Fusible cut-outs without proper covers to retain the highly-heated fused metal, and the replacing of fuses situated over combustibles whilst the current is "on."
2. Resistance coils not sufficiently isolated from combustible materials.
3. Want of spacing apart of unenclosed conductors from each other, or from gas pipes or other earthed metal work.
4. Use of corrosive fluids, in jointing conductors, in place of resin.
5. Loose or otherwise imperfect connections, especially at switchboards.
6. Arc lamps with broken globes.

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7. Sparks from unenclosed and badly placed motors and dynamos.
8. Unguarded incandescent lamps arranged in contact with flimsy goods in show windows.
9. Straying currents of dangerously high potential, through accidental contacts, as between telephone wires and trolley wires.

At the back of the form now sent by the Guardian Fire Office to wiring contractors asking for particulars of electrical installations they have carried out, it is included among other "memoranda":—

Conductors.—Their conductivity and insulation should conform with the rules of the Institution of Electrical Engineers of current date.

Current Density.—This must not exceed the table of maximum currents attached to the above-mentioned rules.

It is to be hoped that this is the thin end of the wedge, and that by the time the Institution has evolved its new set of rules its code will be adopted *in toto* by all the fire insurance companies.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Feb. 7 to Feb. 13, with the ports of destination:—

Africa—Cape Town, £2,188 (including £899 telegraph material); Durban, £767; East London, £217; Port Said, £57. *Australasia*—Auckland, £40; Brisbane, £119 (telegraph material); Hobart, £25; Melbourne, £10; Otago, £134; Rockhampton, £1,249 (including £1,195 telegraph poles); Townsville, £148; Wellington, £31. *Belgium*—Ostend, £20. *Ceylon*—Colombo, £742 (including £467 telegraph material). *Denmark*—Copenhagen, £35 (telegraph cable). *France*—Rouen, £74. *Germany*—Hamburg, £615 (including £400 telegraph material). *Holland*—Amsterdam, £60; Rotterdam, £60. *Hong Kong*—£509 (including £43 telegraph material). *India*—Calcutta, £1,551; Madras, £101. *Italy*—Leghorn, £12. *Japan*—Yokohama, £5,593 (including £328 telegraph paper and £105 telegraph material). *Norway*—Christiania, £58 (including £48 telegraph wire). *Siam*—Bangkok, £27. *Straits Settlements*—Penang, £287 (telegraph material); Singapore, £21,044 (including £21,000 telegraph cable). Total £35,773, against £11,472 in the corresponding week last year (Feb. 8 to 14).

MUNICIPAL, FOREIGN, AND GENERAL NOTES.

Bath.—The accounts of the electricity department will be presented at the next meeting of the Corporation. There is a gross profit for the past year of £2,165, and after allowing for interest and sinking fund a net deficit of £1,937, including the adverse balance of £125 brought forward, and the Council are recommended to make provision for the payment of this sum in the next estimates.

Beverley.—The Council have engaged Mr. A. H. Gibbings to prepare a report upon electric lighting matters.

Bradford.—The Corporation on Wednesday adopted the recommendation of the Electricity committee to appoint Mr. R. A. Chattock as borough electrical engineer, in place of Mr. A. H. Gibbings resigned.

Cardiff.—Visits are to be made by a Tramways sub-committee to the electric tramways at Liverpool, Glasgow, Hull and Bradford, in order to collect information as to the most suitable form of traction for the local tramways. An electric traction engineer is to be appointed at a commencing salary of £500 per annum.

Chatham.—The electric light has recently been installed in the Town Hall and municipal buildings at Chatham by Messrs. Stevens and Barker, of Maidstone. Current is taken from the mains of the Chatham, Rochester, and District Electric Lighting Co. A large number of handsome fittings specially designed to harmonise with the building have been manufactured by the Edison and Swan Co. for this installation, the whole being in polished brass. The Edison and Swan Co. also designed and manufactured the fittings for the Town Hall at Blackpool.

Chesterfield.—Application has been made for sanction to a loan of £25,000 for electric lighting purposes. The contract for the erection and complete equipment of the generating station has been provisionally let to the Westinghouse Co., at £25,000.

Church Lighting.—St. Andrew's Church, Plymouth, has been provided with an electric lighting installation of about 300 16 c.p. incandescents.

Colne.—The borough electrical engineer (Mr. A. G. Cooper) has been instructed to prepare plans and estimates for the erection of electricity works.

Competitive Traction.—At the half-yearly meeting of the Great Northern Railway Co. the chairman (the Right Hon. W. L. Jackson, M.P.) in explaining a decrease of about 127,000 in the number of passengers carried in Yorkshire, said that this was due entirely to new competition by electric tramways, which were now being run by local Corporations in their Yorkshire district.

Country House Lighting.—A well-printed and nicely-illustrated pamphlet of about 50 pages is just issued by Messrs. E. Scott and Mountain (Ltd.), Close Works, Newcastle-upon-Tyne, entitled "Electricity in Country Houses." The illustrations have been specially designed to show the interiors of a number of country seats where the electric light has been installed, and in some cases where plant for power has been supplied for domestic purposes. The illustrations are particularly attractive, some of the views being especially fine. We are asked to state that copies of this brochure will be sent to anyone interested in the subject of country house lighting.

Customs Duties.—Under the latest British Indian valuation tariff a duty of 5 per cent. ad valorem is fixed for electric, electric light, galvanic, scientific, telegraphic and telephonic instruments, apparatus and appliances and parts thereof, except in the case of telegraphic instruments and apparatus and parts thereof imported by or under the orders of a railway company, or when such instruments, apparatus, &c., are imported by a a passenger as part of his personal luggage for the actual use or exercise of his profession or calling, in both of which latter cases these articles are admitted into India free of duty.

Electrical conductors imported into Portugal are dutiable as "metallic wire" (under Art. 557 of the Portuguese tariff), which is equal to 9s. 2d. sterling per cwt., or 40 reis per kilog. Dynamos and fittings therefor are dutiable according to the predominating material used therein.

The new Spanish tariff for incandescent electric lamps, mounted or unmounted, is equivalent to 2d. per lamp; voltaic arc lamps, electric meters, switches, and similar apparatus, £4. 1s. 4d. per cwt.; telephone apparatus and separate parts of same, £3. 1s. per cwt. These goods have not hitherto been specially tariffed. Electric and other motors and boilers for steam motors will be dutiable at 7s. 4d. per cwt. on the expiry of the Commercial Convention with Switzerland. Until this event happens the duty is 6s. 11d. per cwt. In similar manner, electrical conductors will have to pay a duty of 8s. 2d. per cwt., against 7s. 6d. at present.

Dunmanway (Cork).—A proposal has been made to light this town electrically, and a committee of the leading ratepayers has been formed in order to formulate a scheme, Mr. J. W. Young acting as secretary.

Edinburgh.—At the Council meeting on Tuesday the convener of the Electric Lighting committee (Bailie Mackenzie) made a statement with reference to the cost of electric lighting in the city. In order to satisfy those who had expressed a fear that undue capital expenditure was going on in regard to the electric lighting undertaking, he had prepared a statement of comparison with other similar large undertakings. The last published accounts showed that up to May last they had expended £395,356, and had the equivalent of 226,740 8 c.p. lamps connected, a capital expenditure equal to £1. 15s. per lamp. Glasgow at the same time had spent £339,782, with 139,772 lamps connected, or a capital expenditure of £2 8s. per lamp. Dundee showed an expenditure of £1. 13s. per lamp; Aberdeen, £1. 14s. 6d.; Manchester, £2; Liverpool, £3. 4s.; Leeds, £2. 18s.; Birmingham, £2. 10s.; Sheffield, £3; Dublin, £2. 14s.; Belfast, £2. 8s.; Brighton, £2. 4s. The London companies show an expenditure as follows: City Co. (the largest in the country), a capital expenditure of £3. 18s. per lamp; Metropolitan Co. (next largest), £2. 12s.; Westminster Co., £2. 6s. None had a smaller expenditure per lamp than Edinburgh. He hoped these figures would reassure the members of Council that the work in Edinburgh had been done economically and, notwithstanding a few slight interruptions, efficiently. They now proposed to get two steam dynamos of 1,200 H.P., similar to the four obtained last season from the same makers (Messrs. Mather and Platt), but at an increased price of 5 per cent. over last year's prices in consequence of increased cost of material. Four new boilers were also wanted, and these were recommended to be got from Mr. Sinclair at a cost of £4,800, an increase of £100 per boiler over last year, but still the cheapest offer. Both boilers and dynamos would be working in September, and no part of the price was to be paid until they are in full operation. The additional machinery would carry them comfortably over the winter of 1900-1901, after which time, if the demand continued as at present, no doubt more plant would be added, for which ample room was provided at the McDonald-road station.

For the Front.—Mr. C. C. Fowler, assistant manager of the Brighton electricity department, having volunteered for service in South Africa, a motion was made at the Corporation meeting last week that he should be paid half-salary during his absence, but an amendment, that he be granted leave of absence without pay, and that on his return his salary be increased on the scale to which he would be entitled had his services been continuous, was carried.

At a meeting of the West Ham Council on Tuesday the Electric Light committee reported that an assistant in the electrical engineer's department had volunteered to join the Electrical Engineers (R.E.) Volunteers who were going out to South Africa, and they proposed that his situation should be kept open. This was approved.

Govan.—The Burgh commissioners have fixed the following terms for the supply of current for lighting stairs: 6 c.p. lamp £1. 5s. per annum, 8 c.p. £1. 7s. 6d., 16 c.p. £1. 17s. 6d. The hours of lighting are to be the same as those in Glasgow.

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Gravesend.—The adoption of a municipal scheme of electricity supply was approved at a meeting of the Gravesend and Northfleet Tradesmen's Association last week.

Great Malvern.—The Council apparently have no intention of immediately carrying out the terms of their provisional order (obtained as far back as 1890), as it has been resolved to ask the Board of Trade to extend the order for a further term of three years, and failing this to allow the Council to transfer the order to a company.

Hartlepool.—The borough engineer has been instructed to prepare an electric lighting scheme.

Huddersfield.—The foundation stone of the tramway power station at Longroyd Bridge was laid on Tuesday by Ald. A. Haigh, chairman of the Tramways committee. It is intended to have the first electric cars running by August along Manchester-road, Buxton-road, New-street, to St. George's-square, Marsh, Edgerton, Lindley, Salendine Nook, and Outlane, to Lockwood, and to Linthwaite and Slaithwaite, about 11 miles of tramway.

Lancashire Electric Power Scheme.—At a meeting on Tuesday of representatives of the urban district councils in Lancashire affected by this scheme, it was resolved to oppose the bill in order to secure protective clauses being inserted. A committee was appointed to formulate and carry on the opposition.

Leamington.—In a report presented on Tuesday to the Town Council the Electric Light committee stated they were not in a position to make a recommendation as to the purchase of the undertaking of the Midland Electric Light and Power Co. It will be remembered that the Corporation obtained a provisional order last year, to come into force only if they offer to purchase the company's undertaking within 12 months from the date of the confirmatory Act.

Leigh.—The town hall is to be lighted electrically.

Leith.—The salary of the burgh electrical engineer (Mr. W. A. Bryson) has been raised from £300 to £400 per annum.

The Leith Dock Commissioners have decided to put down independent generating plant for the electric lighting of the docks.

Light Railways.—An inquiry was held at Gloucester, on Monday, into the application by the Gloucester Tramway Co. for power to take up the present tramway, lay down new lines, and substitute a light railway, the motive power to be electricity. Mr. Coward, for the promoters, said the cost of the undertaking would be about £95,000. There was no opposition, and the application was granted.

An extension of the projected Warrington and Northwich light railway is to be made, in order to meet the wishes of the parish councils of Barnton, Anderton, Little Leigh, and Winnington. The consulting engineer (Mr. R H. Scotter) has already surveyed the route of the proposed extension.

At a recent meeting of the St. Margaret's (Dover) Parish Council, Mr. M. Parker, the resident engineer to the Cinque Ports Light Railway, gave particulars of the scheme. The railway (he said) was practically a continuation of that in course of construction between Ramsgate and Birchington, with which the Cinque Ports Light Railway proposed to make a connection, and the new line would be a continuation of the Thanet one. The proposed Cinque Ports lines would run from Ramsgate to Sandwich, and then follow the coast into Deal through Walmer, Kingsdown, and Oxney Bottom, meeting the St. Margaret's-road at Cliffe-place. The line would meet the main road near Pearson's railway, and follow the main road to Dover, from whence it would proceed from the Folkestone-road towards Hastings. Mr. Parker gave details of the local service, fares, &c. The estimated cost of the entire undertaking was £800,000, and the company would have a capital of at least £900,000. Application had been made to the Dover Corporation for sanction for running powers over their line, the Dover Corporation receiving 1d. for every passenger carried over their lines. The Dover Electricity Supply Co. would supply electric current from Dover to St. Margaret's and from Dover to Folkestone. Between St. Margaret's and Ramsgate they proposed having a generating station at Sandwich. They would also have a station at Rye to supply current between Folkestone and Hastings. The steepest gradient on the route was 1 in 8. The Council eventually decided that, provided arrangements could be made for widening the road through the village, no opposition should be offered to the scheme.

The Cheltenham and District Light Railways Extension order has been submitted to the Board of Trade for confirmation, and objections must be lodged by March 7.

Liverpool.—A service of electric cars from Aintree, at the north end of the city, to Aigburth-street, at the south end, commenced on the 11th inst. The journey covers a distance of about eight miles, the distance being covered in from 40 to 45 minutes.

London County Council.—At Tuesday's meeting the following electricity loans were agreed to: Hammersmith £44,548, Whitechapel £3,000.

The Parliamentary committee recommended that no petitions be presented against the following bills in Parliament: City and South London Railway, London United Tramways (Extension), North Metropolitan Electric Power Supply. The committee recommended that petitions be sealed, and if necessary presented, against the following bills: Baker-street and Waterloo Railway, Brompton and Piccadilly-circus Railway, Charing Cross, Euston and Hampstead Railway, Metropolitan District Railway, Charing Cross and Strand Electricity Supply Corporation, City of London Electric Lighting Co., and County of London Electric Lighting Co. The same committee reported that progress with the London County Tramways Bill was delayed because several of the road authorities, whose consent to the bill was necessary, had not yet given such consents.

The question of the Council's relations with the National Telephone Co. was then referred to on a report from the Highways committee, which said that the company had not obtained a licence from the Postmaster-General to place its wires underground. It had, notwithstanding, carried out works at certain places, in some cases with, and in some without, the permission of the road authorities concerned, but it had not obtained the consent of the Council to these works. The committee had now to state, for the information of the Council, that they had directed the solicitor to take proceedings against the company for having infringed the provisions of the Telegraph Acts in this respect. Mr. BEECHCROFT said it looked as if matters telephonic would remain at a deadlock for twelve years. He would like to know if there had been any further communication from the National Co.? Mr. BENN said the committee had received a letter from the company that day traversing the statements made in the committee's report. On a statement in the report "That if the company had, in the course of the negotiations which had taken place, been ready to give terms to London similar to those given to several provincial cities and towns, the matter could have been settled so far as London is concerned, and that even in that event, the assent of the Council would have been of no avail unless the company should have first obtained a licence from the Post Office," Mr. Gaine, the writer of the letter referred to, said:—

> I think it right that I should state at once, on behalf of the National Co., that I am prepared to prove to demonstration that the statement contained in my circular is strictly in accordance to the facts—that the company has always been willing to consider terms to London *ejusdem generis* with those conceded to provincial towns, and that the Highways committee is fully aware that the Post Office is under express covenant to give to the company the licence they refer to whenever called upon by the company to do so. The position of the negotiations is at present in a nutshell. The company has offered that if the County Council will consent to its putting its wires underground it will supply a service at the same price and on the same terms as the Post Office, and the Highways committee has asked in addition that the company shall give free intercommunication between its London subscribers and the subscribers of the Post Office. This demand is impossible of acceptance. I see that the Highways committee state that my circular was sent to something like 15,000 persons in London. As a matter of fact, it was sent to a much larger number; the number of the company's exchange telephones in London being now just 30,000.

Mr. BENN (continuing) said that while Mr. Gaine said the company was willing to supply on the same terms as the Post Office, they did not know what the terms of the Post Office would be; and it was obvious that when the Post Office started competing the company would have to come down in price. By the proposals of the Government they were deprived of the opportunity of having a municipal service, but they considered it their duty to support the Post Office, and insist on a free intercommunication with the Post Office. The company had tried to get rid of the effects of their own miserable mismanagement by putting it on to the Council, and it was an episode which did not redound to the credit of any decent undertaking. Mr. ROBINSON said the company were asking the local authorities to allow the wires to be placed underground and permission was being freely granted. Mr. BENN said that was quite true. With regard to the company, it was a fact that the dividends on its watered capital was paid by London. Mr. WESTACOTT said that while the Council and the company were quarrelling the users of the telephone were suffering. If they were to dictate terms to the company, why did the Council object when the local road authorities asked for terms to allow the roads to be used for the Council's tramways? Something ought to be done to put an end to such a disgraceful state of things. Mr. FLETCHER called attention to the danger of overhead wires, and asked if the committee could not fight the battle with the company on some other point. After Mr. WEBB had made a robust attack on Sir James Ferguson and Sir Henry Fowler for connecting themselves with such a monopoly, and the National Telephone Co., the unprofitable and not particularly dignified discussion terminated.

Morecambe.—The Local Government Board have sanctioned the borrowing of £4,000 for the purchase of land for technical schools, electric lighting, &c., but an application for a further loan of £24,000 for electric lighting extensions has been refused, on the ground that the Council have already reached the limit of their borrowing powers. A sub-committee has been appointed to report upon the financial position of the Council.

Motor Vehicles.—An interesting report by Mr. G. W. E. Higgens, A.M.Inst.C.E., surveyor to the Vestry of Chelsea, London, has recently been presented to that body. Mr. Higgens deals exclusively

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with steam vehicles, but the report is an interesting one from many points of view.

M P.—Mr. W. Mather, senior partner in the firm of Mather and Platt, was elected Member of Parliament for the Rossendale division of Lancashire on Tuesday last. Mr. Mather is a governor of Owens College, Manchester, and is chairman of the Castner-Kellner Alkali Co. Mr. Mather has previously sat in Parliament as member for the Gorton division of Lancashire, but retired in 1895. He is prominently associated with the technical education movement in Lancashire and the Midlands.

Municipal Telephony.—The Manchester Special Telephone committee have resolved that it is desirable that the telephone service in Manchester should be municipal, and immediate steps are to be taken to ascertain the best method of carrying this resolution into effect.

Newcastle-on-Tyne.—The Lighting committee have reaffirmed the principle of lighting the chief thoroughfares in the city electrically. This will cost a little more than gas lighting, but the Corporation will get 180,000 c.p., instead of the present 72,000 c.p. A deputation visited Leeds to examine the system of electric lighting there.

Pacific v. All-British Cable.—A report from Governor Sir C. B. H. Mitchell to the Colonial Office, dated October 25th last, deals with the Christmas and Cocos-Keeling Islands and discusses a report by Mr. A. S. Baxendale, superintendent of posts and telegraphs at Selangor, who was appointed commissioner to pay the annual visit to these islands in 1899. Interesting particulars are given of the population and the work being carried on there. The most important commercial enterprise at Christmas Island is that of the phosphate company, which owns about 4,500,000 tons of phosphates. The inhabitants of Christmas Island speak highly of its pleasant and salubrious climate, the temperature seldom rising above 83°F. in the shade. One of the Cocos-Keeling group is known as Direction Island and the report states that the Eastern Extension Telegraph Co. has made application to Mr. G. C. Ross, owner of the islands, for sanction to land a cable, and it is possible, although, we believe, not definitely settled, that Direction Island will be selected for this purpose. It is probable (the report continues) that not only the Eastern Extension Co., but other cable companies anxious to adopt the Indian Ocean route, will use the most suitable of the Cocos Islands as landing places for their cables. Following are Mr. A. S. Baxendale's notes on the subject of the all-British *versus* the Pacific cable :—

There can be no doubt that in many ways an all-British route through the Indian Ocean would be incomparably superior to the proposed Pacific cable. The following are the advantages that would be possessed by the former route :—

(*a*) India would be connected by an all-British cable.

(*b*) The greater part of the line of communication would require no special patrol by Her Majesty's vessels in time of war.

(*c*) The cable ships of several telegraph companies would be available.

(*d*) The theoretical speed on any of the cables, if nothing heavier than a 400lb. core was used, would be 20 words a minute (simplex), against a theoretical 10·7 words a minute, with an 800lb. core, on the Pacific route.

(*e*) It is probable that even without a subsidy a cable connecting Zanzibar with India, Australia, and Java, by way of Seychelles, Chagos, Cocos, and Christmas Islands, would become a commercial success, if worked in conjunction with the African trans-continental line. If the tariff from Europe to Zanzibar was 1s. 3d., the rate to India might be lowered to 2s 3d., to Java 3s., and to Australasia from 3s. to 3s. 6d. It would not require a heavy subsidy to arrange that the Seychelles should be connected by an all-British route with England *via* the Cape.

Pacific Cable Scheme.—Reuter states that the Inter-State and Foreign Commerce committee of the United States House of Representatives has decided, by eight votes to five, to report the Pacific cable bill, after rejecting a proposal for Government ownership of the cable.

Pembroke (Dublin).—A settlement of the dispute with the Tramways Co. has been arrived at by the Council. The Master of the Rolls recently granted an interlocutory injunction prohibiting the laying of conduits outside the company's paved parts of the roads. The present agreement provides that the injunction shall be made perpetual ; that the conduits already laid shall be taken up, if found to interfere with the works of the Council, the question as to whether they do or do not so interfere to be submitted to arbitration, and all the costs to be paid by the company.

Portugal.—In a report on the trade of Portugal for the years 1897-98 it is stated that, of the considerable increase in the value of imported apparatus, utensils, &c., into Portugal during 1898 over 1897, a noticeable feature is the importation of electric light apparatus, &c., valued at £5,500 in 1898, compared with £3,200 in 1897. The principal supplies of this apparatus, &c., are drawn from the United Kingdom.

Post Office London Telephone Exchange.—In the House of Commons, on Friday, Mr. Hanbury, replying to Mr. Provand, said that the tariff and regulations for the Post Office London telephone exchange system were practically complete, but until the work of constructing the main system was also complete it had been thought better not to publish details.

Private Bill Legislation.—The Hastings Tramways Co.'s Bill seeks powers to construct nearly 11 miles of electric tramway within the borough, and to make a connection with the Bexhill and St. Leonards light (electric) railway authorised in 1899. The capital of the Hastings company is to be £300,000 (£200,000 in ordinary shares, and £100,000 as preference), with authority to create £100,000 debenture stock. Power is also sought to take over the Bexhill and St. Leonards Light railway order (1899). The first directors are Messrs. W. M. Murphy, J. Barber Glenn, A. J. Salter, and J. S. Gardner.

The bill of the Poole and District Electric Traction Co., seeks powers to construct three sections of electric tramway of an aggregate length of nearly eight miles. The tramways will be worked electrically, and the generating station is to be erected at Christchurch. A clause in the bill prohibits the local authorities from exercising their statutory right of purchase until after 35 years. The bill also proposes to amend the law by enacting that the terms upon which the company may be required to sell its undertaking shall be only on payment of a fair market value as a going concern, but without allowance for compulsory purchase.

In the bill of the Whitechapel and Bow Railway Co., power is sought to raise £300,000 additional share capital and £100,000 in loans, and the Metropolitan District and the London, Tilbury and Southend Railway Co's. are to be empowered to subscribe for the capital. It is asked that the time originally granted for the construction of the railway shall be extended from August, 1902, to August, 1904.

Pudsey.—The Council have resolved to erect refuse destructor works, and it is probable that an electricity supply scheme will be carried out in conjunction therewith.

Reigate.—A difficulty has arisen in connection with the purchase of land for the site of the electricity station, and the Local Government Board refuse to sanction the necessary loan in consequence of a clause in the transfer deed against the carrying on of a noxious or offensive trade. The opinion of counsel (Mr. Asquith, Q.C.) has been obtained, and this has been forwarded to the Local Government Board. According to the opinion of the electrical engineer (Mr. F. H. Medhurst) the works would not involve the carrying on of a noxious or offensive trade, and the committee therefore think that there is nothing in the transfer deed which would prohibit the laying down of an electrical installation on the sandpit site bought by the Council.

Salford.—The work of constructing the tramway on the overhead system was commenced on Friday last.

Sevenoaks.—A deputation has been appointed to visit various electricity supply works, and to report to the Council upon the question of municipal electricity supply.

Sheffield.—In presenting the minutes of the Electric Light committee at the Corporation meeting on Wednesday, Ald. Styring made a statement as to the working of the electricity department last year. The total revenue was £23,342, against £19,038 in 1898, and the cost of production £9,021, compared with £6,334. The gross profit amounted to £14,321, and in 1898 to £12,703. Interest on loans absorbed £9,409, and sinking fund contribution £3,996. This left a net profit of £914, and as they began with £1,330 in hand, they had a surplus of £2,244. There was an increase in the number of units sold, compared with 1898, of 35·9 per cent., and in the number of lamps connected of 34·8 per cent. The minutes were approved.

Sleaford.—A report from a second electrical expert on the question of establishing electricity supply works is to be obtained.

South Shields.—At last week's meeting of the Town Council an estimate amounting to £36,750, was submitted by Mr. J. A. Jeckell, the borough electrical engineer, in respect of the supply of additional plant, mains, &c., for the Council's electricity undertaking. These estimates were sanctioned, and it was authorised that application should be made to the Local Government Board for power to borrow the necessary moneys. The work is to be put in hand forthwith. The total is made up as follows :—

Circulating pump	£650
Pipes and connections for pump	1,000
Girders and fixing pump	150
Sub-station	250
Switchboards for sub-station	300
Transformers	2,400
High-tension and low-tension cables	20,000
Pipes and trenches	9,000
Connecting up consumers	3,000

Smoke Nuisance.—At the Marylebone (London) Police-court, on Wednesday, the Metropolitan Electric Supply Co. were summoned for failing to comply with the provisions of an order made in August, 1898, in respect of the abatement of the smoke nuisance. Defendants urged that no breach of the order had been made. It was impossible to construct a furnace to consume the whole of the smoke when bituminous coal was used. They contended that the nuisance had been abated, that they had fitted their furnaces with Gregory's

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air injector and smoke consumer, a system which the complainants themselves (the Marylebone Vestry) had in use at their baths and washhouses, and had used, when possible, Welsh coal. The magistrate (Mr. Curtis Bennett) said defendants possessed a lucrative monopoly, and must so conduct their business as not to create a nuisance to other people. Penalty imposed, 20s. with £2 2s. costs on each of the nine summonses—total, £27 18s.

Swansea.—Application is to be made by the Corporation to the Light Railway Commissioners for authority to construct extensions to the tramway system. These extensions include all the proposals of the local tramway company which were recently rejected by the Light Railway Commissioners owing to the opposition of the Corporation. Powers to construct a light railway to Port Tennant and other additional lines are also to be sought.

Taunton.—The statement of accounts of the electricity department for the past year was presented and approved at the Council meeting on Wednesday. These show a net profit of £603 on the year's working. After paying working expenses, interest and sinking fund, with the balance of £794 from the 1898 account there was a surplus of £1,398 to be disposed of; and the committee recommended that £904 be placed to renewal account, £300 to go towards the reduction of the general district rate, £160 for the payment of temporary loans, and the balance (£94) to be carried forward. It was also decided to promote a presentation to the chairman of the Electric Lighting committee (Ald. Potter) in recognition of his efforts during the last seven years to put the electricity undertaking on a sound financial basis.

Telephone in London.—The Works committee of the Strand Board of Works has reported on letters from the Postmaster-General, the National Telephone Co., and the London County Council. The correspondence arose over the National Telephone Co.'s request to be allowed to construct telegraphs in the Strand district. The Postmaster-General points out that the company commits a nuisance and is liable to prosecution for disturbing any thoroughfare, notwithstanding that consent of the local authority has first been obtained; and the County Council also put their spoke in the company's wheel. The committee recommended that the Board decline to take sides, and that the National Co. be informed that the Board of Works offers no objection to their proposal to lay cables underground where it seems more expedient than to increase the number of overhead lines.

Tiverton.—Mr. W. P. Adams has been appointed consulting engineer to prepare an electric lighting scheme for the borough. In the event of the scheme being adopted, he will be engaged by the Council to carry out the work, and the fee of £21 for the report is to be merged in the commission—3 per cent. on the outlay and £20 for travelling and hotel expenses. The borough surveyor (Mr. Siddalls) is to receive 2 per cent. on the outlay for the extra work which would devolve upon him and for the preparation of the preliminary report.

Tonbridge (Kent).—A lengthy discussion took place at the last meeting of the Urban District Council on the proposal to establish electricity supply. The proceedings occupied about two hours. About three years ago a provisional order was obtained by the Council and Mr. F. H. Medhurst was engaged to make a preliminary report at a fee of 20 guineas. The matter proceeded no further at that time. In the early part of 1899 Mr. Robert Hammond visited the town and lectured to the Ratepayers' Association upon the advantages of the electric light for a town like Tonbridge. Subsequently the Electric Lighting committee recommended the appointment of Mr. Hammond as consulting engineer, but the remainder of the Council (in the absence, it was stated, of the majority of the members of the committee), decided to appoint Mr. Medhurst as consultant. This led to a somewhat acrimonious correspondence between Mr. Hammond and Mr. Medhurst. Upon this correspondence, which was read at the last meeting of the Council, the Electric Lighting committee made the following report:—

> A full meeting of the committee has considered the correspondence read to the Council at its last meeting, and has also considered the terms upon which Mr. Medhurst would be prepared to act as consulting engineer to the Council. These terms are 5 per cent. on capital outlay, the fee for report already paid by the Council to merge in such commission. The committee recommend that Mr. Hammond be employed to make a preliminary report at a fee not exceeding 50 guineas.

Mr. Isaac Race now moved the adoption of this recommendation, and said it had been carried by a majority of five to two of the seven members constituting the committee. He pointed out that a number of the councillors were strongly in favour of the electric light, and only a small minority against it. Among this minority was Mr. F. East, who, since he had been elected a director of the gas company, had become averse to the electric lighting project. Mr. East indignantly repudiated this charge, which was withdrawn. Mr. Race said it was strange that the introduction of the electric light had caused dissension in many towns, and he called upon the Council to adopt the recommendation of the committee. He challenged anyone present to show that the Council had done anything involving their selection of Mr. Medhurst as consulting engineer. The matter had been left in the committee's hands, and they had appointed Mr. Medhurst to furnish them with a report, for which he had been paid; and he challenged Mr. Medhurst's right to assume that he had any claim to further work in connection with their electricity scheme. Mr. Hammond was a gentleman who had reached the very top position in his profession, and the committee were desirous that they should have the best possible advice, and therefore recommended the Council to approach Mr. Hammond with a view to obtaining his terms. Immediately that course was taken by the Council (continued Mr. Race) Mr. Medhurst had put in his claim of prior right to be consulted in the matter. He (Mr. Race) pointed out that many towns had had two reports, and were thus able to compare and decide which was the best scheme of the two in the light of local conditions, &c. Mr. Little seconded the adoption of the report. Mr. East again repudiated any objection to the electric light, his sole objection being that they should not be too hasty in the matter. He pointed out that Mr. Medhurst was acting as consulting engineer and conducting works amounting to £170,000. (Mr. Race: He is not.) Mr. East said that he was prepared to prove his statement. He did not, however, wish to put Mr. Medhurst and Mr. Hammond against each other, but only wished that the actual facts of the case should be put before the Council. Mr. Broom was of opinion that while this bickering was going on there was as much chance of Tonbridge getting the electric light as there was of him becoming Archbishop of Canterbury. He failed to see where the £20,000 required for the electric lighting scheme was to come from, or who were to become the customers of the undertaking. Mr. Little pointed out that when the previous resolution of the Council appointing Mr. Medhurst was passed the clerk had advised them that the resolution did not bind them to anything. The clerk (Mr. A. H. Neve) said the effect of the resolution was that Mr. Medhurst should be retained as consulting engineer on it being ascertained that his terms would be satisfactory. At the present time the Council were quite free to appoint anyone they chose. A number of amendments were put to the vote, but were all rejected, and ultimately the committee's recommendation that Mr. Hammond should be asked for a report was carried by 10 votes to 6.

Tonypandy (Glamorgan).—Residents here are endeavouring to induce the Rhondda Council to allow the construction of the British Electric Traction Co.'s proposed light railway to Tonypandy, with a pledge from the company that they will apply for powers to extend the projected line from Tonypandy to Treherbert and Porth, through Tylorstown to Ferndale.

Works Lighting.—Messrs. Bolckow, Vaughan and Co., Middlesbrough, have decided to put down electricity generating plant for lighting and power purposes. It is intended to light Eston jetty, the Clay-lane ironworks, the South Bank ironworks, the Cleveland furnaces, and the Cleveland steel works. Electric motive power will also be utilised for driving the machinery on the railway bank and other outlying machinery. The power house will be on the immediate foreshore, at the east end of the company's Eston jetty. It will contain three compound vertical condensing steam engines of 500 H.P. each, and three three-phase dynamos, producing electric current at 3,000 volts. The work is to be proceeded with immediately, and it is expected to be completed by the autumn.

York.—The official starting of the electricity supply works has been fixed for 26th inst.

Yeadon.—The report of the Council's consulting engineer (Mr. J. S. Enright) on the proposal to establish electricity works has now been received. It is stated that the Council might expect within twelve months after current being available to have the equivalent of 4,500 8 c.p. lamps connected to the mains. For public lighting Mr. Enright suggests that the present gas lamps should be adapted for electric lighting, two 8 c.p. incandescent electric lamps to replace each gas lamp. The total capital expenditure involved is put at about £12,600; the annual expenditure (including interest and sinking fund) at £1,540, and the anticipated income at £2,035. The latter is based on the expectation that each 8 c.p. lamp wired would consume 20 units of current per annum. The price of current is taken at 5d. per unit, a figure which the Council is advised not to exceed. A special meeting of the Council will be called to consider the matter. As the Yeadon order was obtained in 1894, it is not too much to expect the Council to take the present opportunity of deciding whether they themselves will carry out its provisions or make a transfer of their order.

Annual Dinner.—The staff of the Postal Telegraph Factory held their sixth annual dinner at the Hotel Cecil on Saturday, Mr. W. Bosomworth in the chair, and Assistant-Superintendent Mr. W. A. Rylands in the vice-chair. The guests included Sir G. Murray, K.C.B.; Mr. J. C. Lamb, C.B., C.M.G.; Mr. J. Ardron, Mr. J. Gavey, Mr. M. F. Roberts, Mr. G. Morgan, Mr. G. W. Hook, Mr. J. F. Lamb, Mr. A. Brooker (General Electric Co.), and Mr. W. V. Morten (National Telephone Co.), those unable to attend including the Duke of Norfolk, Sir W. H. Preece, K.C.B.; Sir H. Fischer, K.C.M.G.; Mr.

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A. F. King, Mr. J. Hookey, Mr. C. E. Stuart, Mr. S. C. Hooley, Mr. A. F. Varley, and Capt. Davy, R.E. After the toast of "The Queen," "Engineering" was proposed by Mr. J. M. G. Trezise, and responded to by Mr. Gavey. The secretary (Sir G. Murray), in responding to the toast of "The Post Office and Telegraph Services," proposed by Mr. M. F. Roberts, expressed his pleasure at the opportunity of meeting the staff on the first anniversary of his appointment to the Post Office. Other toasts followed, and an excellent programme of music by members of the staff and their friends added much to the enjoyment of the evening.

PATENT RECORD.

The following list of Applications for Patents and Specifications published has been compiled for this journal by Messrs. J. C. CHAPMAN and Co., *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs, and Trade Marks may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after the acceptance of the complete Specification. The names within parentheses are those of communicators of inventions. When complete specification accompanies application, an asterisk is affixed.*

January 19, 1900.

1,170. E. W. MOORE. Bradford. Automatic electric alarm.
1,174. A. R. TAYLOR. Derbyshire. The electric night light.

January 20, 1900.

1,245. J. D. F. ANDREWS. London. Improvements in arc lamps.
1,267. J. A. BRODIE. Liverpool. Improvements relating to permanent way for tramways and points therefor, specially applicable to electric tramways.
1,276. A. J. BOULT. London. Improvements in or relating to electric chain link welding machines. (La Société E. Giraud et Cie., France.)*
1,284. W. F. Jones. Hammersmith. Improvements in electric switches
1,297. A. VICKERY. London. Improvements in conduits for underground pipes, mains, electric cables, and so forth.
1,309. J. EARLE. London. Improvements in the manufacture of compound tubes suitable for gas and electrical conductors.*

January 23, 1900.

1,4 7. R. BROWN. London. Improvements relating to electric traction.
1,445. A. H. LORING and H. E. CLARK. London. Improvements in electric transformers. (Date applied for under Patents, &c., Act, 1883, Sec. 103, June 24, 1899, being date of application in United States.)*
1,449. D. R. BROADBENT. London. Improvements in or relating to electric glow lamps.
1,450. T. HOLME. Dursley. Push for electric bells or the like. (J. V. J. Silferberg, Denmark.)
1,457. W. BARNES. London. Improvements in and relating to electrolytic apparatus.*
1,464. J. McLEOD MURPHY. London. Improvements in surface contact electric railway systems.*
1,475. J. SCHIELE and J. BOISSELOT. London. Improvements in electric igniters for explosion motors.*

January 24, 1900.

1,512. W. G. PRIMROSE. Manchester. Improved method of holding magnet winding.
1,528. J. SCHUIL. London. Improvements in continuous-current dynamos and electro-motors.
1,531. J. R. HATMAKER. London. Electric light dimmer.
1,537. C. GARNER. London. Improvements relating to the preparation and treatment of filaments for incandescent electric lamps.
1,555. E. G. FORESIO. London. Improvements in the method of transmitting electric energy through ether and devices for same.

SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1899.

19,354. TIMAR. Thermophor, with electric heating arrangement.
21,968. LEIGH (Drohan). Arc lamps and roller clutch mechanism for feeding and controlling the electrodes therein.
22,088. THE BRITISH THOMSON-HOUSTON CO. (LTD.). (Steinmetz). Incandescent electric lamps.
22,257. HARTER. Means for mounting electric lamps on signs, letters, and other articles and surfaces.
22,534. THE BRITISH THOMSON-HOUSTON CO. (LTD.) (Steinmetz). Means for generating alternating electric currents.
23,283. THE BRITISH THOMSON-HOUSTON CO. (LTD.) (Thomson). Systems of electrical distribution.
23,318. HOUGHTON. Electrodes for medical applications of electricity.
23,403. ABBOTT. Electric igniting apparatus useful for lighting cigars or for similar purposes.
23,713. TRIPP, STEPHENSON and LARTZ. Electrically-illuminated advertisements or signs.
23,723. WUILLOT. Manufacture of lead plates for secondary batteries.
23,739. THE BRITISH THOMSON-HOUSTON CO. (LTD) (Potter). Electric railway systems and cars.

COMPANIES' MEETINGS AND REPORTS.

St. James' and Pall Mall Electric Light Co. (Ltd.).

The ordinary general meeting of this company was held on Tuesday last, at the office, Carnaby-street, Golden-square, London, W., Mr. WALTER LEAF (vice-chairman) presiding.

The MANAGER and SECRETARY (Mr. Frederick J. Walker) read the notice convening the meeting.

The CHAIRMAN, having excused the absence of the chairman of the company owing to ill-health, said: Gentlemen, the last year has been again one of rapid growth. The policy of a reduction in price of current, which Mr. Balfour announced to you last year, has fully answered the hopes of the board. In place of the diminution which some more timorous spirits prophesied, our gross revenue shows a growth of £7,723, or about 11 per cent. The new lamp connections during the year 1899 amounted to the equivalent of 21,897 8 c.p. lamps, as against 16,026 for 1898; but perhaps I ought to add that the latter year was below the average, and that you may more fairly compare this increase of nearly 22,000 with the average for three years of 17 022. Our business is therefore not merely increasing, but increasing at an increasing rate. Our total lamp connections have now reached 161,750 in 8 c.p. lamps, and the demand so far shows no sign of falling off in the six weeks of 1900 which have already elapsed. You will all, I am sure, join with the board in congratulating our engineering staff in general, and Mr. Dobson in particular, on the manner in which this growing demand has been met without a hitch. The year has been by no means without anxiety for them. In face of the state of the coal market, of which no householder is ignorant, it has been a remarkable achievement not merely to have kept up an uninterrupted supply of smokeless Welsh coal, but to have done so with the perfectly nominal increase in total cost per unit of $\frac{1}{100}$d., from 1·95d. to 1·96d. But, gentlemen, if the discipline and industry of your engineering staff deserve your warmest recognition, no less is due to Mr. Walker and the office staff. For them, too, the year has been one of exceptional anxiety and hard work. I will touch briefly on three matters of vital importance which have kept us fully occupied during the last twelve months. In the first place, we had our bill in Parliament for the compulsory acquisition of land adjacent to this station. We proved to the satisfaction of committees of the two Houses the absolute necessity of this extension, and obtained our Act. We have already entered into possession of our land, and cleared it, and are leaving no stone unturned in order to erect on it the buildings which we shall need in order to meet next winter's increased demand. And here let me turn aside to make one remark. This large expense is, as I have said, absolutely necessary if we are to meet the demands of our customers. In our efforts to do so we have, I think, a right to expect the cordial co-operation of our customers' representatives on the local authorities with whom we have to deal. These local authorities have large powers to delay, even where an Act of Parliament makes it beyond their power to forbid. But in a case like this delay is very costly, and any want of goodwill to make things move can in the end only result in loss to the customers themselves by putting off the day when we shall again see our way to offer them a fresh reduction in price. We have, as you know, had to pass through Parliament a second bill, in conjunction with our friends and neighbours, the Westminster Company, in order to provide a station outside the parish large enough to meet all future demands for many years. Here again we have been able to prove our case to the satisfaction of Parliament, and have been actively engaged in the acquisition of the scheduled sites in Lodge-road, Marylebone. Where negotiations are in progress, the less said the better; but you will allow me to congratulate the company on having now an assured means for meeting all prospective demands for some years to come. Of the third matter which has occupied your board and given your staff an immense amount of hard work, the issue of the new shares, I need say no more than that it was most ably carried through by the staff, and went off without a hitch. Since our accounts were closed the final instalment has been paid up, and you have now in hand a reserve fund of some £75,000. The new extensions in Marshall-street and Marylebone will require in the not distant future fresh supplies of money to carry them through. The market, for reasons which are familiar to all of you, is at the moment against us, and the question of finance is likely to occupy the board for some time to come. We can only assure you that we shall spare no trouble in order to raise the money on terms which shall properly safeguard your interests. In the distribution of the increased gross profit of the year you will see that we propose not only to carry forward a larger balance to next year, which in the circumstances of the time you will feel to be no more than ordinary prudence, but that we have written off a larger sum to depreciation. This provision, £12,000, is by no means too large; in fact, I hope that we may in future augment it more than in proportion to the growth of our capital expenditure. You must remember that it has to cover not only the necessary wear and tear of our machinery, but also the very real though unascertainable possibilities of invention, which may at any time make it needful to renew considerable portions of our plant. The increase under this heading we have devoted to completely writing off two items which have for a long time been weak points in our otherwise unassailable balance-sheet—the cost of the artesian well and the cost of the three-wire licence. This licence was essential to us in the early days of the company, but the patent has now expired, and the rights we obtained under it can no longer be regarded as having any value as an asset. There is one other point on which you will perhaps allow me to say a word, though it really belongs to your side of the table and not ours. A resolution will be put before you to increase the remuneration of your auditors from 75 guineas, at which it

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now stands, to 150 guineas. The lower figure was fixed some years ago, at a time when the capital and revenue of the company and the time required for the audit were less than half what they now are. Under these circumstances the board do not think that the figure suggested is other than a reasonable one; but the matter is of course one for the shareholders to decide. Finally, gentlemen, I have merely to say that I am sure you will approve the action of the board with regard to the six reservists we had in our service, and who have been called out and have gone to the front in South Africa. We have promised to pay half wages during their absence to their families, and it is our intention when they return, as we hope they will, to reinstate them. They are good men, and we shall be glad to do everything in our power to assist them. With these few words, I propose—

"*That the report and accounts for the year ending December 31, 1899, as submitted by the directors, be received and adopted, and that the dividends and bonus recommended therein be declared, and paid on February 24, 1900.*"

Sir JOHN H. MORRIS, K.C.S.I., seconded the resolution.

Mr. C. FRY: If the two closing months of last year had not been exceptionally foggy weather, I doubt whether it would have been possible to have maintained the dividend. We are now committed to very heavy capital expenditure in connection with the Carnaby-street extension. A sum of £52,000 has been spent on freehold land, and I should like to know, if possible, how much it will cost to put up the buildings and machinery, so as to bring that station into a fit and proper state.

The CHAIRMAN: Mr. Dobson says that he thinks the Carnaby-street extension will cost, inclusive, from £100,000 to £120,000. That is, as near as he can estimate at the moment.

The resolution was then carried *nem. con.*

Mr. Eustace J. A. Balfour and Sir John H. Morris were then re-elected directors of the company, and Messrs. Deloitte, Dever, Griffiths and Co. were re-appointed auditors.

Mr. ARTHUR HODGSON: Before the meeting concludes, I think it right that the shareholders present should express their approval of the policy of the directors of the company. Notwithstanding the increase in the price of coal and materials, and the decrease in the price charged by us for current, they have been able to give us again a dividend of 14½ per cent. It is a good policy to, if possible, lower the price of current, as it is an inducement to consumers to be more liberal in the use of our light, and it induces new customers to come to us. I am glad that our directors have made a large allowance for depreciation, and I think we on this side of the table fully approve of their policy. I beg to propose a cordial vote of thanks to the chairman, directors and staff for their able conduct of the business.

The proposal having been carried with unanimity,

The CHAIRMAN suitably replied and the proceedings terminated.

Kensington & Knightsbridge Electric Lighting Co. (Ltd.).

The ordinary general meeting was held on Wednesday, at 1, Great George-street, Westminster, Mr. GRANVILLE R. RYDER presiding.

The SECRETARY (Mr. R. S. Erskine) read the notice calling the meeting and the minutes of the previous annual meeting.

The CHAIRMAN said: Gentlemen, I am pleased to be able to submit to you a satisfactory report and balance-sheet for 1899. No doubt in some respects this has been rather an ideal electrical winter: we have had plenty of fog and darkness, and that has of course made a demand on electric light. But at the same time, quite apart from any adventitious occurrences such as that, there has been a considerable spring in the business. There has been not only an increase, but a progressive increase. First I will ask you to look at the growth in the number of shops and houses which have taken the light. In 1898 the increase in the figures was 231, and last year it was 259. Then with regard to the lamps, of which we have 183,462 in our district, there has been an increase of 27,304 in 1899, against an increase of 18,205 in the preceding year. That is a very considerable advance. In net profits we have £19,201, against £14,564 for 1898. Then as to the units sold. The number was 2,463,950 during the period under review, which represents an increase of nearly 400,000, while in 1898 there was an increase over 1897 of 182,712 units. But apart from this increase there is a satisfactory feature, and that is the small extra sum that it had cost to produce the increase in the electricity sold. I think that it is specially creditable to our chief engineer that the additional expenditure on coal was only £1. 11s. 6d. for the year, while the whole cost of generating the current amounted to £16,830, against £16,517 in 1898, an increase of only £313. With regard to renewal account, we have set aside £4,764 for that account, thus raising the total amount of it to £30,339, which we consider to be a satisfactory figure. In the early years of the company's existence we could only go on estimates of what the amount to be set aside should be, but experience has now shown us that the £4,000 odd that we have this year transferred to renewal account represents the right percentage to be allowed for depreciation. With regard to the conversion which has been going on steadily for the last two or three years, we have now got to the point at which two-thirds of our customers have wired their houses and got lamps which will carry 200 volts. We hope that the remaining third will be practically all in the same condition before the end of this year. As to capital account, I may say that we did not issue any new capital during 1899, but we have spent a certain amount on capital account from the capital remaining over from former years. As you will see, about £10,000 has been expended during the year, mainly on mains and plant. There will be a good amount of new capital required during the current year. We have many things on hand: new mains to bring to the new works, and we have considerable sums to pay for the purchase of the freehold of the short leasehold premises in our occupation. The secretary informs me that the balance of the second preference shares —£16,525—has been more than subscribed. There is, I would point out, a contingent advantage in this amount being subscribed, inasmuch as it complies with the requirements of the Stock Exchange, so that we shall be able to get a quotation for our shares. Our issued share capital will thus be increased to £175,000, the nominal capital of the company being £350,000. By the rules of the Stock Exchange the issued capital must amount to half the nominal capital before a quotation is granted, and we shall now comply with that rule. With regard to the bill which was sanctioned by the shareholders last year for the purpose of obtaining powers to erect a new generating station in conjunction with the Notting Hill Electric Lighting Co., I am glad to say that it has become an Act, and considerable progress has been made in carrying out its provisions. Two members of each board form a committee for supervising the scheme. The land has been acquired and a considerable amount of work has been done. A good many contracts have been entered into, and I think I may say that the thing is going on swimmingly. A good deal of progress will no doubt be made so soon as we get rid of the present frosty weather. The money to be raised would be kept entirely separate from the funds of this company. The two companies will have to act as guarantors of whatever amount may be borrowed. The idea is to borrow it in one sum from an insurance company, as it is believed that that will be the most convenient way of providing for the cost of the works. I do not suppose that there will be any difficulty in getting the money at a fairly low rate, certainly not exceeding 4 per cent. I think that this is all I have to say, and I will therefore now move:—

"*That the report and accounts be adopted and entered on the minutes.*"

Sir FREDERICK J. BRAMWELL, Bart., F.R.S., seconded the motion, which was carried unanimously.

Resolutions approving the dividend of 6 per cent. for the half-year, and the re-election of Mr. R. W. Wallace, Q.C., and Sir Charles Grant, K.C.S.I., as directors, and the re-appointment of Messrs. Lovelock, Whiffin and Dickinson as auditors were agreed to.

Mr. WALLACE inquired if the company had powers to raise money by guarantee under the Articles. He had been asked the question by a shareholder, but had not been able at the moment to put his finger on the particular article which related to the matter.

Mr. METCALFE said that the company had the power. The Act of Parliament expressly authorised them to do so, and that was sufficient without any authority under the Articles.

Mr. CHAMPERNOWNE asked what would be done with the premiums obtained on the new shares.

The CHAIRMAN: In the past the premiums have been used for writing off certain of the assets, and I suppose we shall do the same again. Of course, we have assets which as time goes on represent only a nominal value.

A vote of thanks to the chairman brought the proceedings to a close.

Westminster Electric Supply Corporation (Ltd).

The report of the directors of this company for the year 1899 sets out that the supply of current on Dec. 31, 1898, was provided for the equivalent of 339,986 lamps of 8 c.p. On Dec. 31, 1899, there were on the books an equivalent of 421,445 lamps. The actual additional lamps applied for and connected during the year was 54,691. The balance of 26,768 lamps represents the results of a re-examination of consumers' connections which has been made during the year, and which showed that the number of lamps connected was to this extent in excess of those which had been originally applied for. At the present time there are on circuit the equivalent of 427,221, and applications have been received for a further 8,951 lamps of 8 c.p. The length of roadway in which mains have been laid now exceeds 51 miles, making about 208 miles of ways, into which upwards of 176 miles of copper (strip and cable) have been drawn.

Notwithstanding the continued high price of Welsh steam coal, there is again an increase in the net profits for the year, owing to the very large number of lamps added during the twelve months, the greatest number in any year since the corporation commenced business.

In regard to the change of pressure, 99 per cent. of the consumers are now supplied at 200 volts, and the directors hope to complete the work during the present year. While these consumers have received a reduction in price, in consideration of the alteration, the Corporation cannot obtain any advantage until the entire change has been completed.

Progress has been made in acquiring and developing the site for the new joint supply station of the Central Electric Supply Co. (Ltd.), and building operations will shortly commence. The Westminster Corporation and the St. James' and Pall Mall Co. each hold a half interest in this undertaking.

An interim dividend at the rate of 10 per cent. per annum, for the half-year ended June 30, 1899, has been distributed. After allowing for depreciation, sinking fund, &c., the net balance available for dividend is £34,668 1s. 6d. Payment of a dividend at the rate of 16 per cent. per annum (less tax) for the past half-year, making 13 per cent. for the year to Dec. 31, is recommended, carrying forward £3,773 8s. 2d.

National Telephone Co. (Ltd.).

The report of the directors of the National Telephone Co. for the half-year ended Dec. 31 is issued. The income of the half-year amounted to £663,523. 1s. 11d., compared with £573,707. 3s. 6d. for the corresponding period of 1898, an increase of £89,815. 18s. 5d. The working expenses amounted to £359,302. 14s. 5d., compared with £312,462. 4s. 4d., an increase of £46,840. 10s. 1d. The net result for the half-year (after deducting the Post Office royalties, amounting to £64,176. 8s.) was a profit balance of £240,043. 19s. 6d., compared with £205,888. 6s. 4d. for the corresponding period of 1898, an increase of £33,155. 13s. 2d. The rentals carried forward for unexpired terms of running contracts amount to £631,590. 6s. 9d., compared with £536,651. 3s. 4d., an increase of £94,936. 2s. 5d.

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Out of the available balance of £199,949. 16s. 9d. the directors recommend the payment of a dividend at the rate of 6 per cent. per annum (less tax) on the first and second preference, 5 per cent. per annum (less tax), on the third preference, and 6 per cent. per annum (free of tax) on the ordinary shares. It is further proposed to transfer £80,000 to reserve, and to carry forward £6,199. 16s. 9d.

Capital Expenditure.—£369,821. 19s. 8d. has been expended on capital account during the half-year, in the erection of 10,000 additional exchange and private lines and in the construction of underground lines.

Scarborough Electric Supply Co. (Ltd.).

The annual report of the directors states that during the past year 82 additional consumers, and the equivalent of 4,837 8 c.p. lamps, have been added to the company's system, making 465 consumers and 27,171 lamps now connected. During the year 257,412 units of electrical energy were supplied to customers, at a revenue (including meter rents) of £6,235. 12s. 11½d., against 220,009 units and £5,442. 9s. 8½d. in 1898. Although the increase in the price of coal has proved a serious item, the profit on the year's working is £2,705. 8s. 9½d., against £2,331. 16s. for 1898. Adding to this £368. 6s. 11½d. from 1898, and £80 (premiums on new shares), there was, after making sundry payments and putting £471. 17s. 5d. to depreciation, £2,576. 0s. 11d. available for distribution. The directors recommend paying a dividend of 6 per cent. (tax free), absorbing £2,416. 13s. 3d., leaving £159. 7s. 8d. to be carried forward. The whole of the company's capital being issued, and further expenditure being required to keep pace with the growth of business, the directors advise the shareholders to increase the capital to £100,000 by the creation of 5,000 additional shares of £10 each, to be issued and called up as required. The directors state that they have recently been approached by the Scarborough Corporation with a view to purchase by the latter of the company's undertaking. No definite proposals have yet been formulated. In the meantime the Corporation have introduced a bill in Parliament, which in one or more of its clauses affects the company, and the directors have taken the necessary steps to watch their interests.

Central London Railway Co.

The directors' report for the half-year ended Dec. 31 last, states that the expenditure for the half-year amounted to £325,899 9s. 8d., the total reaching £3,167,884 7s. Of this £488,165 was due to the Electric Traction Co. for work done and plant supplied, as certified by the engineers. The progress of the works, as set out in the report of the engineers (which accompanies that of the directors) has been satisfactory. Much has been accomplished during the past six months, and the work remaining unfinished is mainly that which could not be commenced until the underground portion was out of hand. The running lines in both tunnels have been laid in concrete and are practically complete. The whole of the stations are erected up to the first floor, and it is not intended to proceed with the building of the upper stories at present. The subway at the Bank station was partially opened on Jan. 8. The electric lifts, with the necessary machinery, are in position at seven stations, and at the other six stations their construction is proceeding.

At the Shepherd's Bush depôt all the boilers and two of the main generating engines have been under steam. The four remaining engines will shortly be completed. All the electric locomotives have been delivered, and generally the erection of the electric plant has advanced to such a stage that the directors hope an experimental train will be running by the end of this month.

In a bill which the proprietors are to be asked to approve, it is proposed to repeal the original Act relating to workmen's trains and to substitute other provisions.

Dublin United Tramways Co. (Ltd.).

The half-yearly meeting of this company was held at Dublin on Tuesday. The chairman (Mr. Wm. Murphy) said that during the half-year they had practically completed the conversion of their system from horse to electric traction. The generating station at Ringsend (opened in August) was working for some months under unfavourable conditions for the most economical production of electrical energy. The overlapping of expenses and disorganisation incident to the changes could not be wholly avoided. Moreover, between the war and the prevailing epidemic, many of their skilled men were not available, so that they could not at all times provide sufficient service to carry the public. But still the profits enabled them to increase their dividend by 1 per cent. The company's accounts showed an increase of £5,561 in gross receipts, but the net profits were £10,691 more than in the corresponding period, from which it was apparent, not only that they increased their traffic receipts by more than £5,000, but that it cost them £5,000 less to earn the increased receipts; and that was the secret of the success of the electric system—namely, increased receipts and diminished expenses. £1,641 of the increased profits were absorbed by wayleaves which only accrued in the last half-year. Their cars during the half-year travelled 2,180,832 miles, of which 730,245 miles, or more than one-third of the whole, were still covered by horse haulage. There was a proved difference of 4d. per mile in favour of electric haulage. The increase in the net profits of the Southern District Co.'s system was £2,644, the profits being in 1898 £8,951, and in 1899 £11,594, after deducting wayleaves of almost equal sums in both cases. The debenture interest chargeable against this company being also the same in the two half-quarters, the whole of this increased net revenue was available for dividend. The proportion of working expenses to gross receipts on the Southern system was 48·5, and by charging each system with its own proper expenditure and by a rateable division of expenses for horse and electric working the United Co.'s system did not exceed 50 per cent. of the gross receipts. They had 180 cars in operation, and he looked forward to finding profitable business in August next for at least 250, and they were providing that number. They also looked forward to a large saving in the cost of production of electrical energy in the Ringsend power station. The economy in working from Ringsend had led to the closing of the Contarf station, and when the machinery was completed the Ballsbridge station would be closed down and the entire system would be worked from the central station, thus saving £25,000 per annum. The past half-year was not a favourable one, owing to the high price of money, for selling the balance of debentures, and they did not press the sale. £90,000 debentures were still unissued, and they would have to raise additional capital. The chairman then referred to the difference with the British Thomson-Houston Co. regarding the cost of lowering the Kingstown sheds, which they were advised was due to them by the company under their indemnity. That opinion was disputed, and the matter would be disposed of by a friendly suit. The company had given the public a speedy and luxurious means of travelling at little more than half the former fares.

After a short discussion, the directors' report and accounts were adopted.

BRISTOL TRAMWAYS AND CARRIAGE CO. (LTD.)—The half-yearly meeting was held on Wednesday. The chairman (Mr. C. H. Low) said they had reduced the expenditure from 72½ per cent. in 1898 to 68 per cent. The increased receipts from the tramways department were £7,799, and from the carriage department £4,703—total £12,507; and the increased revenue was £12,500, and the increase in net profits amounted to £10,250. So that they were able, after allowing for the amounts paid for interim dividend at the rate of 7 per cent. per annum, interest on debentures, temporary loans and preference shares, to recommend a dividend at the rate of 8 per cent. per annum for the past half-year, and to carry £7,260. 5s. 1d. to the various reserve funds, bringing the total reserves up to £10,444. 11s. 6d. They fully anticipated being able to open the whole of the reconstructed lines, together with the extensions, some time during the ensuing summer. In the meantime it was satisfactory to know that the additional electric lines which were opened last year had been working very smoothly and with the greatest possible satisfaction to the citizens generally. He had no doubt that when they opened the complete system they would have a large accession of traffic, for which they were taking care to provide. The directors' report and accounts were adopted.

GIANTS' CAUSEWAY, PORTRUSH, AND BUSH VALLEY RAILWAY AND TRAMWAY CO. (LTD.)—Dr. Anthony Traill, J.P., presided over the meeting of this company last week. The directors' report stated that there was an increase in the receipts, compared with the previous year—of from £2,405. 8s. 9d. to £3,010. 17s. 10d. This was almost entirely due to the increase in the number of passengers carried during the year—74,877, against 94,151. The credit balance on the year's working was £914. 16s. 3d., against £502. 5s. 5d. in 1898. The number of miles run by electricity during the year had been 17,875, against 11,333 in 1898; and the miles run by steam were reduced from 13,979 to 11,771, making the total miles run last year 29,645, against 25,312 in 1898. The directors are involved in a lawsuit, instituted by the Portrush Council, to compel the company to discontinue running cars by electricity through the streets of Portrush, and to remove the overhead equipment. The financial result of the year's working allowed the payment of the interest in full on all debenture stock, amounting to £12,950, and on the mortgage for £10,000.

GUERNSEY RAILWAY CO. (LTD.)—The report of the directors for the year ended Dec. 31 states that the capital expenditure amounted to £31. 9s. 3d. on equipments and £25. 14s. 10d. on buildings; against this there is a credit of £14 from sale of old stock. The gross receipts amounted to £5,968. 10s. 5d., compared with £6,253. 14s. 4d. in 1898, a decrease of £285. 3s. 11d. The traffic has been seriously affected by the falling off of visitors to the island during the year. The railway working expenses show a decrease of £354. 16s. 10d. Heavy repairs at the cost of revenue have been made to two motor cars. A new boiler has been ordered of sufficient power to drive both engines in the generating station, and will be erected within the next two months. The original locomotive boilers will be kept in reserve. A condensing plant is also on order. The directors have given consideration to the practicability of extending the application of electric traction and further providing the rapid and convenient means of transit which the system is capable of supplying. The most promising field of extension is the route between the town and Rohais *viâ* Victoria-road. The States have contributed a grant for the improvement, and the roadway has been widened to an extent which will permit the passage of cars with facility should the necessary concession be obtained. Out of the net revenue account (£1,054. 12s.), after paying debenture interest (£360), writing off £505 from improvements account, omnibus undertaking and stock of rails, placing £300 to general renewals reserve account, and providing for a dividend of 5 per cent. on the preference shares, the directors recommend a dividend of 4 per cent. on the ordinary shares, leaving £35. 4s. 4d. to be carried forward.

LIVERPOOL OVERHEAD RAILWAY CO. (LTD.)—The twenty-third half-yearly meeting was held at Liverpool on Tuesday, Mr. Richard Hobson, deputy-chairman, presiding. In moving the adoption of the report the chairman congratulated the shareholders upon the record report in regard to both the number of passengers carried and earnings. The report was unanimously adopted. An extraordinary meeting was afterwards held to authorise the issue of further capital to the extent of £50,000 in ordinary shares of £10 each. The chairman explained that the money was required to carry out arrangements proposed to be made with the tramway companies of Waterloo, Seaforth and Great Crosby to inaugurate a system

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of tramways running in connection with the railway. The motion was carried. At a further extraordinary meeting a resolution approving of a bill to be introduced into Parliament to authorise the company to make certain new railways and to widen a portion of the existing railway was adopted.

METROPOLITAN DISTRICT RAILWAY CO.—At the meeting of this company yesterday the chairman (Mr. J. Staats Forbes) read a report on the question of electric traction for the railway—by Sir W. H. Preece and Sir J. Wolfe Barry—which dealt with recent experiments. Trials between the Earl's Court and High-street Kensington stations (about a mile) had been completely successful, and a gain of four seconds over the average time occupied hitherto was made in the run. Further tests are to be carried out. The question of using electrical traction on their lines was surrounded by circumstances entirely different from those of the ordinary electric railways, which were constructed in a special manner for use by electric power. They had a totally different problem to consider, and it was this: having a railway constructed on totally different principles, how it could be adapted to electric traction; and that was not such an easy thing as people said. The report of the two engineers referred to showed that they were perfectly satisfied that the essential factors had been determined, and those were that by electricity they could move a much larger weight than the weight of their ordinary trains, and that the capacity would be quite 500 passengers per train, as against 450; that they could propel them more rapidly, with greater certainty, with much less exhaustion of time, either in stopping or starting, and they believed more economically per train mile. That was the thing to be determined, and that was the result of the report, and they would be shortly prepared to satisfy any inquiry by tests. Economy in working and increased capacity in working would produce equivalent benefits and quite compensate for the change. The companies with running powers over their lines would have to be persuaded, he supposed, to use electricity.

NEWCASTLE AND DISTRICT ELECTRIC LIGHTING CO. (LTD.)—The annual meeting was held at Newcastle on Tuesday, Mr. J. D. Millburn presiding. The supply of electric current continues to give satisfaction, and the installations connected to the company's mains during the year were equal to 5,600 10 c.p. lamps, bringing the total up to about 41,878; and 1,008,622 units of electrical energy had been supplied, against 778,828 units in 1898. During the past year 3,433 yards of main and branch piping have been laid, together with 9,768 yards of main and branch cables. The gross earnings during the year amounted to £8,811. 7s. 9d., and after paying interest and placing £1,000 to reserve and making provision for depreciation, the directors recommend a dividend of 5 per cent. for the half-year to Dec. 31 (less tax), which, together with the interim paid in August, make 8½ per cent. for the year. The chairman referred to the substantial progress made by the company, and added that they had found it necessary to look out for further productive power. They had obtained a suitable site at a very moderate price, and proposed to erect new works to supplement the present station. The new site had a frontage of 300ft. on the river, which enabled them to obtain water for condensing direct from the Tyne and to get coal delivered direct from craft to boiler furnaces by means of mechanical conveyors. The area of the site was more than 4,000yds., and the plant would be capable of dealing with 14,000 E.H.P. They had already made contracts for the supply of energy corresponding to 400 H.P., and so were beginning to draw largely, so far as contracts go, on the new premises and their output. They had also found it desirable to fit up continuous current works in the present premises. A good proportion of the new capital to be raised would be spent in buying the land and laying out the new works. He considered that the company had a bright future before it. The report was adopted. At an extraordinary meeting which followed it was decided to increase the capital of the company to £200,000 by the creation of 10,000 new ordinary shares of £10 each.

SMITHFIELD MARKETS ELECTRIC SUPPLY COMPANY (LTD.)—The second ordinary general meeting of this company was held on Friday last, Mr. H. S. Leon presiding. The chairman, in his opening remarks, said: Certain circumstances have adversely affected the company ever since it came into existence, and these circumstances have to some extent affected other electric lighting companies; but, unfortunately, they have affected us more than others, as the light generated by our predecessor was unpopular in the markets at Smithfield. Then we have never had adequate working capital. As in other commercial and industrial undertakings which should be more or less progressive, extra working capital is continually being required, and we have been handicapped in not having it. But the directors have this matter in hand, and recognise the importance of increasing the value of the stock of the company. With regard to the business of the company, there are 408 shops in the Smithfield Markets, London, and on Sep. 30, 1898, we had 188 of those shops connected, with the equivalent of 9,723 8 c.p. lamps. On Dec. 31, 1899, there were 266 installations connected, with a total of 16,960 lamps. This leaves 146 shops not connected, and we are of course anxious and hope to obtain some of these as our customers. Besides this we have four other large installations, the profits from which we shall not be able to ascertain until the end of the current year. The gross revenue for the year to Sep. 30, 1898, was £6,501, expenditure £5,742, and after paying all interest and other charges there was a net loss of £775. The gross revenue for the 15 months ended Dec. 31, 1899, was £12,083, expenditure £8,643; net profit, after paying all interest and other charges, £565, thus reducing the deficit from £775 to £210. This deficit has been entirely wiped out by the profits made during the month of Jan., 1900, alone; in fact, we are very nearly £100 to the good. Therefore, under the most disadvantageous circumstances, we may fairly expect, even after allowing for depreciation, to show a net profit at the end of this year. We expect to save something by our battery of accumulators, which were not in working order during the summer months of 1899. I do not want to be too sanguine on that point because of the very high price of coal, which may wipe off a great deal of the savings we expect to make upon our accumulators. On capital account we have spent on accumulators £2,643, on mains £1835, on extensions (new shops) in markets £1,830, on improvements in generating station £627, making together £6,985, of which £1,700 has been paid out of revenue. To assure our position we wish to place £6,000 more of the 5 per cent. second debentures, as circumstances are continually arising by which, with the judicious expenditure of a small amount, we can profitably increase our business. Taking the least sanguine view of the situation, the interest on our debentures is quite covered, and I think, offer a good investment. With regard to the ordinary shareholders, I confess that the position does not seem very hopeful for the next year. A reserve fund will have to be made for depreciation, and in the estimate for the current year the secretary has allowed £1,000. If the ordinary shareholders desire to obtain their dividend more quickly they should put some money into the debentures; if they do not, the board will be obliged to pay out of revenue amounts which certainly should be put to capital account. The amount of debentures authorised was £25,000. In May last we asked the shareholders to take £12,500, but only £2,450 was subscribed. We now want you to take debentures to the amount of £6,000, of which I should be perfectly willing to subscribe £1,000 or £2,000 if other gentlemen in the room would do the same. I would mention that we have no Stock Exchange quotation; but the responsibility for that does not rest with the board. Mr. Greenhill said it had been his intention to go into the matter of the bright hopes held out in the prospectus, but after the explanation which had been given by the chairman he would not do so. He thought the directors deserved the gratitude of the shareholders for taking no fees. The report and accounts were adopted.

WINDSOR ELECTRICAL INSTALLATION CO. (LTD.)—The annual report of the directors states that the number of lamps and motors installed on Dec. 31, 1898, was equivalent to 7,914 8 c.p. During the past year 5,964 were added, bringing the total to 13,878 at the end of 1899, of which 869 represent motor power. During the year large additions to the mains and machinery have been made to meet the demands for public and private lighting, £21,947. 16s. 1d. having been spent on capital account, bringing the total expenditure to £47,362. 1s. 3d. A new boiler has been added, and two sets of engines and dynamos with a capacity of 200 H.P. and 400 H.P. respectively. The two small sets with which the company originally commenced have been sold and replaced with a larger one of 160 H.P., effecting considerable economy in the working. Ten miles of mains have been laid, covering the whole of Windsor and Eton. These works have been carried out under the supervision of the company's engineer. Contracts have been entered into for the public lighting of both Windsor and Eton for a period of five years. Many lights have been added at Windsor Castle, and considerable additions are in hand; the parish church and town hall are lighted electrically and large extensions have been made at Eton College. Experiments are also being made at St. George's Chapel with a view to lighting the sacred building by electricity. The net profit for the year was: Installation work, £1,577. 16s. 2d.; lighting, £2,552. 0s. 7d.; total, £4,129. 16s. 9d.; against £2,539 12s. 2d. for the previous year. Out of the total amount available for distribution (£4,129. 16s. 9d.) the directors recommend a dividend at the rate of 8 per cent. per annum, being 4 per cent. out of the profits on the lighting department, and a bonus of 4 per cent. out of the profits on installation work. An interim dividend of 3 per cent. was distributed in September, and the balance of 5 per cent. will be paid forthwith. Out of the balance of £2,290. 12s. 3d. the directors recommend that £750 be added to depreciation, renewal and reserve, £500 to a special account for equalising dividends, leaving £1,040. 12s. 3d.; and, as no provision has been made in the accounts for directors' fees, the shareholders will be asked to vote £350 for their services, leaving the remainder to be carried forward. An issue of £10,000 further capital was made during the year at a premium of 2s. 6d. per share, and the directors recommend that the whole of the premiums (less expenses of issue), amounting to £1,272. 0s. 6d., be transferred to the depreciation, renewal and reserve fund, making that account £2,922. 0s. 6d. A further issue of £15,000 capital has recently been made, at a premium of 5s. per share, to shareholders only. The price of current was reduced to 6½d. per unit.

NEW COMPANIES, STATUTORY RETURNS, &c.

ELECTRICAL REGULATING AND LIGHTING SYNDICATE (LTD.)—This company was registered on Feb. 9, with a capital of £75,000 in £1 shares, to acquire certain patents for inventions by Walter Emmott (Nos. 21,236 of 1896 and 4,761 of 1898) and to carry on the business of electrical and general engineers, brass and ironfounders, &c. The subscribers are J. Longthorpe, J. Wilson, J. E. Crossley, J. Hillary (consulting engineer), A. Deakin, W. L. Smith and H. H. Barnes. The first directors are T. R. Bottomley, W. Emmott, J. Longthorpe, J. Hillary and F. Whiteley.

NEW BRITISH INCANDESCENT ELECTRIC LAMP CO. (LTD.)—According to the annual return to Dec. 31 the capital is £30,000, in £1 shares, 23,857 of which have been taken up and paid for in full.

PACIFIC AND EUROPEAN TELEGRAPH CO. (LTD.).—The annual return to Dec. 22 has been filed. The capital is £100,000 in £10 shares, all of which have been taken up. £4 per share has been called up and paid.

RYDE ELECTRIC LIGHT AND POWER CO. (LTD.).—The annual return to Jan. 10 gives the capital as £10,000 in £5 shares, seven of which have been taken up. No calls.

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CITY NOTES.

MEMORANDA.—Bank rate 4 per cent. (since Jan. 25, 1900). Price of silver 27½d. per oz. (Feb. 15). Consols (2¾ per cent.) 100⅜—100⅝ for money, 100⅞—101 for account; 2½ per cent. 98—98½ (Feb. 15). Stock Exchange Settling Day: Consols, Mar. 1; Stocks and Shares Continuation Days, Feb. 21 and Mar. 12; Ticket Days, Feb. 22 and Mar. 13; Pay Days, Feb. 23 and Mar. 14; Mining Share Carry-over Days, Feb. 20 and Mar. 10.

BRITISH ELECTRIC TRACTION CO. (LTD.)—During the week the Electric and General Investment Co. (Ltd.) invited subscriptions for a further issue of £150,000 5 per cent. perpetual debenture stock at 120 per cent.

EDISON AND SWAN UNITED ELECTRIC LIGHT CO. (LTD.)—The directors have resolved that a payment on account of the dividend of the current year be made at the rate of 6 per cent. per annum (less tax) on the "A" shares of the company in respect of the half-year ended Dec. 31. This will work out at 1s. 9½d. per share on the partly paid £5 shares (£3 paid) and 2s. 9½d. per share on the fully paid £5 shares (less tax). Dividend warrants have been posted.

GENERAL HYDRAULIC POWER CO.—The directors' report to Dec. 31 states that the gross receipts of the London and Liverpool undertakings during the year amounted to £99,159, against £89,599 in 1898. After providing for debenture interest, and £6,260 for depreciation, the balance is £52,495. The directors propose a dividend for the year at the rate of 8 per cent.

W. T. HENLEY'S TELEGRAPH WORKS CO. (LTD.)—Subject to audit, the dividend on the ordinary shares of this company (payable March 1) for the past year will be 15 per cent. (less tax), including the interim dividend of 4 per cent. paid in September last.

SANITAS CO. (LTD.).—The report for 1899 shows a credit balance of £15,173. £3,700 has already been paid as interim dividend, leaving (after payment of directors' fees) £10,697. The directors propose to place £2,000 to reserve, and recommend a further dividend of 4½ per cent. and a bonus of ½ per cent., making a total distribution of 7½ per cent. for the year, absorbing £9,153, and leaving £1,544 to carry forward.

STIRLING AND BRIDGE OF ALLAN TRAMWAYS CO. (LTD.)—The provisional agreement with the British Electric Traction Co. for the transfer of the undertaking to the latter company for £30,000 has been confirmed by the shareholders of the Stirling company.

S. Z. DE FERRANTI (LTD.)—We are informed that Mr. Francis Ince and Mr. Charles Pratt Sparks have resigned their positions as directors of this company.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee has appointed the 22nd inst. a special settling day in 125,000 vendors' ordinary £1 fully-paid shares (Nos. 1 to 125,000) of the *Aron Electricity Meter (Ltd.)*. The committee has also ordered 12,000 non-cumulative 5 per cent. £10 fully-paid preference shares (Nos. 25,001 to 37,000) of the *British Columbia Electric Railway Co. (Ltd.)* to be quoted in the official list. The Committee has also been asked to appoint a special settling day in, and to grant a quotation to the further issue of 20,000 6 per cent. cumulative £10 fully-paid preference shares of the *British Electric Traction Co. (Ltd.)*

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	'99–1900	£	£		£	£
*Birmingham Tramways.	Feb. 10	3,628	– 61	6	23,454	+ 1,172
Blackpool Corporation...	„ 8	133	+ 20	45	21,494	+ 4,443
Blackpool and Fleetwood	„ 10	128	– 15	6	869	– 12
Bradford Corporation ...	„ 11	295	+ 32	78	25,647	...
Brisbane Trams	Dec. 27	2,239	+ 640	13	28,906	+ 8,861
*Bristol Trams & Carriage	Feb. 9	2,362	+ 5	6	15,697	+ 1,042
*Buenos Ayres & Belgrano	Jan. 14	2,281	+ 503	2	4,935	+ 1,380
City & South London Ry.	Feb. 11	1,149	+ 30	6	6,739	– 32
Dover Corporation	„ 10	141	...	45	90,96	+ 1,045
Dublin United	„ 9	2,701	+ 84	6	16,441	+ 1560
Dublin Southern Dist....	„ 9	545	– 39	6	3,348	
*Glasgow Corporation ...	„ 10	7,453	– 386	...	...	...
*Liverpool Corporation...	„ 3	6,471	+ 1,078	5	33,097	+ 4,395
Liverpool Overhead Rly.	„ 11	1,344	+ 121	6	8,897	+ 1,141
*Sheffield Tramways	„ 12	1,620	+ 429	6	10,740	+ 3,527
*South Staffs. Trams....	„ 9	539	– 15	6	3,549	+ 99

* Partly electrical.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Feb. 7.		Price Wednesday, Feb. 14.		Rate per Cent. Yielded. £ s. d.	Dividend Due.	Business Done During Week Ending Feb. 14. Highest	Lowest
			TELEGRAPHS.								
£110,900	100	4%	*African Direct Telegraph 4% Mort. Deb. (red.)	99	103	99	103	3 17 8	January and July	...	...
25,000	10	...	Amazon Telegraph	3	4	3	4	...	June and December	...	...
£125,000	100	5%	Do. 5 per Cent. Debentures	85	90	85	90	5 11 1	...	...	...
£875,520	Stock	28/6	Anglo-American xd	65	68	63	66	5 11 5	Feb., May, Aug., Nov.	65	...
£3,062,240	Stock	30/0	Do. Preferred xd	115	116	114	115	5 4 4	„ „	116	114½
£3,062,240	Stock	27/0	Do. Deferred xd	16¾	17¼	14½	15	8 14 2	...	17¾	14⅞
$10,000,000	$100	$2½	Commercial Cable Capital Stock	165	175	165	175	...	Jan., Apr., July, Oct.	...	...
£1,563,078	Stock	4%	* Do. 4 per Cent. Debenture Stock	102	104	102	104	3 16 11	„ „	103½	103½
16,000	10	8/0	Cuba Submarine Ordinary	9	10	9	10	8 0 0	February and August	9½	9
6,000	10	10,0	Do. Preference 10 per Cent.	19	20	19	20	5 0 0	„ „	...	...
12,931	5	2/0	Direct Spanish Ordinary	4	5	4	5	4 0 0	April and October	...	...
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference	9	10	9	10	5 0 0	„ „	...	...
£30,000	50	4½%	Do. 4½ per Cent. Debentures	101⅝	105⅝	101⅝	105⅝	4 5 9	January and July	...	...
60,710	20	3 0	Direct United States Cable	11½	12	11½	12	5 16 8	Jan., Apr., July, Oct.	11¾	11⅝
£120,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red.)	99	102	99	102	4 8 3	June and December	...	...
£4,000,000	Stock	5%	Eastern Ordinary	153	158	154	159	4 8 4	Jan., Apr., July, Oct.	159	156½
£1,795,000	Stock	3½%	Do. 3½ per Cent. Preference Stock	98	101	98	101	3 9 3	„ „	100½	98⅝
£1,432,268	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.)	115	120	116	121	3 6 8	May and November	119	...
250,000	10	2/6	Eastern Extension	15¼	15¾	15½	15¾	4 8 11	Jan., Apr., July, Oct.	15¾	15 5/16
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock xd	117	122	115	120	3 6 8	February and August	...	...
£16,200	100	5%	* Do. 5% (Austln. Gov. Sub.) Deb.,1900 (reg.)	99	103	99	103	4 17 1	January and July	...	...
£64,400	100	5%	Do. (Bearer)	100	103	100	103	4 17 1	„ „	...	...
£300,000	100	4%	*Eastern and S. African 4% Mort. Deb., 1909	100	103	100	103	3 18 5	February and August	...	...
£200,000	25	4%	Do. 4 per Cent. Mauritius Sub. Debs. (red.)	101⅞	104⅞	101⅞	104⅞	3 16 10	May and November	...	...
180,227	10	1/9	Globe Telegraph and Trust	11	11⅜	11¼	11⅜	4 9 4	Jan., Apr., July, Oct.	11 3/16	11¼
180,042	10	3/0	Do. 6 per Cent. Preference	15½	16	15½	16	3 15 0	„ „	15 1/16	15⅜
150,000	10	5/0	Great Northern of Copenhagen	30	32	30	32	3 18 2	January and July	30½	...
£86,300	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb.(red.)	99	102	99	102	4 8 3	...	...	...
17,000	25	12/6	Indo-European	49	53	49	53	4 14 4	May and November	...	...
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904	106	109	106	109	5 10 1	March and September	...	...
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.)	101	104	101	104	3 16 11	June and December	...	...
11,839	8	4/0	Reuter's	7	8	7	8	5 0 0	April and October	...	...
3,381	£100 Cert.	6%	Submarine Cables Trust	124	129	124	129	4 14 6	„ „	125	...
15,609	10	...	West African Telegraph	2½	3½	2½	3½	4 9 3	December and July	...	...
£200,000	100	5%	* Do. 5 per Cent. Debentures (red.)	98	101	98	101	4 18 9	March and September	...	...
30,008	2½	...	West Coast of America	½	1	½	1	...	...	...	...
£150,000	100	4%	* Do. 4 per Cent. Debentures	100	103	100	103	3 17 8	January and July	...	...
88,321	10	6d.	West India and Panama	⅞	1⅛	⅞	1⅛	...	May and November	1 1/16	...
34,563	10	6/0	Do. 6 per Cent. 1st Preference	9¼	9¾	9¼	9¾	6 3 1	„ „	...	...
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	7	8	7	8	7 10 0	„ „	...	...
£80,000	100	5%	* Do. 5 per Cent. Debentures	104	107	104	107	4 13 6	January and July	...	...
£389,731	Stock	4%	Western & Brazilian 4 per Cent. Debenture Stock	100	104	100	104	3 16 11	June and December	...	...
207,930	10	3/0	Western Telegraph (late Brazilian Submarine)	14¾	15¼	14¾	15½	4 11 10	Mar., June, Oct., Dec.	15 1/16	14¾
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1900)	106	109	106	109	4 11 9	June and December	...	...
£158,100	100	6%	*Western Union 6 per Cent. Sterling Bonds (red.)	98	103	98	103	5 16 6	March and September	...	...
			TELEPHONES.								
44,000	£5	3/0	Chili Telephone (fully paid)	2	3	2	3	6 13 4	August	2 1/16	...
224,850	10s.	0/1½	Consolidated Telephone Const. & Manufacturing	⅛	¼	⅛	¼	4 15 3	July	...	...
72,680	1	2½%	Monte Video Telephone Ordinary	⅜	⅝	⅜	⅝	5 0 0	November	...	...
86,492	1	1 0	Do. 5 per Cent. Preference	¾	1	¾	1	5 0 0	„	...	...
490,000	5	3/0	National	5⅛	5⅜	5⅛	5⅜	5 6 8	February and August	5⅛	5⅜
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Preference	14	15	14	15	4 0 0	„ „	...	...
15,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference	14	15	14	15	4 0 0	„ „	14⅛	...
207,930	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref.	5⅜	5⅝	5⅜	5⅝	4 8 11	„ „	5 1/16	5⅛
1,329,471	Stock	3½%	* Do. Debenture Stock 3½ per Cent. (red.)	98	100	98	101	3 10 0	June and December	99½	97¾
171,504	1	0/4	Oriental	¾	1	¾	1	5 0 0	April and October	...	...
58,000	5	2/6	United River Plate	4½	5½	4½	5½	7 2 10	July	...	...
16,639	5	1/4	Do. 5% Cumulative Preference	4½	5½	4½	5½	5 12 7	June and December	...	...
£179,917	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	103	105	103	106	4 14 4	„ „	...	...

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	NAME.	Previous Week's Price, Feb. 7.		Price Wednesday, Feb. 14.		Rate per Cent. Yielded. £ s. d.	Dividend Due.	Business Done During Week Ending Feb. 14. Highest	Lowest
			ELECTRICITY SUPPLY COMPANIES.								
100,000	1	...	Bl'okh'th & Gr'nw'ch D'st'ct Elec.Lt.Ord.(fully pd.)	⅜	½	⅜	½	...	...	...	...
6,000	10	7/9⅔	Bournemouth and Poole Elec. Supply Ord.	12	13	12	13	3 0 0	...	13⅛	12½
6,000	10	4/6	Do. 4½ per Cent. Cumulative Pref. xd	10	11	10	11	4 1 10	...	...	...
19,661	5	2/6	Brompton & Kensington Electricity Supply Ord.	7	8	7	8	3 15 0	...	...	...
12,000	5	3/6	Do. 7 per Cent. Preference	8½	9½	8½	9½	3 13 8	March and September	...	...
20,000	5	...	Calcutta Elec. Supply Ordinary (fully paid)	6½	7	6½	7⅛	...	...	...	...
30,000	5	4/0	Charing Cross & Strand Electricity Supply Corp.	10½	11½	10	11	3 18 8	February and August	10 5/16	10½
20,000	5	...	Do. (Nos. 30,001 to 50,000)	10	11	10	11	...	...	...	...
20,000	5	2/3	Do. 4½ per Cent. Preference	5⅝	6½	5⅝	6½	3 13 0	,, ,,	5⅝	...
34,000	5	2/6	Chelsea Electricity Supply Ordinary	7⅛	8⅛	7⅛	8⅛	3 10 7	March	...	...
£100,000	Stock	4½%	* Do. 4½ per Cent. Debenture Stock (red.)	109	111	110	112	4 0 11	June and December	...	...
$1,200,000	$1,000	5%	Chicago Edison 1st Mort.5% 30 year Gold Bonds(red.)	100	110	100	110	4 10 11	April and October	...	...
60,000	10	7/0	City of London Electric Lighting Ordinary	10½	11½	10½	11½	5 4 4	February and August	10⅝	...
40,000	10	6%	Do. 6 per Cent. Cumulative Preference	13	14	13	14	4 5 9	January and July	13⅛	13⅛
£400,000	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	122	127	122	127	3 13 9	June and December	...	...
40,000	10	...	County of London and Brush Prov. Ordinary	9½	10½	9½	10½	...	...	10⅛	...
20,000	10	6/0	Do. 6 per Cent. Cumulative Preference	13½	14½	12½	13½	4 8 11	March and September	...	...
£200,000	Stock	4½%	Do. 4½% Deb. Stock Certs. (all pd.) (red.)	108	111	108	111	4 1 3	...	111	...
15,000	5	10%	Kensington and Knightsbridge Ordinary	12	13	12	13	4 1 6	...	...	...
10,000	5	6%	Do. 6 per Cent. 1st Preference	7½	7⅝	7	7⅛	4 0 0	January and July	...	...
110,000	3	...	London Electric Supply Ordinary	1⅝	2⅛	1⅝	2⅛	...	...	2	1 15/16
45,050	5	3/0	Do. 6 per Cent. Preference	4½	5½	4⅝	5	6 0 0	...	5	4⅝
£100,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures	101	103	101	103	3 18 1	Mar., June, Sept., Dec.	...	...
62,500	10	5/0	Metropolitan Elec. Supply Ord. (Nos. 1 to 62,500)	14½	15½	14½	15½	3 4 6	April and October	15½	...
22,500	10	3/7½	Do. (Nos. 62,501 to 85,000)	14	15	14	15	3 5 8	...	14⅝	14⅛
£220,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage	114	117	114	117	3 16 11	June and December	...	...
£125,000	Stock	24/8	Do. 3½ per Cent. Mort. Deb. Stock (red.)	95	97	95	97	3 12 3	...	96½	...
6,452	10	6/0	Notting Hill Electric Ordinary	15½	16½	16	17	3 10 7	March	16⅜	...
10,000	5	5/0	Oxford Electric Ordinary	6 7/16	7 7/16	6 7/16	7 7/16	3 9 0	,,	...	...
300,000	1	8%	Rand Electric	½	½	½	½	10 13 4	...	...	...
£130,070	Stock	5%	River Plate El.Lt. & Tr'ct'n, Ltd., 5% 1st Mor.Deb.	75	85	75	85	5 18 0	...	...	...
150,000	$100	$2	Royal Electric Company of Montreal Shares	150	170	150	170	4 14 2	...	...	...
£123,200	100	4½%	* Do. 4½ per Cent. 1st Mortgage Debentures	104	106	104	106	4 5 6	April and October	...	...
31,980	5	5/6	St. James's and Pall Mall Electric Ordinary	15	16	15	16	4 10 8	February and August	15⅜	15½
20,000	5	3/6	Do. 7 per Cent. Preference	9	9½	9	9½	3 13 8	,, ,,	...	...
65,000	5	...	South London Electric Supply Ordinary (fully paid)	4	4⅛	4	4⅛	...	...	...	...
79,900	5	5/0	Westminster Electric Supply Ordinary	14½	15⅛	14	15	4 0 0	March and September	14⅝	...
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
125,000	1	7½d.	Aron Electricity Meter 6 per Cent. Cum. Pref.	⅜	½	⅜	½	6 17 3	...	...	...
45,000	1	...	British Electric Works Co. Ordinary	⅜	1	1	1⅛	...	...	...	...
50,000	1	...	Do. 5 per Cent. Cumulative Preference	½	1	½	1	...	...	...	...
£50,000	100	...	Do. First Mortgage Debentures	97	99	99	101	...	...	...	...
40,000	5	5/0	British Insulated Wire Ordinary	13	14	13	14	3 11 5	...	...	...
27,500	5	3/0	Do. Preference	6	6½	6	6½	4 12 4	...	6⅜	...
90,000	2	2/0	Brush Electrical Engineering	1⅞	2	1⅞	2	5 0 0	September	1 15/16	...
90,000	2	1/2½	Do. 6 per Cent. Pref. Non-Cumulative	2⅛	2⅜	2⅛	2⅜	5 1 1	,,	2⅛	...
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Deb. Stock	110	115	110	115	3 18 5	February and August	...	...
£50,000	Stock	4½%	* Do. 2nd Debenture Stock (red.)	102	105	102	105	4 5 9	June and December	...	...
20,000	5	5/0	Callender's Cable Construction Ordinary	13½	14½	13½	14½	5 3 5	,, ,,	13⅞	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5½	6	5½	6	4 3 4	...	5 1/16	5⅛
£90,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb. (red.)	110	115	110	115	3 18 3	November and May	110⅛	...
300,000	1	0/9⅜	Castner-Kellner Alkali Co. (fully paid)	1⅛	1⅜	1⅛	1⅜	5 16 5	...	...	...
60,000	1	0/7½	Chadburn's Ship Telegraph Ordinary	⅞	1⅛	⅞	1⅛	5 6 8	...	...	...
60,000	1	0/7½	Do. 6 per Cent. Cumulative Preference	⅞	1⅛	⅞	1⅛	5 6 8	...	...	...
32,098	3	1/9⅜	Crompton and Co. (Nos. 1 to 32,098)	3½	4	3½	4	4 10 9	January and July	...	...
£100,000	100	5%	* Do. 5 per Cent. First Mortgage Deb. (red.)	98	101	98	101	4 19 0	,, ,,	100	...
60,000	1	0/3	Davis and Timmins 6 per Cent. Cum. Pref.	¾	1	¾	1	...	...	...	...
99,261	5	1/9⅜	Edison and Swan United ("A" Shares) (£3 paid)	2	2⅛	2	2⅛	7 3 9	February and August	2⅛	2 1/16
17,139	5	2/9⅜	Do. (£5 paid)	3½	4⅛	3½	4⅛	6 13 4	,, ,,	4⅛	...
£314,023	Stock	4%	Do. 4 per Cent. Mortgage Deb. Stock (red.)	93	95	93	95	4 4 3	June and December	...	...
26,100	5	5/11⅛	Edmundson's Electric Corporation Ord.(fully pd.)	4⅛	5⅛	4⅛	5⅛	5 14 3	Half-yearly	...	...
112,100	2	1/2⅜	Electric Construction Co. (Limited)	2⅛	2⅜	2⅛	2⅜	5 1 1	January and July	2 1/16	2⅛
25,000	3	2/9⅜	Do. 7 per Cent. Cumulative Preference	3⅛	3⅛	3⅛	3⅛	4 6 2	July	...	...
182,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	103	106	103	106	3 15 6	January and July	...	...
30,000	5	...	Henley's Telegraph Works Ordinary	13½	14½	13½	14½	...	February and August	14½	14
15,000	5	...	Do. 4½ per Cent. Preference	5½	6	5½	6	3 15 0	,, ,,	...	...
£50,000	Stock	4½%	Do. 4½ per Cent. Mortgage Deb. Stock (red.)	111	114	111	114	4 0 0	,, ,,	...	...
50,000	10	10/0	India Rubber, Gutta Percha, &c., Works	21	22	21	22	4 11 10	,, ,,	21½	...
£300,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	100	104	100	104	3 16 11	March and September	...	...
37,350	12	12/0	Telegraph Construction and Maintenance	37	41	37	41	4 7 9	March and July	39	37½
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909	102	105	102	105	3 16 2	...	...	...
20,000	5	3/0	Do. Manufacturing Ordinary	9	10	9	10	3 10 0	...	...	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5½	6	5½	6	4 3 4	...	...	...
30,000	5	5/0	Willans and Robinson Ordinary	9½	10½	9½	10½	4 5 8	April and October	10½	10
30,000	5	3/0	Do. 6 per Cent. Cumulative Preference	7½	7⅞	7½	7⅞	3 17 5	,, ,,	7 15/16	7⅞
£100,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Debentures	104	106	104	106	4 0 2	May and November	...	...
			ELECTRIC RAILWAYS, TRAMWAYS, &c.								
12,000	10	6/0	Blackpool and Fleetwood Tramways	17½	18½	17½	18½	3 15 8	...	...	...
£167,900	100	5%	Brisbane Tramway 5 per Cent. Debentures	104	106	104	106	4 14 4	...	...	...
50,000	10	7%	Bristol Tramways and Carriage Ordinary	23	24	23	24	2 17 3	February and August	...	...
25,000	10	...	Do. Cumulative Preference (£6 paid)	6½	6¾	6½	6¾	...	...	...	...
£100,000	Stock	4%	Do. 4 per Cent. Debentures	117	118	117	118	3 7 3	...	...	...
30,000	10	9/0	British Electric Traction Ordinary (Nos. 1 to 30,000)	16	17	16	17	3 10 7	...	16⅝	...
£15,000	10	...	Do. (Nos. 30,001 to 75,000)	15½	16½	15½	16½	...	...	...	...
30,000	10	6/0	Do. 6% Cum. Pref. (Nos. 30,001 to 60,000) xd	13½	13⅝	13½	13⅝	4 7 3	...	13⅝	13½
£200,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures	125	128	125	128	3 18 6	...	126	...
40,000	5	1/9	Buenos Ayres & Belgrano 6% "A" Cum. Pref.	4⅞	5⅛	4⅞	5⅛	5 17 1	...	5 1/16	...
27,500	5	...	Do. "B"	4	4⅛	4	4⅛	...	...	4 1/16	4
320,000	Stock	5%	Do. 5 per Cent. Debentures	105	108	105	108	4 12 7	...	...	...
213,553	10	3/0	Central London Ordinary	9½	10	9½	10	3 0 0	June and December	10	9⅝
£855,000	Stock	1¼%	City and South London Railway Con. Ordinary xd	59	62	58	61	3 1 6	January and July	59½	...
37,000	10	...	Do. (Nos. 22,501 to 60,000) (£5. 10s. paid)	4	5	4	5	...	...	...	...
£150,000	Stock	5%	Do. 5 per Cent. Perpetual Preference (1891) xd	143	145	140	145	3 9 0	January and July	...	...
£200,000	Stock	5%	Do. (1896) xd	135	140	132	137	3 13 0	...	...	...
2187,701	Stock	4%	Do. 4 per Cent. Perpetual Debenture	125	130	125	130	3 1 11	May and November	...	...
20,000	10	7½%	†Imperial Tramways Ordinary	23	24	23	24	...	March and September	...	...
10,000	10	6%	† Do. 6 per Cent. Preference	15	15½	15	15½	3 16 2	,, ,,	...	...
£300,000	Stock	4½%	† Do. 4½ per Cent. Debenture	113	115	113	115	3 17 11	January and July	...	...
30,000	10	1/3	Kidd'rm'nst'r&Dist.E.L.&Tr'ct'n 5% Pref.(£8 pd.)	8	8½	8	8½	4 14 1	May and November	...	...
37,500	10	2½%	Liverpool Overhead Railway Ordinary	9⅜	9½	9 15/16	9 15/16	3 7 0	February and August	...	...
10,000	10	5%	Do. 5 per Cent. Preference	13	13½	13	13½	3 15 6	,, ,,	...	...
125,000	Stock	4%	Do. 4 per Cent. Debenture	105	107	105	107	3 14 11	January and July	...	...
24,000	5	...	New General Traction Ordinary	3⅞	4	3⅞	4	...	...	...	...
30,000	5	6/0	Do. 6 per Cent. Cumulative Preference	5	5⅛	4⅞	5⅛	5 11 3	May	...	...
4,000	10	...	Oldham, Ashton and Hyde Elec. Tramway Ord.	18	19	18	19	...	February and August	...	...
4,000	10	5/0	Do. 5 per Cent. Preference	10⅜		10⅜	10⅝	4 11 11	,, ,,	...	...
13,334	10	...	Potteries Electric Traction Ordinary	11⅛	12⅛	11⅛	12⅛	...	...	...	...
20,000	10	5/0	Do. 5 per Cent. Cumulative Preference	10	11	10	11	4 10 11	...	...	...
£5 40,000	Stock	3%	Waterloo and City Ordinary xd	101	104	101	104	2 17 8	June and December	...	...

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.
† The London Stock Exchange Committee refuses to quote these.

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THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,136. [No. 18. Vol. XLIV.] FRIDAY, FEBRUARY 23, 1900. PRICE SIXPENCE (by post, 6½d.), Abroad, 8d., or 15 cents, or 80/r., or 70pf.

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NOTES.

MR. OLIVER HEAVISIDE resumes this week his valuable series of articles on "Electromagnetic Theory." Our readers will have missed his luminous mathematical treatment of important aspects of electrical theory during the time that has elapsed since he brought to a close the articles embodied in Vol. II. of his treatise. They will now be able to follow him into remoter recesses of the labyrinth of electromagnetic theory, and perchance some of them will be inspired by the vigour and originality of his treatment to investigate for themselves along new lines of applied theory. For it is not the truth that theory must always follow the lead of practice; on the contrary, fresh fields for practical research are not infrequently revealed by the light of newly-developed theory.

INTEREST will be excited in electrical financial circles as to the manner in which the Kensington and Knightsbridge Electric Lighting Co. and the Notting Hill Co. intend to adjust their arrangements with regard to the new works which are to be erected and run in their joint interests. The report to the shareholders of the first-named company states that provision will have to be made "for its proportion of the capital expenditure," which can be readily understood; but by what magic process this proportion is to be assessed "in proportion to the extent to which each company shall participate in the output of the new works" is not disclosed. An output is a continuous phenomenon—it goes on indefinitely; whereas a capital expenditure is an event of a definite period. The intelligent shareholder is left to conjecture whether it will be the output of the first year, or the tenth, or of the first ten years, upon which the share of costs is to be assessed. Then, again, the extent to which each company will be a burden on the new works will not be a simple matter of output, but a far more complicated question involving considerations of load factor, &c.

BETTER light, however, is thrown upon the details of the arrangement by the report of the directors of the Notting Hill Electric Lighting Co., and this discloses a scheme possessing several points of novelty:—

> It is estimated that the expenditure on these joint works will amount to between £80,000 and £100,000, and it is proposed to raise the necessary capital by a loan to be redeemed by a sinking fund in the year 1931, when the property of this company is liable to be purchased by the local authority. The two companies have entered into a mutual agreement to take current from the station in accordance with their several requirements, and to contribute each year, in proportion to the current taken, such amount as may be required for the working expenses and upkeep, together with the interest and sinking fund of the borrowed capital. In the year 1931 the property will revert, free of encumbrances, to the two companies in proportion to the respective amounts contributed.

This scheme, it will be discerned, is the first important step towards that complete fusion of interests of these two undertakings which is their manifest destiny, unless indeed the local authorities devour them.

THE rapidity and persistence of the increase of popularity of electric supply for lighting and general purposes is well illustrated by the facts brought out at the recent Local Government Board inquiry into the application of the Leicester Corporation for power to borrow an additional £100,000 for electric supply works extensions. The inspector who conducted the inquiry was evidently surprised at the amount it was proposed to borrow, especially since only three years ago the Corporation had borrowed some £34,000 for the same purpose. But Mr. COLSON, the energetic and enterprising engineer to the Corporation, was able to make it quite clear where all the money had gone, and why so large an additional sum was now urgently needed. An increase from 204,084 units in the latter half of 1897 to 437,943 units in the corresponding six months in 1899 spoke for itself, and sufficed to excite amazement in the inspector. Moreover, notwithstanding a reduction in the price per unit, the last half-year showed a profit sufficient to pay off the original net loss and leave a small margin. Mr. COLSON'S

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scheme of extensions involves an increase in capacity of the power station sufficient to raise it to 3,400 kilowatts, together with the laying down of some 36 miles of new mains. Some £18,000 will be spent on new buildings, £34,000 on new plant at the station, and £34,000 on new cables, leaving a balance to cover the capital already over-expended.

THE current number of the *Nineteenth Century* contains a timely article, from the pen of Mr. CAMPBELL SWINTON, on "Electrical Engineering and the Municipalities." Partly a brief summary of the history of the attitude of local authorities towards electrical development in this country, and partly an attempt to forecast the consequences of persistence in this mischievous policy, the article as a whole is an able and lucid statement of the case as against municipal interference. It is enough for us to say, with regard to Mr. SWINTON'S arguments, that they reiterate what we ourselves have repeatedly advanced. Municipal supineness and opposition in the pioneer days of electrical progress have been followed by municipal greed and misplaced monopolising now that the prospects of profit are secure. If it was right that municipalities should refrain from speculating with ratepayers' money in the early uncertain days, it is equally just to demand now that they shall not use ratepayers' money to thwart private enterprise in the development of new lines of progress.

THE well-known American steam engineer, Mr. C. T. PORTER, has announced that he expects to produce a horse-power with 9lb. of steam per hour "before the century expires." To accomplish this in so short a time he must needs have the details well worked out already. Superheated steam and high ratios of expansion appear to be the plan of action. The boiler pressure is to be 300lb., and the expansion in the engine is to be fixed for all loads at 30 volumes. Regulation is to be effected by throttle valve, the cut-off being fixed in all the four cylinders it is proposed to use. We should like to see the light-load diagrams of the two lower pressure cylinders; they would scarcely commend themselves to electric power station engineers. However, when the new century dawns we hope to hear more about this wonderful engine; and if it bears out Mr. PORTER'S expectation it will not be unwelcomed by electrical engineers. But perhaps he is a twentieth century man, in which case he has plenty of time before him.

A CORRESPONDENT, who has a grievance against the way foreign languages are taught in this country, and particularly against the omission of technical terms from dictionaries claiming to be up to date, writes to suggest that we might help in the matter by publishing in our magazine "a short catalogue of technical electrical terms and phrases, with their translation into various modern languages." We do not know how many modern languages would satisfy him, but we have in our library a dictionary of about 3,000 pages dealing only with technical terms in German, French, and our own mother tongue. It would greatly lighten our editorial duties, and simplify technical journalism immensely, if we were to turn *The Electrician* into a polyglot dictionary for a year or two; but we are afraid this would be impracticable, if not distinctly Utopian.

The Royal Society.—Among the Papers down for reading yesterday was "The Ionisation of Dilute Solutions at the Freezing Point," by W. C. D. Whetham.

Obituary.—A Reuter's telegram from Rome announces the death of Senator Betrami, the eminent mathematician and President of the Accademia del Lincei.

Municipal Trading.—In reply to a question from Mr. Kimber in the House of Commons on Monday last, Mr. Balfour stated that he proposed to put down the Committee on Municipal Trading on the paper without delay.

The Electrical Engineers (R.E.) Volunteers.—*The Times* of Tuesday last states that the Electrical Engineers Volunteers, who are shortly to embark for the Cape, are to be provided from ordnance stores with camp equipment on the same scale as for regular troops.

Cable Interruptions:—

	Date of Interruption.
Latakia—Cyprus	June 21, 1899
Cayenne—Pinhieros	Oct. 11, 1899
Tangier—Tarifa	Jan. 3, 1900
Paramaribo—Cayenne	Feb. 16, 1900
Ceara—Maranham	Feb. 20, 1900

Personal.—Owing to the death of his brother, in consequence of an accident in the hunting field, Mr. C. E. Hodgkin has been compelled to resign his position as works manager at the Falcon Works of the Brush Electrical Engineering Co. On terminating his duties at Falcon Works Mr. Hodgkin will join the board of the Brush Co.

Northern Society of Electrical Engineers.—The annual dinner of this society was celebrated on Friday last at Manchester. The occasion was of peculiar importance, inasmuch as it marked the cessation of the Northern Society, as such, and the inauguration of its new life as the Manchester section of the Institution of Electrical Engineers.

The Late Prof. Hughes.—At the meeting of the French Academy of Sciences, held on Feb. 12, it was announced that the late Prof. D. E. Hughes had bequeathed to that institution a sum of £4,000, the income of which is to be used as a prize for the most important discovery in physical science, preference being given to a discovery in electricity or magnetism.

Triplicate Cable between Europe and South Africa.—The laying of the cable between Ascension and St. Vincent was finished yesterday (Thursday), thus completing (in conjunction with existing duplicate lines of the Western Telegraph Co. and existing triplicate lines of the Eastern Telegraph Co.) a triplicate route to South Africa. This route is now open for traffic.

Dry Batteries.—A German contemporary recommends the following composition for filling dry cells. The formula has been given by Herr B. Fischer, of the Breslau laboratory. Crystallised calcium carbide ($CaCl_2 + 6H_2O$) 30 per cent., granulated calcium chloride 30 per cent., ammonium sulphate 15 per cent, crystallised zinc sulphate ($ZnSO_4 + 7H_2O$) 25 per cent.

Carbon Electrodes.—Mr. Roberts, of New York, has recently patented a method for the manufacture of carbon electrodes which has some claims to novelty. In lieu of the ordinary carbonaceous materials which have been employed for binding together the ground carbon or coke, he uses glass dust, which he mixes with the granulated carbon, which is then subjected to hydraulic pressure in a red-hot mould, so that the liquid glass is forced into the interstices between the carbon particles. The conducting quality of the electrode is improved if its surface is removed by means of an emery wheel, or by immersion in a hot solution of caustic soda. Only sufficient glass to bind the carbon is used, any excess being squeezed out by the pressure employed.

Water Power from the Chicago Drainage Canal.—According to the *Engineering News* of New York, an agreement has been come to by the Chicago city electrician and the engineer of the drainage canal for the utilisation of the water power from the drainage canal for electric lighting and power purposes. The total amount of power which can be developed at the wheel is estimated at 20,000 H.P., of which, allowing for a 20 per cent. loss in transmission, about 16,000 H.P. will be delivered to the machines.

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The rental to be paid by the city is $80,000, which, together with the cost of developing the power (including electrical equipment, cables, &c., and dams and works at the wheels), involving an outlay of $3,100,000 corresponds to $14 per H.P., thus comparing very favourably with the $30 per H.P. as generated by steam. The lease is for 75 years. The work must commence within 90 days from the signing of the contract, and be completed by July 1, 1901.

The Post Office Metropolitan Telephone System.—All the exchanges which the Post Office will erect in London will be on the Western Electric Co.'s central battery system, described in detail in *The Electrician*, Vol. XLIII., p. 401. It will be remembered that in this system there are no batteries at the subscribers' end of the line, all being concentrated at the exchange. In addition, the calling signal is transmitted automatically, on the subscriber removing his telephone from its hook, and the clearing signal is also automatically conveyed as soon as the receiver is replaced. The indicators in the exchange are miniature incandescent lamps, and there is a clearing lamp on each cord of every pair, so that the operator does not break the connection until both subscribers have hung up their receivers. The engineering department of the Post Office does not anticipate serious difficulty in connection with "extension instruments," and is satisfied that the system will adapt itself satisfactorily to trunk line communication.

Double-Current Generators.—The following opinion of our contemporary the *Electrical World* of New York on the controversial question of double-current generators is of interest. It is confined to a consideration of the suitability of such machines for use as an auxiliary on a continuous-current electric lighting system using an alternating current for suburban districts:—

> For general alternating-current distribution a central station double-current machine should deliver 60 cycles from its collector rings. To be sure, 60-cycle rotary converters are common, but it must be remembered that they have a much higher angular speed than is common in generators. It is true that in at least two cases 60 cycles is the frequency used with double-current machines and long-distance transmission and reconversion for railway purposes, but the generators in these cases are belted. It is difficult to see how under existing conditions of engine speed a direct-connected 60-cycle double-current machine could be built. Look where one will from 50 to 5,000 H.P. sizes, and it will be found that direct-connected 60-cycle alternators force the engine speed up to maximum allowable limits and force the armature diameter out until economy of material is considerably sacrificed, and even then the poles are crowded for an alternator and squeezed beyond all reason for a direct-current machine. It is needless to state that where such a refinement as double-current working is desired belts would be out of the question. Under existing conditions about the only cases where direct-coupled double-current 60-cycle machines could be used are hydraulic plants with high heads using wheels with high rotational speeds. A probable new factor in steam electrical work which would make 60-cycle double-current machines easy of construction is the steam turbine. Large direct-coupled alternators now building have four poles and run at 1,800 revs. per min., giving 60 cycles. The angular speed is so high that a great peripheral speed is obtained with the most desirable ratio of armature diameter to length. This high peripheral speed gives room between pole centres even at 60 cycles for the many slots and teeth necessary for direct-current work.

Death from Low-Pressure Shock.—A remarkable case of death from low-pressure shock is recorded in detail by Herr Alfred Kolben in the *Elektrotechnische Zeitschrift* of Feb. 15. The accident occurred in a chemical factory near Prague, in which electric power transmission from a 200 H.P. three-phase dynamo is employed. The lighting of the factory was usually carried out from a 110 volt continuous-current dynamo, but, at the time, the lamps were connected between the mains and neutral point of the power generator during repairs to the continuous-current machine. As the pressure on each phase was 190 volts, the pressure between the neutral and mains was 110 volts. The unfortunate man was standing on the wooden cover of a wrought-iron cylinder containing soda lye, the cover having upon it a layer of potash saturated with the soda lye, and he therefore was in excellent contact with earth. He touched with his hand a bare conductor leading to a lamp, and was unable to remove his hand. He was pulled away five minutes later, and life was found to be extinct. Subsequent measurement showed that a pressure of only 95 to 96 volts existed between the wire in question and earth, and no leakage to earth could be found anywhere on the system. A post-mortem examination revealed that the man suffered from chronic alcoholism, a condition which renders a man particularly sensitive to electric shock. This accident again points to the necessity of the most perfect insulation and protection of all wires and apparatus forming part of an electrical installation in a chemical factory, or in similar situations where men are working under conditions which decrease the electrical contact resistance of their skin.

An Improved Form of Wehnelt Interrupter.—Those who have had occasion to work with the electrolytic interrupter constructed in the manner originally described by Wehnelt are all aware of the considerable difficulties which intervene in its use owing to the glass tube containing the platinum wire cracking. Very little improvement is experienced by substituting indiarubber or porcelain for the glass. Dr. R. H. Cunningham describes, in a recent number of the *Electrical Review* of New York, a form of interrupter applicable for light and heavy currents, which it is claimed is perfectly durable. The details of its construction are as follows: The acid electrolyte is contained in a hard-rubber cell, with a tight-fitting top that is perforated for the insertion of the anode and for the two ends of the coil of small lead pipe that forms the cathode. A short tube of hard rubber is screwed into the top, and through this the fumes escape *via* a flexible rubber tube into a jar containing a number of sponges moistened with a strong solution of washing soda By syphoning water through the lead pipe any desired temperature of the electrolyte can be maintained for hours. The adjustable anode is made of a brass rod threaded with a long thread at the upper end for the adjusting thumb-nut, and into the lower end the requisite sized platinum wire is brazed with silver solder. After thoroughly coating this rod with some thick unguent—for instance, with vaseline—it is inserted into a thick-walled, closely-fitting, hard-rubber tube that has a *lava* bushing firmly screwed and cemented into its lower end with some acid-proof, non-conducting cement. The hole through this bushing should be smooth, and the platinum wire should fit snugly. If a thick platinum wire (No. 6 or No. 8) is used, this form of the interrupter is capable of passing heavy currents without the least danger of breaking down.

MEETINGS OF SCIENTIFIC AND ENGINEERING SOCIETIES, &c.

(TO-DAY) FRIDAY, February 23rd.

PHYSICAL SOCIETY.

5 p.m. Meeting in the Rooms of the Chemical Society, Burlington House. Agenda: Prof. R. W. Wood, of the Wisconsin University, U.S.A., will exhibit and describe his (1) Photographs of Sound Waves and the Kinematographical Demonstration of the Evolutions of Reflected Wave-Fronts; (2) a New Seudoscope; (3) Diffraction Colour-Photographs; (4) Artificial Parhelia.

ROYAL INSTITUTION.

9 p.m. Evening Discourse "Recent Studies in Gravitation," by Prof. J. H. Poynting, F.R.S.

SATURDAY, February 24th.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.

6 p.m. General Meeting in the Lecture Theatre, Technical College, Hart-road, West Hartlepool. Included in the business of the evening is a Paper by W. C. Borrowman on "Some Considerations affecting the Training of Young Engineers."

WEDNESDAY, February 28th.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. Paper to be read: "Pneumatic Despatch," by Prof. C. A. Carus-Wilson.

FRIDAY, March 2nd.

PHYSICAL SOCIETY.

4 30 p.m. Special Meeting in the Physical Laboratory, University College, Gower-street. Papers to be read: (1) "The Relative Rates of Effusion of Argon, Helium, and some other Gases," by Dr. F. G. Donnan. (2) "On the Distillation of Liquid Air and the Composition of the Gaseous and Liquid Phases," by E. C. C. Baly. (3) "The Reversibility of Galvanic Cells," by T. S. Moore. (4) "On the Damping of Galvanometer Needles," by M. Solomon.

INSTITUTION OF JUNIOR ENGINEERS.

8 p.m. Meeting at the Westminster Palace Hotel. Paper to be read: "Electrolytic Zinc as a Protective Metallic Coating for Iron and Steel," by W. Paddon.

SATURDAY, March 3rd.

INSTITUTION OF JUNIOR ENGINEERS.

3 p.m. Visit to Messrs. Maudslay, Sons and Field's Belleville Boiler Works, East Greenwich.

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CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

Penetration of Polonium Rays.—The rays emitted by "polonium" are particularly remarkable on account of their being undeflected by a magnet, and on account of their lack of penetrative power. Their absorption is altogether anomalous. It has been found that Röntgen rays have the greater penetrative power the farther they have already penetrated. In other words, absorption weeds out all but the rays of the greatest penetrative power. In polonium rays, as pointed out by their discoverer, Sklodowska Curie, the case is just the opposite. Of two beams of equal intensity, that beam is most rapidly absorbed which has already had to penetrate an absorbing layer. The rays thus behave like a projectile which loses its penetrative force with every obstacle it has to penetrate. The author's experiments go to show that polonium rays do not penetrate the air at ordinary pressures farther than about 4cm., or about the same distance as Lenard rays. Those radium rays which are not deflected by a magnet behave exactly like polonium rays. It is difficult to discover any law of absorption in radium rays by themselves, as they consist of two species of rays obeying different laws of absorption. It is possible that these different laws indicate a fundamental difference in the nature of the deflected and undeflected rays.

[S. Curie, *Comptes Rendus*, Jan. 8, 1900.]

A Magnetic Anomaly.—One of the most extraordinary magnetic anomalies is presented by the province of Kursk in Russia. At the invitation of the Imperial Russian Geographical Society, the French Minister of Public Instruction sent Prof. Moureaux to make a magnetic survey of that region. Taking the town of Kursk as a base, Prof. Moureaux made excursions to 109 different stations in the province. The plateau between the Plota and Solotinka rivers extends over an area of about 2 sq. miles. In this restricted area the declination was found to vary from 34deg. E. to 96deg. W., and the inclination from 48deg. to 79deg., values which correspond respectively to the normal inclinations in Morocco and Spitzbergen. But the most remarkable abnormality is to be found in the intensity, which yielded horizontal components varying from 0·50 to 0·59, and vertical components exceeding 0·97. The observations have since been continued by Prof. Leyst of Moscow, who found a point near Kotchetowka where the dipping needle points vertically. There is nothing observable in the surface conditions of this region to explain its magnetic characteristics. It is a rolling country, covered with a very fertile black soil reposing upon cretaceous rock. No iron has been found down to depths of 600ft. below the surface.

[G. W. Littlehales, *Terr. Magn.*, Dec., 1899.]

Magnetic Hemispheres.—A. de Tillo traces a well-marked connection between the magnetic elements and the distribution of land and sea over the globe. It is evident that the hemisphere bordered by the degrees of longitude from 170 deg. to 350deg. E. contains most dry land, amounting, as it does, to 22 per cent. more than the opposite hemisphere. Still, the hemisphere between 110deg. and 290deg. is almost as continental, as it comprises 20 per cent. more land than the opposite hemisphere, which includes the whole of the Pacific. Magnetically, two divisions are possible. If the total force is considered, the maximum hemisphere extends from 90deg. to 270deg., while the declination yields a positive hemisphere extending from 130deg. to 310deg. The mean between these two would be just the hemisphere from 110deg. to 290deg. which, as already mentioned, excludes the Pacific. This same hemisphere is also distinguished as regards temperature, for it is the coldest of hemispheres that the earth can be split up into through the poles. These facts indicate a general rule that low temperature and prevalence of land go hand in hand with western declination and northern dip. The author does not investigate whether the land or the temperature are the primary cause, and he excludes the polar regions north and south of 60deg. from consideration.

[A. de Tillo, *Terr. Magn.*, Dec., 1899.]

Resistance Hysteresis.—When a wire is subjected to periodic variations of temperature its electric resistance varies in a very irregular manner. If R is its resistance at a temperature T_0, and it is heated to a temperature T_1 and subsequently cooled down to T_0, its resistance will finally be different from R. The difference is due to some allotropic transformation undergone by the metal, which is subject to hysteresis. There is not only a change of temperature, but also a complication introduced by the alternate annealing and tempering of the wire. Some system is introduced into the complications by the work of H. Chevallier on a silver platinum alloy which resists oxidation. He made the temperature oscillate a large number of times between T_0 and T_1, and found that the resistance at T_0 acquired values differing from each other by a less and less amount as the alternations proceeded, without the difference, however, disappearing entirely. Several series of 70 oscillations each between 150deg. and 15deg. gave final values for 15deg. amounting to 1·01509, 1·01500, 1·01493, 1·01490, 1·01488, and 1·01487 respectively. The last limiting value is practically final for 15deg., but it is disturbed by heating the wire to a temperature above 150deg. By repeating the oscillations and introducing the disturbance systematically the author obtains a limit of the limits which completely fixes the final temperature for the range and disturbance specified.

[H. Chevallier, *Comptes Rendus*, Jan. 15, 1900.]

Scalar and Vector Masses.—Vaschy showed some time ago that any vector field can be specified by means of (1) scalar masses analogous to discontinuous bodies, or the Laplacian masses of electricity or magnetism; (2) vector masses acting like current elements, and localised in places where the vector field is not derived from a potential. A. Broca points out that the latter can be replaced by "shells" of the former, analogous to magnetic shells. He further proves the following proposition: If in any vector field there is a transformation of energy, either permanent or variable, or if there are bodies in it which do not allow the field to exist within the space which they occupy, Vaschy's scalar and vector masses exert a mechanical action upon each other, which is of the same mathematical form as the action between magnetic masses and elements of a current. If the field has a finite rate of propagation for any disturbance, its production is due to localised energy. Stated in this general form, the proposition covers a great variety of phenomena—not only those of electricity and magnetism, but also those of bodies floating on the surface of liquids, of acoustic resonators, the pulsating spheres of Bjerknes, and a number of other mechanical analogies of electromagnetic phenomena. The theoretical proofs are based upon the conservation of energy.

[A. Broca, *Comptes Rendus*, Jan. 15, 1900.]

Last Week's Snowstorm.—From every part of the country news comes of the terrible havoc and considerable destruction to life and property occasioned by the recent heavy snowstorms. Men have been frozen to death, railways have been obstructed, rivers have become flooded and have overflowed their banks, and telegraph and telephone lines have given way under the strain of the wet snow accumulating on and clinging to the wires. The worst accounts came from—though by no means confined exclusively to—the North Country districts. Telegraphic communication between London and Glasgow, Newcastle-on-Tyne, Middlesbrough, West Hartlepool, Sunderland, Bradford, Leeds, Sheffield, and Nottingham was practically stopped. Only three out of the twenty lines between London and Glasgow were available, while only two of the twelve lines between Manchester and Liverpool remained intact. Telegraphic and telephonic communication between Greenock and the Clyde coast towns was stopped, owing to the posts having been blown down. For the same reason the passenger train service on the entire North-Eastern railway system was suspended.

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ELECTROMAGNETIC THEORY.—CXII.*

BY OLIVER HEAVISIDE.

§ 451. The following story is true. There was a little boy, and his father said, "Do try to be like other people. Don't frown." And he tried and tried, but could not. So his father beat him with a strap; and then he was eaten up by lions.

Reader, if young, take warning by his sad life and death. For, though it may be an honour to be different from other people, if Carlyle's dictum about the 80 millions be still true, yet other people do not like it. So, if you are different, you had better hide it, and pretend to be solemn and wooden-headed. Until you make your fortune. For most wooden-headed people worship money; and, really, I do not see what else they can do. In particular, if you are going to write a book, remember the wooden-headed. So be rigorous; that will cover a multitude of sins. And do not frown.

There is a time for all things: for shouting, for gentle speaking, for silence; for the washing of pots and the writing of books. Let now the pots go black, and set to work. It is hard to make a beginning, but it must be done.

Electric and magnetic force. May they live for ever, and never be forgot, if only to remind us that the science of electromagnetics, in spite of the abstract nature of the theory, involving quantities whose nature is entirely unknown at present, is really and truly founded upon the observation of real Newtonian forces, electric and magnetic respectively. I cannot appreciate much the objection that they are *not* forces; because they *are* the forces per unit electric and magnetic pole. All the same, however, I think Dr. Fleming's recent proposal that electric force and magnetic force shall be called the voltivity and the gaussivity a very good one; not as substitutes with abolition of the old terms, but as alternatives; and beg to recommend their use if found useful, even though I see no reason for giving up my own use of electric and magnetic force until they become too antiquated.

Having thus got to the electric and magnetic forces, it is only a short step farther to near the end of the book—namely, to the simple cases in which they occur simultaneously. It does not follow that the matter which comes towards the end of a treatise—for instance, Maxwell's great work—is harder than that in the first chapter of his Vol. I. On the contrary, some parts of it are easier out of all comparison. In the course of the next generation many treatises on electromagnetics will probably be written; and there is no reason whatever (and much good reason against it) why the old-fashioned way of beginning with electrostatics (unrelated to the general theory) should be followed. After all, should not the easier parts of a subject come first, to help the reader and widen his mind? I think it would be perfectly practical to begin the serious development of the theory with electromagnetic waves of the easy kind. First of all, of course, there should be a good experimental knowledge all round, not necessarily very deep. Then, considering the structure of a purely theoretical work to co-ordinate the previous, a general survey is good to begin with, with consideration in more detail of the properties of circuits and the circuital laws. Then, coming to developments, start with plane electromagnetic waves in a dielectric non-conductor. The algebra thereof, even when pursued into the details of reflections, &c., is perhaps more simple than in any other part of the science, save Ohm's law and similar things; and the physical interest is immense. You can then pass to waves along wires. First the distortionless theory in detail, and then make use of it to establish the general nature of the effects produced by practical departures from such perfection, leaving the difficult mathematics of the exact results for later treatment. Now, all this and much more is ever so much easier than the potential functions and spherical harmonics and conjugate transformations with which electrostatics is loaded, and there is more exercise for the brains in the electromagnetic than in the electrostatic problems. The subsequent course may be left open. There are all sorts of ways.

§ 452. At present, in dealing with some elementary properties, the object is to smooth the road to the later matter. First of all, how prove the fundamental property of a plane wave, that it travels at constant speed undistorted, if there be no conductivity, or, more generally, no molecular interference causing dispersion and other disturbances? We have merely to show that the two circuital laws are satisfied, and that can be done almost by inspection. Thus, let the region between two parallel planes *aaa* and *bbb* be an electric field and a magnetic field at the same time, the electric force **E** being uniform and in (and parallel to) the plane of the paper, whilst **H** is also uniform, perpendicular to **E** and directed up through the paper. Also let their intensities be connected by $E = \mu v H$, or $H = cvE$; c being the permittivity and μ the inductivity, whilst v is defined by $\mu c v^2 = 1$. This being the state at a given moment, such as would be maintained stationary by steadily acting impressed forces $\mathbf{e} = \mathbf{E}$ and $\mathbf{h} = \mathbf{H}$ in the slab between the planes, what will happen later, in the absence of all impressed force?

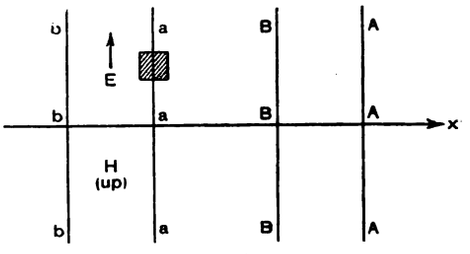

FIG. 1.

Apply the two circuital laws. They are obviously satisfied for all circuits which are wholly between the planes a and b, or else wholly beyond them to right or left. There are left only circuits which are partly inside and partly outside the slab. Consider a unit square circuit in the plane of the paper, as shown in the figure. The circuitation of **E** is simply E, and by the second circuital law this must be the rate of decrease of induction $\mathbf{B} = \mu\mathbf{H}$ through the circuit downward, or its rate of increase upward. Then turn the square circuit at right angles to the paper. The circuitation of **H** is then simply H, and by the first circuital law this must be the rate of increase of displacement $\mathbf{D} = c\mathbf{E}$ through the circuit. Now let the plane *aaa* move to the right at speed v. The two rates of increase are made to be $v\mu H$ and vcE respectively. That is, $E = \mu v H$ and $H = cvE$ express the circuital laws. They are harmonised by the definition of v. We prove that the circuital laws are satisfied in the above way. That there is no other way of putting induction and displacement in the two circuits may be seen by considering circuits two of whose

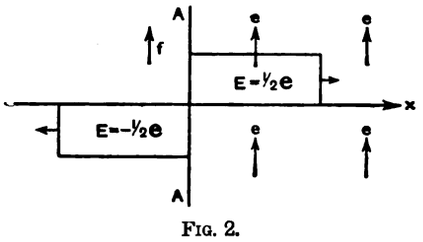

FIG. 2.

sides are infinitely near the plane a on opposite sides. The fluxes must be added on just at the plane itself, extending the region occupied by **E** and **H**. Similar reasoning applied to the plane *bbb* proves that it must also move to the right at speed v. Thus the whole slab moves bodily to the right at speed v, so that a moves to A and b moves to B in the time given by $vt = a\mathrm{A}$ or $b\mathrm{B}$.

The disturbance transferred in this way constitutes a pure wave. It carries all its properties with it unchanged. The density of the electric energy, or $\mathrm{U} = \frac{1}{2}cE^2$, equals the density of the magnetic energy, or $\mathrm{T} = \frac{1}{2}\mu H^2$. The flux of energy is $\mathbf{W} = v(\mathrm{U} + \mathrm{T})$, the simplest case of the general formula $\mathbf{W} = \mathrm{V}(\mathbf{E} - \mathbf{e})(\mathbf{H} - \mathbf{h})$. *See* Vol. I., § 70.

What is proved for a discontinuity is proved for any sort of variation. For the slab may be of any depth and any strength, and there may be any number of slabs side by side

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behaving in the same way, all moving along independently and unchanged. So $E = \mu v H$ expresses the general solitary wave, where, at a given moment, E may be an arbitrary function of x, real and single-valued of course, but without any necessary continuity in itself or in any of its differential coefficients. Denoting it by $f(x)$ when $t = 0$, it becomes $f(x - vt)$ at the time t.

If we change the sign, and make $E = -\mu v H$, this will represent a negative wave, going from right to left. There may be a positive and a negative wave coexistent, separate in position, or superimposed. This constitutes the complete solution for plane waves with straight lines of **E** and **H**. If E_0 and H_0 are given arbitrarily (with no connection) at the moment $t = 0$, the two waves at that moment are

$$\text{(positive)} \quad E_1 = +\mu v H_1 = \tfrac{1}{2}(E_0 + \mu v H_0),$$

$$\text{(negative)} \quad E_2 = -\mu v H_2 = \tfrac{1}{2}(E_0 - \mu v H_0),$$

as may be immediately verified. Move E_1 to the right, and E_2 to the left, at speed v, to produce the later states.

Since every slab is independent of the rest, there need be no connection between the directions of E in one slab and the next. The direction may vary anyhow along the wave. This makes a mathematical complication of no present importance, the behaviour of individual slabs being always the same.

The overlapping of positive and negative waves should be studied to illustrate the conversion of electric to magnetic energy, or conversely. For two equal waves moving oppositely, which fit when they coincide, there is a complete temporary disappearance and conversion of one or the other energy, according as **E** is doubled, leaving no **H**, or **H** is doubled, leaving no **E**. If $\mathbf{E}_0$ exists alone initially, it makes two equal oppositely-going waves, of half strength as regards **E**. Similarly as regards initial H_0.

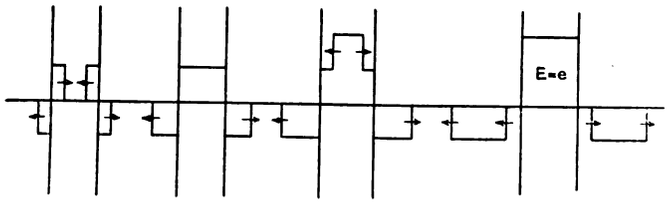

FIG. 3.

The reversal of sign of both **E** and **H** in either a positive or a negative wave does not affect the direction of motion. But if only one be reversed, it is turned from a positive to a negative wave, or conversely. Slabs of uniform strength should be studied, not simply periodic trains of waves, for simplicity of ideas. Only when there is dispersion, and the wave speed varies, is it necessary to consider a train of waves of given frequency or given wave-length; because then a slab spreads out behind as it travels, producing a diffused wave of difficult mathematical representation, by reason of the partial reflection of its different parts as it progresses.

§ 453. Consider next how to generate plane waves by impressed electric or magnetic force. Say by e first. It must obviously be of the same type as **E**, *i.e.*, in uniform slabs. But it is not e itself, but its curl, say f, that is the real source of the waves. A plane surface of f is the simplest case. Let e be uniform on the right side and zero on the the left side of the plane AA, beginning to act at the moment $t = 0$, and continuing steady later. What will happen? Here f the curl of e is uniform on the sheet AA; its intensity is $f = e$, and its direction is upward on the paper. It generates induction at the rate f on the plane AA per unit area. Or we may say that the strength of the source of B is f. Once generated, the induction divides fairly to right and left, and since the speed is v, the amount $\frac{1}{2}f$ is spread over the distance v in a second. Therefore

$$B = \frac{f}{2v}, \quad \text{or} \quad H = \frac{f}{2\mu v} = \pm v E \tag{1}$$

expresses the full connection between f and the waves generated. The plus sign is for the positive wave, and the minus sign for the negative wave. We introduce E in this way because the disturbance, once started, makes free waves. The solution, of course, only holds good up to the two wave fronts, which are at distance vt from the source. **H** is up through the paper in both waves. Here we see the inner meaning of the impedance $2\mu v$ of the doubly infinite unit tube of flux of energy. It depends essentially upon the speed with which the medium can carry away from the source the induction supplied there. The value of **E** is $\frac{1}{2}e$ on the right and $-\frac{1}{2}e$ on the left side of the plane source. Since **E** is the force of the flux **D**, the force of the field, or **E** − e, is of value $-\frac{1}{2}e$ all the way between the two wave fronts.

When f varies anyhow in time, it is just the same as regards the generation of **B**. If f is impulsive, it makes two impulsive waves. Equations (1) may be used when f is variable, if we understand that the elementary slab of **E** and **H** referred to, say at distance x, belongs to the f at the source at the moment earlier by the amount x/v.

It is e that does the work, though, but only when there is electric current. That is, only at the wave front on the positive side, when the source is steady, and intermediately only when f varies; because $-d\mathrm{H}/dx$ measures the current density. The flux of energy **W** is $\mathrm{V}(\mathbf{E} - \mathrm{e})\mathbf{H}$. It is entirely from the right to the left wave front when f is steady. It may be tested that

$$\mathrm{e}\dot{\mathbf{D}} = \dot{\mathrm{U}} + \dot{\mathrm{T}} + \mathrm{div}\,\mathbf{W} \tag{2}$$

is the equation of activity in any case.

In the case of a uniform slab of e of finite depth, there are two plane sources of f, acting oppositely, or one as a source in the above manner and the other simultaneously as an equal sink of induction. There are therefore two positive and two negative waves, separate up to a certain time, and then superimposed. Four stages are shown in the figure.

First, before the initial waves have begun to overlap inwardly; secondly, when overlapping has just commenced; thirdly, before the overlapping is completed; fourthly, a little while after completion of overlapping, showing the emergence of two pure waves. It is the **E** that is referred to. Every wave has its corresponding **H** according to $E = \pm \mu v H$. The final result is $E = e$ in the slab, and two pure waves in which $E = \frac{1}{2}e$. The energy of these free waves together equals that of the steady flux of **D** without **B**, which is established in the slab. The work is done by e on the sides of the slab, and at the inner wave fronts. The total induction is zero, because there are two opposite f's. The total displacement is also zero, for another reason.

In order to generate displacement finitely in total amount, we require another kind of source. Let the impressed force be magnetic, say h. Let its curl be g. Then g generates **D** exactly in the same way as f generates **B**, as before described in detail. Thus, considering a single plane source, g is the total displacement generated per unit time per unit area of the plane, and $\frac{1}{2}g$ the amount going each way, spreading over the distance v in a second. The result is that a steady source makes

$$D = \frac{g}{2v}, \quad \text{or} \quad E = \frac{g}{2cv} = \pm \mu v H \tag{3}$$

between the plane of g and the two wave fronts. The same Fig. 1 will do for this case, only for E must be understood H in the two waves. Otherwise stated, $H = \frac{1}{2}h$ on the right side and $-\frac{1}{2}h$ on the left; whilst $H - h = -\frac{1}{2}h$ on both sides. The work is done by h only where there is magnetic current.

If the impressed force in the slab is e, the problem represented is that of the effect of suddenly electrising the slab intrinsically. If it is h, it means that the slab is suddenly magnetised intrinsically to density of magnetisation $I = \mu H = \mu h = B$. This represents the complete and full induction possible. If it is a material slab, and the inductivity differs from that outside, the waves will not be quite so simple. But it is only when the slab is of finite depth that we can get the full induction; when of infinite depth one way, the final result is only half as much; no steady state is reached; the flux of energy continues indefinitely. And if the slab is infinitely extended both ways, a uniform h cannot produce any induction in it. There is no g source.

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As regards the situations of e and h to suit given f and g, they may be altered in any way we like, provided f and g do not change. Thus, considering the magnetisation of a slab, h may be shifted outside it, provided we reverse its direction. It is now the external region that is the seat of the intrinsic magnetisation. Nevertheless, the induction will be set up in the slab, whilst only the free waves will traverse the magnetised region on their way out.

If the sheet of f, when there is but one sheet, is of finite breadth, instead of extending over an infinite plane, all the above results regarding the generation of waves are true at a given point up to the moment when disturbance reaches that point from the nearer of the two edges of the strip of f. That is, there is immediate failure at the edges, involving two waves of a fresh kind, which "interfere" with the two plane waves. This case will be given later. Reducing the width of the strip brings the source down to a single straight line of f. This generates a single cylindrical wave.

Returning to the infinitely extended plane sheet source of disturbance, let it be the seat of both f and g simultaneously. Then we can adjust them so as to generate a single wave, going either to the right or to the left of the sheet. This may be shown by using the previous results for f and g separately, and superposing them. Take $e = \pm \mu v h$, or $f = \pm \mu v g$; and a single wave will result. It will be of full strength, instead of half strength.

It is perhaps worth while pointing out the corresponding properties in sound waves in air. Let s be the condensation and u the speed in a plane wave, that is, the speed of the air perpendicular to the plane, or in the direction of motion of the wave, whose own speed is v. Then the connections of the two variables s and u are

$$f - v^2 \frac{ds}{dx} = \dot{u}, \quad g - \frac{du}{dx} = \dot{s}, \tag{4}$$

where the new quantities f and g represent sources. If ρ is the density, and $F = \rho f$, then F represents impressed moving force per unit volume. What it generates is momentum. And if $G = \rho g$, then what G generates is matter; in another form, it is a source of condensation, real or effective. Comparing with the corresponding equations for electromagnetic plane waves, viz.,

$$f - \frac{dE}{dx} = \mu \dot{H}, \quad g - \frac{dH}{dx} = c\dot{E}, \tag{5}$$

where f is the measure of the curl of e, and g that of h, we may conclude that $u = \pm vs$ is the relation corresponding to the electro-magnetic $E = \pm \mu v H$. That is, in a plane sound wave the air speed and condensation are in constant ratio, and the wave always moves the same way as the air in its condensed parts. (Rayleigh, "Sound," Vol. II., § 245.)

Also, if there be a plane source F generating momentum, F acting normal to the plane,

$$\rho u = \frac{F}{2v}, \quad \text{or,} \quad u = \frac{F}{2\rho v} = \pm vs \tag{6}$$

shows the u in the two waves leaving the source, first by splitting of the momentum, and then by its transfer away from the source.

Similarly, if G is the amount of fluid supplied at the plane per unit area per second,

$$\rho s = \frac{G}{2v}, \quad \text{or,} \quad s = \frac{G}{2\rho v} = \pm \frac{\rho}{v} \tag{7}$$

shows the condensation produced in the two waves which result.

If F and G are coexistent, and $F = Gv$, the result is

$$u = vs = \frac{F}{\rho v},$$

on the right side only. Take $F = -Gv$ to bring it to the left side.

Of course we cannot have a continuous, steadily-acting source of condensation in a fluid; it must fluctuate. There is no such restriction necessary in the electromagnetic case.

(To be continued.)

POLYPHASE DEVELOPMENTS AT NIAGARA.*†

BY J. E. WOODBRIDGE.

The present is a very suitable occasion for a review of the developments and extensions of the Niagara power system, at once the greatest and most elaborate inter-connected system of electrical installations in the world. Especially is this occasion most opportune, that the past year this system has been greatly enlarged; new generators, lines, transforming devices, and loads have been added; one of these loads constitutes by far the largest single application of power in one structure ever made; this with the other additions has nearly doubled the output of the power plant, and the outlook for the future has necessitated the immediate duplication of the generating equipment, which is already the largest in the world. During the last two years the generating plant has been increased by the addition of seven 5,000 H.P. machines to the original three. Several new electro-chemical loads have been added at Niagara Falls, the greatest of which is the new works of the Union Carbide Co., which already absorb 15,000 H.P. The long-distance transmission of power has been greatly extended. Twenty-seven miles from the power plant the Buffalo General Electric Co. takes 3,000 H.P. and transforms it to four different systems of current for its central station service, the running of the steam stations of this company having been discontinued. The International Traction Co., which operates all the street railroads in Buffalo and the adjacent territory, has installed a rotatory converter station in Lockport and four new ones in Buffalo. At Tonawanda a transforming station has been connected up to carry both lighting and traction loads. These various elements of the system that have been recently added are described below in a general way, with as many previously unpublished and novel details of construction and operation as available space will permit.

The original plans of the Niagara Power Co. contemplated the extension of the present power house until it should contain 16 generating units with an aggregate nominal output of 80,000 H.P. During the past year two of these units, the ninth and tenth, have been erected, and here for probably many years the growth of the present house will stop, although the original intention to extend further is evidenced by the temporary wall at the north end. A contract has already been signed with the National Contracting Co. to excavate another wheel pit of sufficient size to accommodate 10 more units, and by this the work will have commenced. This change of plan is due to the fact that the discharge from wheels developing 100,000 H.P. will fill the existing tail-race tunnel, and it is considered preferable to divide this 100,000 H.P. equally between two power houses than to locate 75,000 H.P. or 80,000 H.P. in one and only 20,000 H.P. or 25,000 H.P. in the other. The next subsequent development will, it is expected, be on the Canadian side, where a shorter and consequently less expensive tunnel can be put in. For these reasons the statement is made above that the extension of the original power house has probably ceased for some time to come with the end of the past year.

The new 50,000 H.P. power house will be located on the other side of the entrance canal or forebay from the present building and considerably to the rear towards the river, leaving ample room in front of it for extensions of the transformer house, which already stands on this side of the canal in front of the site of the new structure.

The New Generating Units.—The two new pairs of turbines with their attached dynamos do not differ materially from the five installed during the previous year. The guide chutes in the new wheels are of phosphor bronze instead of cast-iron, to better resist the chipping action of small stones that may work into the penstocks. The turbines are, like their immediate predecessors, mounted on steel girders instead of cast-iron brackets, as were the original three sets.

The two new generators are exact duplicates of the previous five, no possible improvements over those machines being found. While the changes embodied in these five as compared with the original three have been previously published, they have not been noted in these columns, so that a brief mention of them is warranted here. The general design of outside umbrella type fields rotating about an internal stationary armature remains the same. The changes are only in details, and as a rule have been made with the aim of better carrying off the heat generated. Although the machines have an extremely high efficiency, about 98 per cent., the 2 per cent. wasted amounts to 100 H.P., which is considerable to be dissipated from the superficial area of machines concentrated into as small volume as are these.

Fig. 1 shows two vertical half sections through one of the machines, illustrating the two principal improvements over the first designs. One of these is the method of supporting the bearings in accurate concentric alignment with the frame, and the other is the cooling arrangement. The spiders holding the two bearings are forced downwardly, by means of bolts shown, into tapered seats bored in the interior of the frame. The bearings themselves are

* Abstract from the *American Electrician*.

† Previous articles appeared in *The Electrician*, Vol. XLII., pp. 565, 600.

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also forced to a tight fit in the spiders. These bearings are piped to an oil circulating system, as shown in the left-hand section, and chambers cored in them are piped for the circulation of water for cooling purposes, as shown in the right-hand section. The frame itself has vertical ribs in which the armature laminations are dovetailed, and through these ribs run vertical passages, as shown in the left-hand section, through which passages water is circulated for the purpose of cooling the iron. Pipes connect the lower ends of these passages, while the upper ends are capped and connected together by means of small square cross passages cored in the casting. The connections are such that the water must flow up one passage and down the next, and so on throughout the whole series around the frame. In addition to this, there are the usual ventilating spaces in the armature iron, through which air is drawn by the centrifugal action of the fields and air funnels mounted on the drivers.

The field coils are made up of bare copper strap wound edgewise, but differ from usual edgewise coils in that there are four layers. These layers are separated from each other and rigidly held in place by means of metal spacing rods covered with mica and shellac

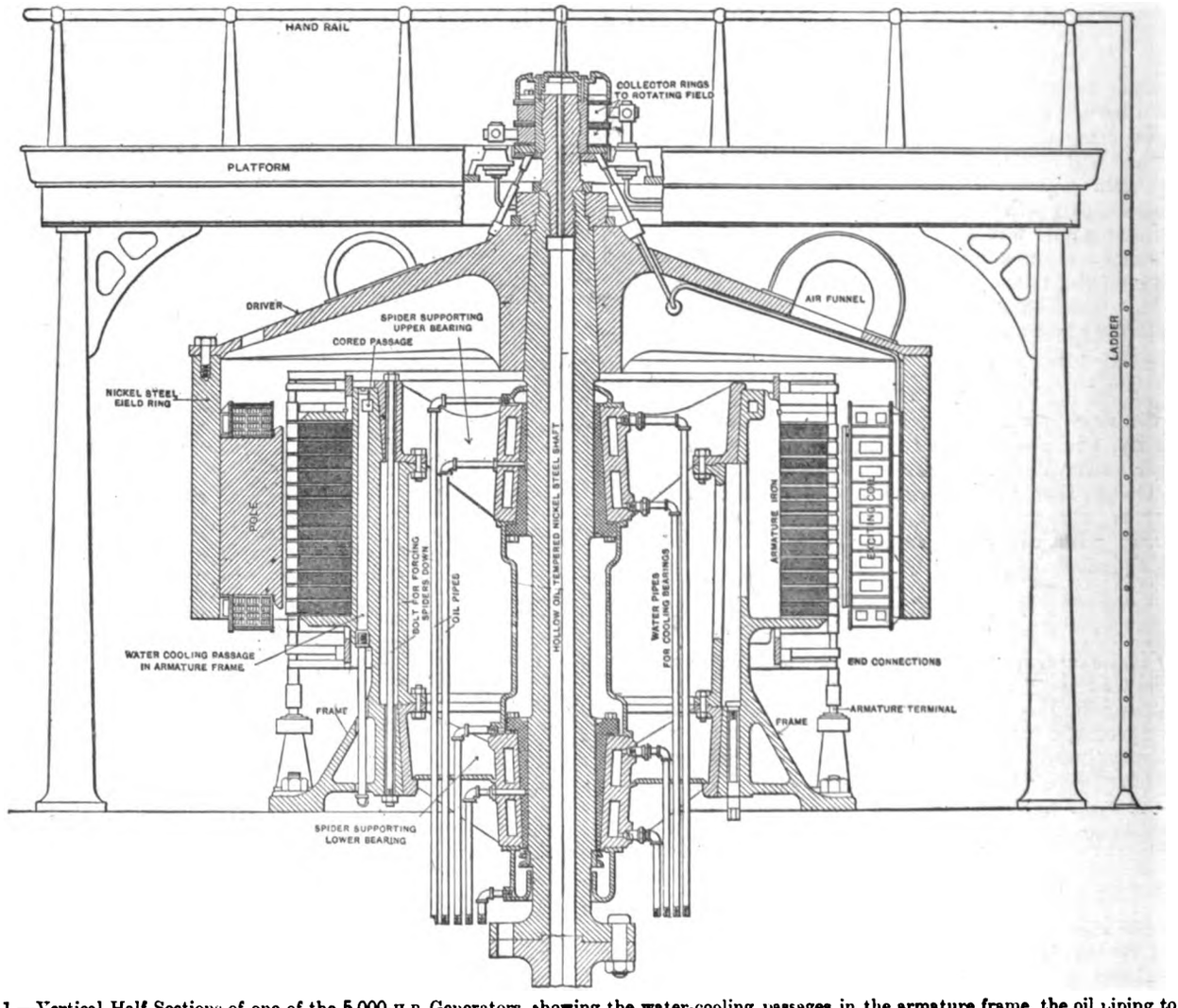

FIG. 1.—Vertical Half-Sections of one of the 5,000-H.P. Generators, showing the water-cooling passages in the armature frame, the oil piping to the bearings, and the water-cooling arrangements of the bearings.

insulation. Between these spacing rods there is ample room for the ventilation of each layer, the circulation of air being permitted by means of ventilating openings in the casing. This casing consists of a brass framework of skeleton ribs and perforated plates riveted together, the spacing rods being fastened to the plates by screws. The edgewise turns of each layer are insulated from each other by strips of built-up mica and shellac insulation inserted between them.

The ten machines are connected in two groups of five each to panels and switch stands on two switchboard galleries laid out on the same general plan as the original gallery for the first three machines. There are two complete sets of two-phase 'bus bars under each gallery, and these sets of bars may be run separately or thrown together by means of 'bus-junction switches. The two original rotatory converters for excitation have been moved to a new location and are maintained, but only as a reserve, the machines being normally excited by any one or more of four turbine-driven direct-current dynamos grouped around the elevator shaft in the centre of the room. These dynamos are of a novel type, being mounted on vertical shafts, the armature overhanging the upper bearing. These exciters have no governors, the gates of their water wheels being driven by hydraulic apparatus in turn controlled by magnetically operated valves switched on or off at the switchboard.

The new main wheels are controlled by magnetic clutch governors, designed by Dr. Coleman Sellers; one of these governors is shown in Fig. 2. The big machines have no circuit breakers, their power being cut off by simply opening the field circuit. The same action starts the governor into motion to shut off the water from the main wheels. The circuit breakers in the field circuits of the machines are wired to an emergency switch, by closing which the fields of all the machines running in parallel with each other may be opened simultaneously in case of emergency, and the gates of the water wheels of the same units may be at the same instant started toward the closed position.

At the time this article was written, in November, the two new machines were not completed and the eight machines in service were being operated in three batteries carrying a load of from 30,000 H.P. to 35,000 H.P. One battery of two machines was necessarily run separately from the others to carry the long-distance transmission loads of Tonawanda, Buffalo, and Lockport. The isolation of these machines and loads from the others was necessitated by the fact that the drop in the transmission lines required a higher pressure than that delivered to local loads in Niagara Falls, and the distributing system of the station is not equipped with boosting or other voltage-varying devices for delivering different pressures from one battery of machines in parallel. Of the two other batteries of three machines each, one battery was running on the mammoth load of 15,000 H.P. absorbed by the new plant of the Union Carbide Co., while the other battery was carrying local loads of the other "tenants," as they are called, consisting of electro-chemical and metallurgical works situated on the power company's property near the station. These two batteries were normally run separately, so that trouble on one should not affect the other. A machine could be shut down only by throwing the two last-mentioned batteries together and carrying

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their combined load on five machines, which could be done at certain times of day. Fig. 3 shows a daily load curve. The three batteries were respectively excited by three of the four turbine-driven exciters running independently of each other.

Among other improvements carried out within the power house during the past year are the following. The brick walls of the new section of the wheel pit have been extended throughout the old section, carrying all leakage from the rock faces through passages behind the brickwork, and rendering the whole pit dry and habitable without mackintoshes, which were formerly as essential here as in the Cave of the Winds under the Falls below. With these brick walls the penstocks and shafts may be painted and kept from rusting and consequent depreciation. The complete duplicate oil-piping system has been finished for lubricating the thrust and other bearings, and the oil pumping, drying, filtering, and storing system has been completed. There is an arch 16ft. wide and 35ft. long, branching from the wheel pit and cut out of the solid rock 130ft. below the floor of the dynamo room. In the foreground is a Worthington duplex pump, the driving cylinders of which are operated by water from the canal above, while the driven cylinders compress air for the pneumatic switch pushers and other compressed air apparatus up above. To the rear of this is situated an induction motor which drives a Quimby screw pump for lifting the oil to a reservoir up

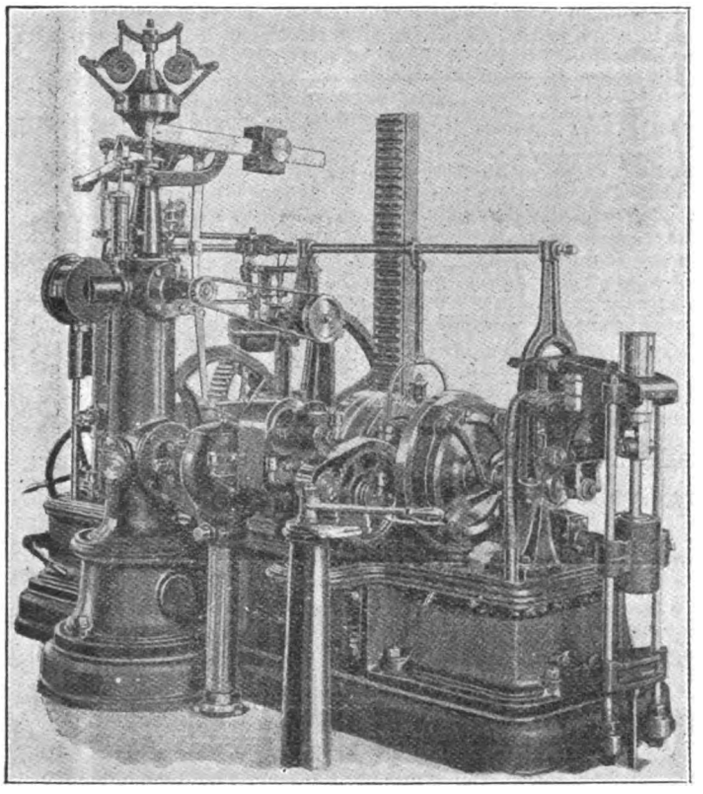

FIG. 2.—One of the New Governors. The centrifugal weights operate contacts in an oil bath, and these contacts close the circuits of electro-magnetic clutches, one for the opening and the other for the closing motion of the gates.

under the eaves of the power house, from which it circulates by gravity through the bearings and down again to the pit. Another similar pump is provided, coupled to a small turbine. Behind these again is situated the oil recuperating system, consisting of tanks in which the oil is first boiled and then filtered. The boiling is accomplished by means of electrical heaters, the purpose being to drive off any water that may become mixed with the oil.

The other three arches will be occupied by pumps for the water-works system supplying Niagara Falls, and two of these pumps are now being installed, one in each of the two arches. The pumps will be driven by 12ft. Pelton water wheels, and will each be capable of discharging 6,000,000 gallons in 24 hours against a pressure of 170lb.

The Carbide Transmission.—By far the most interesting of the new developments about the power house is the apparatus installed for delivering 15,000 H.P. to the new works of the Union Carbide Co. Although these works are situated only 11,000ft. from the power plant, there are three transformations between the generators and the furnaces, requiring for the amount of power now used transformers with an aggregate capacity of 50,000 H.P. This is due to the fact that on account of the low cost per kilowatt and high efficiency of the transformers which could be used it proved preferable to step the voltage up at the power house and to change the number of phases from two to three. There was also discovered a peculiar difficulty in transmitting this large amount of power underground at the machine pressure of 2,200 volts, on account of the overheating of the conduit. There is a double step-down transformation at the receiving end.

It has always been considered advisable in connection with this plant to make the rated output of a transforming unit a simple aliquot part of the rated power of one of the generators. A transforming unit in this case consists of two transformers connected on the Scott two-phase three-phase system. Previous to the present year the largest transformers in the world were a battery of 10 transformers rated at 930 kw. or 1,250 H P. each, used to step up the power from this plant for transmission to Buffalo and other distant cities. Of these transformers four, making two two-phase three-phase units, would transform 5,000 H.P., the rated output of one generator. The next size larger that could be used conforming with this requirement would be twice as large, each transformer being rated at 1,875 kw. or 2,500 H.P. This is the size adopted for the Carbide transmission.

The transformers in the power plant transformer house are arranged as follows. At either side are the new Westinghouse 2,500 H.P. machines, oil insulated and water cooled. Behind and between these are the older 1,250 H.P. transformers of the forced-draught type, of the General Electric Co.'s type, and used for the Buffalo line. The six step-down transformers for the Carbide transmission are oil insulated and water-cooled. The current transmitted to the Carbide Co. is accomplished thus. There are three feeders leading from the generator switchboards over the wire bridge across the canal to the transformer room. Each of these feeders is designed to carry 5,000 H.P. and consists of four single-conductor cables for the four sides of the two-phase system. In the transformer room each feeder ends in a switchboard panel. This panel contains

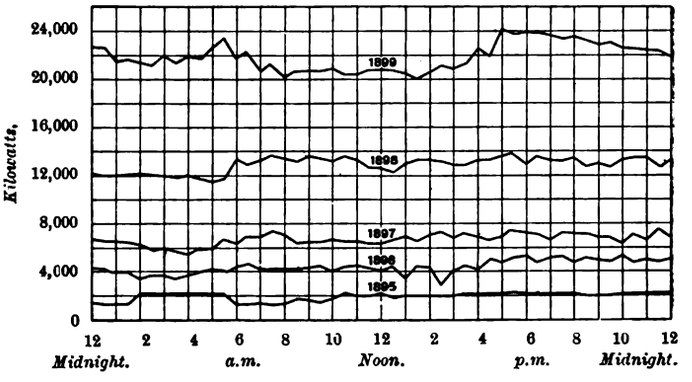

FIG. 3.—A Set of Comparative Total Load Curves for the same date (Dec. 10) of five successive years. They show the uniformity of the load throughout the 24 hours, as well as the rapidly increasing growth from year to year.

two circuit breakers, one in one side of each phase. The panel also carries throw-over switches, by means of which a spare transformer may be substituted for any one of the other six. The high-tension winding of the spare transformer ends in flexible cables which can be carried down the battery of transformers and connected up temporarily in place of any one of the regular transformers which may fail at any time.

The secondaries of these transformers are connected up as usual for the Scott transformation, one terminal of one secondary, termed the teaser, being connected to the centre of the other secondary, termed the main, the three other terminals giving three-phase currents. These three terminals are carried to high-tension panels, where they pass through three ammeters and three switches and thence to the cables leading to the transformer sub-station at the other end of the line. Here the transformers are similarly connected to give two-phase secondary from three-phase primary, the connections at both ends of the line being such that the current goes from teaser to teaser and main to main. The three high-tension circuits from the three pairs of Scott-connected step-up transformers to the three pairs of Scott-connected step-down transformers are not electrically cross connected. The step-down transformers, however, are paralleled on their low-tension sides at the 'bus bars of 2,200 volt switchboard in the step-down sub-station. From these 'bus bars current is taken to the ten 2,000 H.P. transformers of the Union Carbide Co., which reduce it to 110 volts, at which pressure it enters the furnaces.

The circuit breakers in the 2,200 volt feeders at the transmitting end are of a new form, laid out on what is known as the time-element principle. This principle has been quite generally adopted on Niagara power transmission, and has been broadly patented by Mr. L. B. Stillwell. The general purpose of the time-element feature is to prevent a short-circuit at a point distant from the power house opening any but the nearest circuit breaker to it. For instance, in the Carbide transmission line the feeders from the 2,200 volt 'bus

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bars at the receiving sub-station to the 2,000 H.P. transformers are protected by circuit breakers. A dead short-circuit beyond one of these, however, might trip all of the circuit breakers in the feeders at the transmitting end—if these were made to operate instantly—before the circuit breaker in the one feeder at the receiving end could open and break the arc. For this reason the circuit breakers at the transmitting end are made with a special attachment such that they will only operate if the overload or short circuit holds for a certain length of time, which may be changed by adjusting the apparatus. In case a short-circuit occurs beyond a breaker at the receiving end, this breaker opens practically instantaneously and cuts off the power before the breakers at the transmitting end get a chance to operate, because these latter breakers have the time-element feature. In case a short comes across the lines between the two sets of breakers, it of course continues until those at the transmitting end open the circuit.

In construction these time-element circuit breakers resemble the ordinary brush type of circuit breaker built by the Westinghouse Co., with arms of sufficient length to break a 2,000 volts circuit. The armatures of the tripping magnets of these breakers are connected to levers which extend downwardly toward a rectangular box on the face of the board below the two breakers. This box contains a spring motor mechanism tending to drive a Foucault-current disc between the poles of permanent magnets exactly like the retarding mechanism of integrating wattmeters. The motion of this mechanism is restrained by a pawl which is mechanically connected with the tripping mechanism of the breakers. When an overload comes upon either of the breakers its armature moves a slight distance, releasing the spring motor mechanism, but is restrained from further movement until the spring motor runs for a certain distance, when the armature of the breaker is left free to move further and operate the trip, provided the overload still exists. The time during which the overload must last to operate the breaker is adjusted by moving the magnets on the retarding disc just as the speed of an integrating meter is adjusted. Both breakers, one in each phase, are checked by the same time-element mechanism.

The ammeters on the 11,000 volt side of the step-up transformers are supplied through series or current transformers of a new design of the Westinghouse Co. Each of the three currents at 11,000 volts passes through a coil contained within two long vertical insulating tubes, which are provided to prevent the high pressure from creeping over the surface to the iron core and secondary of the instrument transformer. The flat horizontal iron core is of the figure-eight type surrounding the middle of two of these tubes, and the secondary coil is wound around the central cross-bar of the eight. The high-tension switches are fixed below these series transformers. The connections for these are run through long, corrugated, hard-rubber tubes to prevent the creeping of the currents. These switches are not intended to be opened under load, but simply to cut off the step-up transformers from the underground cables after the load has been removed by circuit breakers or low-tension switches at some other point.

The cables are at present seven in number, two for each block of 5,000 H.P., with one spare. They are triple-conductor 000 and paper insulated, made by the Standard Underground Cable Co. After they were installed the insulation of each conductor was subjected to a test under 20,000 volts pressure applied for half an hour. In this test the other two conductors and the lead were connected together and to the opposite side of the 20,200 volt circuit from that connected to the conductor under test. The whole 87,000ft. of cable stood this test without a breakdown. On account of the capacity of the cable, 45 apparent kilowatts were absorbed in each test—that is to say, the capacity current amounted to about 2¼ amperes, which, multiplied by the pressure of 20,000 volts, gives 45 apparent kilowatts, although the real absorption of power was of course much less. The tests for capacity and insulation resistance gave results respectively of 0·29 of a microfarad per mile and 50 megohms per mile between one conductor as one side of the condenser and the other two and the lead connected together as the other side. The cables were drawn into Camp conduit containing 36 ducts, only seven of which are now used.

(To be continued.)

GLASGOW SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

The first ordinary meeting of this section was held on Friday, the 16th inst., at 8 p.m., in the rooms of the Glasgow and West of Scotland Technical College, when a Paper was read by Mr. W. B. Sayers on "The Problem of Arc Lighting from 250 volt Supply." The author, in opening the subject, welcomed the advent of the present high voltages that were being almost universally introduced for central station supply, and were, generally speaking, the highest limits allowed by the Board of Trade; and he considered that the pressure of 250 volts reached the limits of safety as regarded injury to the person, and thought that this pressure might be accepted as final, at any rate so long as the present methods of distribution were in vogue. Mr. Sayers complimented Mr. Chamen upon going to the full limit for the Glasgow system that the Board of Trade allowed, and he wished him every success and a rapid recovery from the trouble and worry of the change over. In the early days of electric lighting incandescent lamps were made for low voltages, and if it was necessary to use them with a high voltage, they were occasionally put in series. When the standard voltage came to be recognised as 100 no difficulty was found with incandescent lamps, but with arc lamps the difficulty of having to run two in series was met with to a comparatively slight extent. With, however, the present 250 volt supply this trouble was found to be very greatly increased.

In order to meet this demand the enclosed arc lamp was brought strongly into notice, and besides having the advantage of requiring a greater voltage, this has the additional advantage of burning about 20 times as long as the open arc lamp. As regarded the voltage that an enclosed arc lamp would burn satisfactorily at, the author had seen a lamp wound to take the full 250 volts across its terminals, but the result was simply an apology for light. As far, therefore, as a 250 volt circuit was concerned, there were only two arrangements in common use—viz., two enclosed arcs in series, or four or five open arc lamps in series. The economy question was discussed from the consumers' point of view, and the obvious disadvantages of having five lamps in series, and so necessarily all controlled by one switch, was pointed out.

The author then went on to describe a series of tests he had carried out at the Glasgow Corporation lamp testing department by permission of Mr. Chamen. The results obtained are given in the following table, and it might be pointed out that they do not aim at theoretical accuracy, but rather at a good general practical comparison. The comparisons were made by the ordinary grease-spot method, and also by the shadow method, and the ratio of the squares of the distances between the respective lamps and the position where the grease spot became invisible or the intensity of the thrown shadows equal were taken. As regarded the globes used, the open arc lamp was fitted with an opaline globe, as generally now used, and the enclosed arc lamp was fitted with two obscured globes, as is customary in practical use.

Table showing comparison between light-giving power of open and enclosed arc lamps, and comparison with incandescent lamps, all using the same power and running on 250 volts.

Type of lamp..	Open arc.	Enclosed arc.		Incandescents (new clear globes).			
How arranged ...	5 in series	2 in series	Single	16 of 16 c.p.		31 of 8 c.p.	
Steadying resist'nc	4 ohms	12 ohms	...	...		...	
Current	10 amps.	4 amps.	2·75 amp.	4·4 amps.		4·48 amps.	
Watts per lamp ...	500	500	680	1100	500	1120	500
Comparison	1	0·375	0·1	0·68	0·31	0·75	0·33
Comparison (taking 16 c.p. as unity)	3·25	1·54	0·325	...	1	...	1·07

The figures in the table speak for themselves. With regard to the steadying resistance in circuit with the single enclosed arc, this was combined with the lamp itself, so that without unnecessary trouble this figure was unable to be filled in. Under the heading of power taken per lamp (in the case of the arcs, and of course per cluster in the case of the incandescents), owing to a mistake in the tests when testing the incandescent lamps, too much was taken, so a second column has been added reduced in proportion to bring the amount in line with the other figures. The comparisons were made with the open arc, but in order to make them clearer they have been reduced to a basis, taking a 16 c.p. lamp as unity. It will be seen that a single enclosed arc lamp is only about one-third as efficient as a 16 c.p. lamp, that when two enclosed arcs are run in series the efficiency is about one and a half times that of a 16 c.p. lamp, while an open arc lamp has about three and a quarter times the efficiency of a 16 c.p. lamp. This shows the open type arc lamp to be over 100 per cent. more efficient than the enclosed type arc lamp, the latter running under its most favourable conditions.

From these figures it is clear that the enclosed arc would have no chance of being popular with the public if a single open type arc could be used under similar conditions. The objections to open type arcs are: (1) The necessity of running five lamps in series, or if less are used, of absorbing the difference by means of a resistance; (2) Owing to five lamps being in series, any unsteadiness or flickering occurring in one lamp will be shown in the others on the same circuit, so that there will be five times the amount of flickering; (3) The necessity of having all the lamps in each series of the same size, type, and current. The enclosed arc lamps have the same objections, although to a very much less extent, but in the author's opinion any advantages in this respect are far more than counterbalanced by the less amount of light obtained from them for the same expenditure of power.

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The author considers that there are two remedies that can be employed to overcome the difficulty of running open arc lamps on a 250 volt circuit—viz., (1) by the use of a step-down transformer; (2) by the use of an arrangement designed by the author, and which he calls a "ganger switchboard." In this arrangement a separate pair of leads is run from every individual lamp to a central position where a main switchboard is fitted. This switchboard is so arranged that any lamp can be plugged into a circuit of five. The disadvantages of this method are two in number: (1) That special telephones or other signalling arrangements have to be employed for signalling to the main board, where an attendant has to be more or less constantly stationed; (2) all the lamps in the whole installation have to be exactly of the same pattern and size, and have to take the same current, and they must all be adjusted so as to work satisfactorily one with another in any combination. This difficulty is the more important seeing that as a rule arc lamps are now adjusted in the series on which they will be run, and are then numbered and set up in the same combinations. The author states that this arrangement of a ganger switchboard is not new, as it has been in use very satisfactorily at the Midland Railway Co.'s station at St. Pancras, where it was designed by the author's brother, Mr. J. Sayers, and put up under the direction of Mr. W. Langdon, the company's engineer. There was no doubt in the author's mind that when the number of lamps admitted of it the step-down transformer was the best and most satisfactory solution of the difficulty. He considered that the advantages might be enumerated as follows: (1) The economy that would result in being able to use any single lamp just when and where required; (2) the advantage of not being tied down to certain fixed sizes for the lamps, but being able to use just whatever size was required or was most suitable for the position; (3) that it was possible with equal economy to have any number of lamps installed, and not necessarily a multiple of five; (4) that extra lamps could be added when and where required; (5) that the voltage of the circuit could be made exactly that which was found to be the most satisfactory for the most efficient burning of the lamps.

There were, of course, objections also to the use of a step-down transformer for this purpose—viz., (1) the first cost, and also the maintenance cost; (2) the expenditure of power necessary to drive the transformer itself. In the author's opinion, however, these disadvantages are far more than counterbalanced by the advantages enumerated above. With regard to the latter objection, the author contended that this loss should be borne by the Corporation or other supplying body, by fixing the meter in the secondary circuit of the transformer.

The last point Mr. Sayers took up was the consideration of the best voltage at which to work the secondary circuit, or, in other words, the voltage at which arc lamps gave the best efficiency, taking into account steadiness, colour, and amount of light for a minimum amount of power absorbed. Mr. Sayers said he thought that the most satisfactory way to answer this point was to get the opinion of the most important makers and users of arc lamps, and so accordingly he addressed a form to these asking for their replies to a set of questions bearing upon the subject. He said that there was only one firm—viz., the Brockie-Pell Arc Lamp (Ltd.), who had replied fully to him, the others having replied in a more or less meagre manner, so that he could not, as he had intended, tabulate the answers received; he thought therefore that the best way would be for him to read the answers of the various people to whom he had applied, and this he proceeded to do. Most of the firms were agreed in recommending a terminal voltage on the lamp of from 42 to 44 volts, some even stating definitely 43 volts. There were two exceptions to this, however, the makers of the Jackson-Mensing lamp recommending only about 35 volts across the terminals, while on the other hand Mr. Langdon, of the Midland Railway, wrote that he considers that arc lamps are used with too low a voltage and that if carbons could be obtained that do not flare, he thinks that they could with advantage be run up to 50 volts across the terminals. In practice he thinks about 46 to 48 volts give the best results. Most makers ask for some 5 to 10 volts to be absorbed in the steadying resistance. One curious point in the replies was that some makers advocated a rather higher voltage with a larger current, while others advocate a smaller current across the terminals under these conditions.

Mr. Sayers concluded his Paper by describing some diagrams in which, by means of curves, he showed the different efficiencies for varying numbers of lamps when arranged (1) in series of five, (2) on the ganger switchboard arrangement, and (3) with a step-down transformer.

The following gentlemen took part in the discussion of the paper: Mr. Lackie, Mr. Henry A. Mavor, Mr. McWhirter, Mr. J. A. Rudd, Mr. Stewart, and Mr. Cormack. Several spoke on the subject from long experience. For instance, Mr. Mavor objected to the use of current of such a high voltage, and he also said that 20 per cent. of the lamps would give out in a couple of months; and Mr. McWhirter favoured the Brockie-Pell system of arc lamps, and was in favour of using a step-down transformer, which had been recommended by Mr. Sayers; and he generally agreed with the position assumed by Mr. Mavor.

A NEW METHOD FOR STUDYING HYSTERESIS CURVES IN SAMPLES OF IRON AND STEEL.*

BY KNUT ANGSTRÖM.

In a very remarkable Paper read before the Konglish Vetenskaps-Akademiens Forhandlingar, in Copenhagen, Prof. Angström described a beautiful method of research into hysteresis curves. The following is a translation in abstract of his Paper:—

The first experimental use of cathode rays in the study of alternating-current phenomena was made by Herr F. Braun. Fig. 1 shows the type of apparatus employed by this investigator in his researches. A glass vacuum tube contains near its middle a metallic diaphragm, D, pierced at its centre with a round hole facing the cathode K. At the far end of the tube, which is similar to the original form of Crookes tube, a surface of some fluorescent material, S, is spread. When the tube is operated in the usual way the cathode stream passing through the hole in the diaphragm impinges upon the screen S and exhibits itself as a small and brilliant spot of light. This stream of cathode rays, as is well known, may be deflected by an electromagnet placed near the diaphragm, and may be made to act as a weightless and exceedingly sensitive indicator of the strength of the magnetic fields. If two

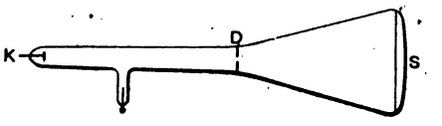
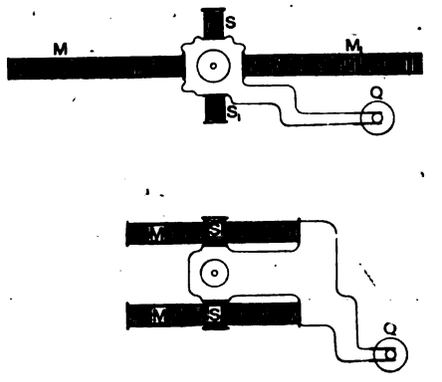


FIG. 1.

similar electro-magnets are placed at right angles to one another and also at right angles to the axis of the tube near the diaphragm, when an alternating current is sent through them, the form of the path of the bright spot at the end of the cathode stream is of course one of Lissajous's curves, and, if the magnets are precisely similar, will take the form of a right line inclined 45deg. to the magnet system. The author used this simple arrangement with certain modifications in the following ingenious way. When a rod of steel or iron is magnetised in a coil, then if the magnetising forces are plotted as abscissæ and the induced magnetism as ordinates in a rectangular system of co-ordinates, the result will be what is known as the hysteresis curve or loop, if the process is carried through an entire cycle up to saturation in both directions.

Fig. 2 shows one arrangement, and Fig. 3 another, which was adopted to make these hysteresis curves exhibit themselves. In either diagram S and S_1 represent coils wound on wooden spools; M and M_1 represent long coils in which are placed samples of the metal to



FIGS. 2 and 3.

be tested. The axis of the tube is perpendicular to the paper, and the diaphragms, with a round hole in its centre, is seen in the middle of the sketch. At Q is a source of alternating currents. The four coils are connected in series as shown. It will be seen that the deflection of the cathode rays produced by the coils S and S_1 in a vertical sense are proportional to the magnetising forces in the circuit, while the horizontal deflection produced by the iron samples in the other coils is due wholly to the magnetic field of the iron contained by them. The superposition of these deflections gives the desired curve.

In Figs. 4 to 6 are shown some specimen curves obtained in this manner. Fig. 4 shows what may be called the static hysteresis curve, produced by taking the sample very slowly through a cycle of magnetisation. Fig. 5 shows the curves for alternating currents of above 20 cycles per second, and Fig. 6 for about 60 cycles per

* From the *Electrical Review* of New York.

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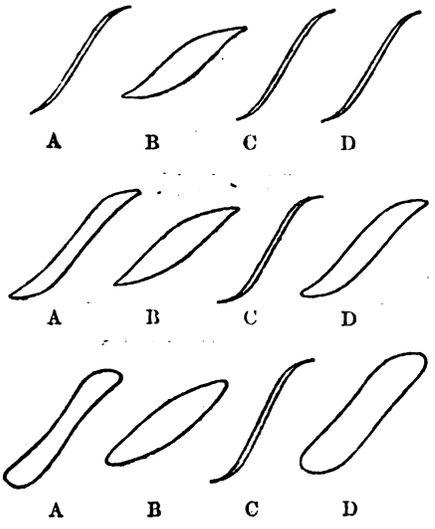
second. In all of these illustrations A refers to a rod 10cm. long and 3mm. in diameter, containing 0·2 per cent. carbon and annealed. B refers to a rod of similar dimensions, but containing 0·8 per cent. carbon and hard tempered. C refers to a bundle of very soft iron wires of fine gauge. D shows a similar bundle of wires bound on the outer surface of a brass tube. It will be noticed that the effect of hardening is very visible, while little difference between a rod and a bundle of wires is noticeable when both are composed of very soft iron.

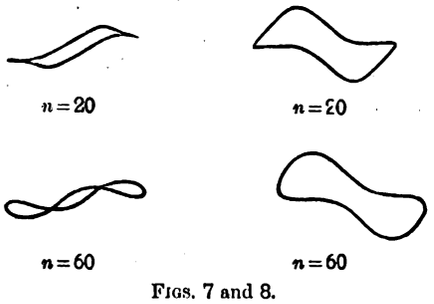
If the two long coils are filled with different varieties of iron, then a differential hysteresis curve is obtained which clearly shows the



FIGS. 4, 5 and 6.

effects of the phase and current variations produced by Foucault currents in the specimen. Figs. 7 and 8 show such difference in curves for frequencies of 20 and 60 periods per second. Fig. 7 is made by the use of the two iron bars described above, while Fig. 8 is produced when the bundles of iron wire, one with and the other without the brass tube, are used.

The author thinks that this simple method is adapted to practical use in testing samples of iron both for their magnetic qualities and also for their carbon contact. If the two coils containing the specimens are used alone and in them identical samples of iron are placed,



FIGS. 7 and 8.

the result will be simply a rectilineal vibration of the light spot. The least difference of magnetic quality in the two will exhibit itself by a characteristic curve. It is a matter of great ease to apply a photographic registering method to these tests, either by the use of a camera or by a flat-ended tube, to which a plate may be directly attached.

ELECTRICITY WORKS ACCOUNTS.

Salford Municipal Electric Supply Works.

This undertaking is rapidly emerging from the unhappy position which characterised the opening years of its career. For the first time the accounts show that the working expenditure has been met by the revenue. This is a good step forward from the disastrous position of a working loss of £901, which was the result of the working during 1897. The position of the concern is, however, better than a mere consideration of the modest working profit of £1,277 would lead one to suppose. The tariff which has been adopted at Salford is very moderate, considering the size of the concern, with the result that the average total revenue per unit is barely 3·85d. The low charges, besides increasing the significance of the working profit, have also an excellent effect on the growth of the concern.

At the end of 1897 the equivalent lamp connections amounted to 24,000 8 c.p. lamps, with 167 consumers and a maximum demand of 231 kw. In 1898 the accession of new business was such that at the end of the year there were 300 consumers, with the equivalent of 40,000 8 c.p. lamps connected, while the maximum demand had risen to 399 kw. These figures are interesting, as showing that the concern is entering upon better days; but the output for the year marked a good stride forward from the position of 1897, and no doubt was—with the improvement in the load factor—largely the cause of the diminution in the costs from over 6d. per unit to 2·92d. In both years the load factor was below the average; in 1897 it was 5·5 per cent., and in 1898 9·42 per cent. In view, therefore, of these conditions the aggregate costs, although still about 0·8d. above the average, now stand at a fairly reasonable figure.

Coventry Municipal Electric Supply Works.

We should like to see this concern make more rapid headway than it does. The costs, even making allowance for the low output and load factor, should, we think, not exceed 3 5d. per unit in the aggregate. The accounts show, it is true, a material diminution in the chief items of expenditure, but not so much as was to have been expected from the increased output and load factor, and in view of the fact that the results are those of the working during a period of 15 months containing profitable quarters of the year.

Owing to this latter fact, it is hardly useful to consider closely the figures contained in our table, but taking about 12,000 units sold as the rate of the annual output in the period, the item "wages at the station" appears more than double what is usual; in fact, all the items of generating costs are abnormally high, except "repairs and maintenance at the station."

The working profit for the period was £307. The interest charges amounted to £1,153, and the instalment for repayment of loans was £783. There is thus a deficit for the period of £1,629.

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

Aberdeen (Municipal)	Jan. 12, 1900	Kingston-on-Thames (Mun.)	April 21, 1899
Ayr (Municipal)	Sept. 22, 1899	Lancaster (Municipal)	Jan. 19, 1900
Bath (Municipal)	Feb. 9, 1900	Leeds (Municipal)	Dec. 1, 1899
Bedford (Municipal)	May 19, 1899	Leicester (Municipal)	Jan. 26, 1900
Belfast (Municipal)	Sept. 15, ,,	Leyton (Municipal)	Sept. 8, 1899
Birmingham (Company)	Sept. 15, ,,	Liverpool (Municipal)	June 9, ,,
Blackburn (Municipal)	Jan. 19, 1900	Londonderry (Municipal)	Feb. 16, 1900
Blackpool (Municipal)	Sept. 29, 1899	Manchester (Municipal)	Aug. 11, 1899
Bournemouth (Company)	April 28, ,,	Newcastle and District (Co.)	Oct. 6, ,,
Bolton (Municipal)	Nov. 24, ,,	Newcastle-upon-Tyne (Co.)	April 14, ,,
Bradford (Municipal)	April 14, ,,	Newport (Mon.) (Municipal)	Dec. 15, ,,
Brighton (Municipal)	May 12, ,,	Northampton (Company)	Oct. 20, ,,
Bristol (Municipal)	July 14, ,,	Norwich (Company)	Nov. 17, ,,
Burnley (Municipal)	Aug. 25, ,,	Notting Hill (Company)	Mar. 17, ,,
Burton-upon-Trent (Mun.)	April 21, ,,	Nottingham (Municipal)	July 21, ,,
Bury (Municipal)	Sept. 22, ,,	Oldham (Municipal)	Dec. 1, ,,
Cambridge (Company)	Mar. 10, ,,	Oxford (Company)	May 19, ,,
Cardiff (Municipal)	Dec. 15, ,,	Pontypool (Company)	May 5, ,,
Charing Cross (Company)	Mar. 17, ,,	Portsmouth (Municipal)	July 14, ,,
Chelsea (Company)	Mar. 31, ,,	Prescot (Company)	Dec. 8, ,,
Cheltenham (Municipal)	Nov. 10, ,,	Preston (Company)	Sept. 29, ,,
Chester (Municipal)	June 23, ,,	Reading (Company)	Oct. 13, ,,
City of London (Company)	May 12, ,,	Richmond (Company)	Oct. 13, ,,
Clerkenwell (Company)	Aug. 18, ,,	Scarborough (Company)	Nov. 3, ,,
Croydon (Municipal)	Feb. 9, 1900	St. Helens (Municipal)	Dec. 8, ,,
Derby (Municipal)	Jan. 26, ,,	St. James' & Pall Mall (Co.)	Feb. 16, 1900
Dewsbury (Municipal)	Nov. 24, 1899	St. Pancras (Vestry)	May 26, 1899
Dover (Company)	June 2, ,,	Sheffield (Municipal)	Dec. 29, ,,
Dundee (Municipal)	Jan. 12, 1900	Shoreditch (Vestry)	Oct. 27, ,,
Eastbourne (Company)	Feb. 2, ,,	Southampton (Municipal)	Nov. 10, ,,
Edinburgh (Municipal)	Nov. 17, 1899	Southport (Municipal)	July 7, ,,
Exeter (Municipal)	Aug. 5, 1898	South Shields (Municipal)	July 7, ,,
Glasgow (Municipal)	Sept. 1, 1899	Stafford (Municipal)	Dec. 29, ,,
Guildford (Company)	May 5, ,,	Sunderland (Municipal)	July 28, ,,
Halifax (Municipal)	July 21, ,,	Taunton (Municipal)	June 16, ,,
Hammersmith (Vestry)	May 26, ,,	Tunbridge Wells (Mun.)	Sept. 1, ,,
Hampstead (Vestry)	Aug. 25, ,,	Wakefield (Municipal)	Dec. 1, ,,
Hanley (Municipal)	April 28, ,,	Walsall (Municipal)	June 23, ,,
Harrogate (Municipal)	Oct. 20, ,,	Wandsworth (Company)	Aug. 19, ,,
Harrow (Company)	June 16, ,,	Westminster (Company)	Feb. 24, ,,
Hast'gs & St. Leonards (Co.)	Feb. 2, 1900	Whitehaven (Municipal)	July 28, ,,
H'use-to-H'use Co. (K'ns'gt'n)	Mar. 31, 1899	Windsor (Company)	Dec. 22, ,,
Hove (Company)	Mar. 10, ,,	Woking (Company)	Dec. 22, ,,
Huddersfield (Municipal)	Oct. 6, ,,	Wolverhampton (Municipal)	June 30, ,,
Islington (Vestry)	Oct. 27, ,,	Woolwich (Company)	Jan. 13, ,,
Kensington & Knightsbr' (Co.)	Mar. 3, ,,	Worcester (Municipal)	April 7, ,,
Kingston-upon-Hull (Mun.)	June 2, ,,	Yarmouth (Municipal)	Nov. 3, ,,

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	SALFORD.		COVENTRY.	
Undertaking Worked by	Salford Corporation.		Coventry Corporation.	
Date of Commencement of Supply	Aug., 1895.		Nov., 1895.	
System of Supply	Alt.-curr. trans. sub-stations feeding 3-w. network, [also house trans. & batt. sub-stations.		Alternate-current transformer sub-stations.	
Chief Engineer	Chas. L. Turner.		G. S. Ram.	
YEAR ENDED	DEC. 31, **1897.**	DEC. 31, **1898.**	DEC. 31, **1897.**	MAR. 31, **1899.***
QUANTITIES—				
Units generated	245,397[a]	547,212	128,845	298,102
„ SOLD (TOTAL)	111,142	329,268	79,583	149,547
„ sold to consumers	111,142	328,418	79,583	145,147
„ sold for public lighting, &c.	nil	850	nil	4,400
„ used on works	16,830	118,076	9,878	25,635
UNITS SOLD PER 8 C.P. LAMP CAPACITY	9·9	29·3	7·3	13·7
Maximum supply demanded	231 kilowatts	399 kilowatts	126 kilowatts	156 kilowatts
Number of public lamps	nil	1 arc	nil	1 arc
Number of consumers	167	300	100	135
Connections to mains in 8-c.p. lamps	24,000	40,000	8,149	10,699
CAPACITY OF PLANT IN 8-C.P. LAMPS	11,240	11,240	10,900	10,900
CAPACITY OF PLANT IN KILOWATTS	360	360	350	350
CAPITAL—	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.
AUTHORISED (TOTAL)	£44,770 / £124	£90,770 / £252	£33,325 / £95·2	£33,325 / £95·2
Share	— / —	— / —	— / —	— / —
Loan (including Debenture charges)	44,770 / 124	90,770 / 252	33,325 / 95·2	33,325 / 95·2
RECEIVED (TOTAL)	44,770 / 124	58,450 / 162	33,695 / 96·3	43,807 / 125
Share	— / —	— / —	— / —	— / —
Loan (including Debenture charges)	44,770 / 124	58,450 / 162	33,325 / 95·2	33,325 / 95·2
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	nil / —	32,320 / 89·8	nil / —	nil / —
Share (unissued)	— / —	— / —	— / —	— / —
Share (uncalled)	— / —	— / —	— / —	— / —
Loan (including Debentures)	nil / —	32,320 / 89·8	nil / —	nil / —
REPAID (TOTAL)	nil / —	nil / —	— / —	— / —
RESERVE OR SINKING FUND	2,995 / 8·32	4,289 / 11·9	— / —	1,574 / 4·50
DEPRECIATION FUND	nil / —	nil / —	— / —	— / —
EXPENDED (TOTAL)	44,289 / 123	62,578 / 174	31,338 / 89·5	45,660 / 130
Lands and buildings	14,250 / 39·6	14,310 / 39·7	10,356 / 29·6	12,323 / 35·2
Plant	15,347 / 42·6	17,809 / 49·5	14,714 / 42·0	18,364 / 52·4
Mains	14,692 / 40·8	29,998 / 83·3	5,819 / 16·6	14,499 / 41·4
Miscellaneous	— / —	461 / 1·28	448 / 1·28	469 / 1·34
BALANCE OF CAPITAL ACCOUNT	481 / 1·34	−4,128[b] / −11·5	2,357 / 6·74	−1,854[c] / −5·30
REVENUE—	Total. / Per unit sold	Total. / Per unit sold	Total. / Per unit sold	Total. / Per unit sold
TOTAL	£1,910 / 4·125d.	£5,278 / 3·847d.	£1,958 / 5·906d.	£3,597 / 5·775d.
Revenue from supply	1,828 / 3·950d.	4,953 / 3·610d.	1,914 / 5·774d.	3,505 / 5·625d.
„ meters, &c.	82 / 0·177d.	234 / 0·171d.	44 / 0·133d.	77 / 0·124d.
„ public lighting	— / —	5 / 0·001d.	— / —	15 / 0·024d.
„ sale of lamps, &c.	— / —	76 / 0·055d.	— / —	— / —
„ miscellaneous sources	— / —	10 / 0·007d.	— / —	— / —
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	£2,810 / 6·074d.	£4,002 / 2·918d.	£1,853 / 5·590d.	£3,290 / 5·280d.
WORKS COSTS	1,985 / 4·290d.	2,646 / 1·928d.	1,275 / 3·846d.	2,445 / 3·924d.
Generation of electricity	*1,782 / 3·850d.*	*2,322 / 1·692d.*	*1,166 / 3·517d.*	*2,039 / 3·272d.*
Fuel (including cartage, &c.)	519 / 1·121d.	889 / 0·648d.	314 / 0·948d.	534 / 0·857d.
Oil, waste, water, stores	157 / 0·339d.	258 / 0·188d.	143 / 0·431d.	279 / 0·448d.
Wages at station	771 / 1·606d.	834 / 0·608d.	627 / 1·891d.	1,157 / 1·857d.
Repairs and maintenance at station	335 / 0·724d.	341 / 0·249d.	82 / 0·247d.	69 / 0·111d.
Distribution of electricity	*203 / 0·439d.*	*324 / 0·236d.*	*109 / 0·329d.*	*395 / 0·634d.*
Wages, &c.	125 / 0·270d.	142 / 0·104d.	20 / 0·060d.	31 / 0·050d.
Repairs, renewals of mains, &c.	77 / 0·166d.	183 / 0·133d.	89 / 0·268d.	364 / 0·584d.
Public lighting	— / —	— / —	— / —	*11 / 0·018d.*
Attendance	— / —	— / —	— / —	11 / 0·018d.
Renewals	— / —	— / —	— / —	
MANAGEMENT AND PROPERTY CHARGES	825 / 1·782d.	1,356 / 0·989d.	579 / 1·746d.	845 / 1·356d.
Royalties	— / —	— / —	— / —	— / —
Rent, rates, taxes	*231 / 0·499d.*	*277 / 0·202d.*	*83 / 0·250d.*	*140 / 0·225d.*
Management	*594 / 1·284d.*	*1,079 / 0·787d.*	*496 / 1·496d.*	*705 / 1·132d.*
Salaries	464 / 1·003d.	549 / 0·400d.	353 / 1·065d.	490 / 0·787d.
Stationery, &c.	45 / 0·097d.	56 / 0·041d.	29 / 0·088d.	29 / 0·047d.
Establishment charges	57 / 0·123d.	445 / 0·325d.	75 / 0·226d.	119 / 0·191d.
Law charges, &c.	28[c] / 0·061d.	28 / 0·020d.	39[d] / 0·118d.	67[e] / 0·111d.
FINANCIAL RESULTS—	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded
WORKING PROFIT FOR YEAR	−£901[d] / −2·10%	£1,277 / 2·39%	£106 / 0·386%	£307 / 0·798%
Sum carried to Depreciation Fund	— / —	— / —	— / —	— / —
Sum carried to Reserve or Sinking Fund	1,156 / 2·70%	1,291 / 2·42%	777 / 2·83%	783 / 2·03%
Net interest on loans (incl. Debenture charges)	1,376 / 3·21%	1,432 / 2·68%	887 / 3·23%	1,153 / 2·99%
BALANCE FROM LAST ACCOUNT	−2,061 / −4·81%	−1,618 / −3·03%	−601 / −2·19%	−1,055 / −2·74%
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	— / —	— / —	— / —	— / —
Deficit	*5,494[e] / 12·8%*	*3,067 / 5·74%*	*2,159[a] / 7·87%*	*2,684[f] / 6·97%*
ORDINARY DIVIDEND PAID	— / —	— / —	— / —	— / —
PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE	147%	75·9%	94·7%	91·5%
Expenditure per kilowatt capacity	£7. 16s. 2d.	£11. 2s. 5d.	£5. 6s. 0d.	£9. 8s. 0d.
REVENUE PER KILOWATT CAPACITY	**£5. 6s. 2d.**	**£14. 13s. 2d.**	**£5. 12s. 0d.**	**£10. 5s. 7d.**
Expenditure per 8-c. lamp capacity	5s. 0d.	7s. 1½d.	3s. 4¾d.	6s. 0½d.
REVENUE PER 8-C.P. LAMP CAPACITY	**3s. 4¾d.**	**9s. 4½d.**	**3s. 7d.**	**6s. 7½d.**
REVENUE PER 8-C.P. LAMP CONNECTED	**1s. 7d.**	**2s. 7½d.**	**4s. 9½d.**	**6s. 8½d.**
Price charged for lighting, per unit	6d. to 2d.[f]	6d. to 2d.[f]	6d. to 3½d.[b]	6d. to 3½d.[b]
Price charged for power, per unit	3½d. to 1d.[f]	3½d. to 1d.[f]	4d.	4d.
Price charged for public lighting	—	—	—	—

SALFORD.—REMARKS—*a* From January 20, 1897, to December 20, 1897. *b* Over-expended: *c* Insurance charge. *d* Working loss. *e* Met to the extent of £3,876 by local rate subsidy. *f* "Wright" system; one-hour scale.

COVENTRY.—REMARKS—* For the period of fifteen months ended March 31, 1899. *a* Met to the extent of £1,181 by payment out of General District Fund. *b* Maximum demand system; two-hour scale. *c* Over-expended. *d* Insurance. *e* £40 to insurance, £27 stamp duty compounded. *f* Met to the extent of £2,236 by payment out of General District Fund.

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Published every Friday, Price Sixpence; Post Free, Sixpence-Halfpenny.
Editorial, Publishing and Printing Offices,

1, 2 & 3, SALISBURY COURT, FLEET ST., LONDON.

Telephone: 949 Holborn. *Telegrams:* "ELECTRICIAN NEWSPAPER LONDON."

All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher "THE ELECTRICIAN," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN" *Printing and Publishing Company, Limited, and be crossed* "*Coutts and Co.*"

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A PROBLEM IN ELECTRIC RAILWAY TRACTION.

An important problem affecting electric traction on railways, and especially suburban railways of the class of which the Central London Railway is a type, is suggested in an interesting letter we publish this week from the pen of Mr. M.B. FIELD, who writes with the view of combating the statements relating to three-phase railway motors made by Mr. KILBURN SCOTT in his letter last week. Briefly stated, the main problem is: What are the best acceleration and braking (or retardation) rates, with regard to the most economical and satisfactory working of railways of this class? As a subsidiary problem, the question arises as to the degree in which acceleration and braking affect the choice of an electrical system. Indeed, it is this latter question with which Mr. FIELD's letter mainly deals, he being at great pains to show that the acceleration and braking which produce the most economical result, with a given time schedule, favour the employment of continuous currents as against polyphase currents. Thus, as any railway engineer would have predicted, the merits of three-phase working are not to be settled off-hand on purely general considerations, but are seen to involve nearly all, if not every one, of the innumerable points of detail which have to be taken into account in the design of a railway line and its rolling stock. Only hasty visionaries will venture to settle the matter without reference to its bearing upon each and all of these technical but nevertheless all-important details.

The question of the suitability of three-phase motors for the class of railway under consideration we do not now purpose to discuss in detail, save only in so far as it may relate to the problems we have just enunciated. We wish, however, to call attention to some of its broader features, and would, in the first place, remark that the conditions which obtain in existing three-phase railways are totally different in almost every respect from those which will operate in the Central London Railway and in other lines of the same type, or again in street tramway networks. The success of three-phase working on a simple track such as that at Lugano no more points to the suitability of that system for town tram-

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ways than would a similarly successful use of funicular haulage. What is eminently suited to the simple circumstances of a single line may be found utterly to fail when applied to a complicated network of lines, with cross-traversing tracks, turn-outs, branches, and other complications. In like manner, though for different reasons, the successful working of the three-phase mountain railways in Switzerland is not in itself sufficient evidence that the three-phase system has advantages over other electrical systems for other classes of railways, especially when it must be admitted that we know absolutely nothing as to the cost of working these Swiss lines. Indeed, the precipitate coquetting with three-phase traction on the part of certain British electricians seems positively ludicrous when we contrast the fulness of the certainty that continuous currents can be made *to pay*, on suburban lines, with the paucity of evidence that three-phase currents can be made even *to work* on them. Consider the overhead electric railway network at Chicago, or, not to go so far afield, the line along the docks at Liverpool. These have been working successfully for years with continuous-current plant; and it is doubtful if at any place electrical energy has been produced cheaper by steam than at Chicago, while the financial success of the Liverpool line has been admirably maintained. Before we can be "off with the old love" we must surely discover something more definite as to the superior attractions of the new.

Turning from the general question, we are led by Mr. FIELD'S letter to consider what form of acceleration curve the trains on such a line as the Central London Railway should have in order to give the best results. Mr. SCOTT favours a velocity-time curve in which "the maximum speed is as constant as possible," a condition which implies very brief periods of acceleration and braking, with correspondingly high rates, at the beginning and end of the run. "Grant these," he writes, "and the case for three-phase traction is strong indeed." Quite so; but what if we cannot grant these? We think that Mr. FIELD has stated good reasons why these conditions cannot be granted—at any rate on railways of the type in question. But he has omitted to give one reason, at least as important as any other, which we shall revert to presently. Mr. FIELD shows that the velocity-time curve suited to three-phase working is one that must involve heavy braking and practically no "coasting," by which term is meant the utilisation of momentum to propel the train before the application of the brakes. Where the runs are short, as on railways with frequent stations, the velocity-curve in practice, whether on steam or electric railways, shows no flat part. It is a matter of common railway locomotive experience that the best practice consists in giving the velocity-time curve three elements: (1) A sharply rising curve in a brief acceleration period, (2) a gradually falling curve over a coasting period, and (3) a brief period of retardation under the brakes. Three main considerations affect the proportioning of these periods, one only of which is dealt with by Mr. FIELD—viz., the energy wasted in the brakes. The other two considerations relate (*a*) to the maximum acceleration and braking rates which can be applied with comfort to the passengers, and (*b*) to the additional capital outlay on locomotive power plant involved by an increase in the acceleration—the point that, in our opinion, tells most of all against the practice advocated by Mr. SCOTT. Evidently, if the maximum speed is to be attained earlier, either to allow of more coasting or to permit of this maximum being longer maintained, the acceleration rate will be increased in proportion as the acceleration period is lessened. This will involve an increase in the maximum available horse-power of the motors, and will react upon the entire electrical equipment of the line, sub stations, and power house, necessitating that that equipment be more powerful, larger, and more costly. Several considerations therefore affect the choice of the actual velocity-time curve which it will be sought to arrive at; but none of these can ever make it probable that the flat straight line advocated by Mr. SCOTT will be favoured by railway engineers for the Central London Railway type of line. If, therefore, as Mr. SCOTT seems to imply, the use of three-phase motors depends upon the adoption of this form of curve, their patronage must rest upon a sorry foundation. But, although rejecting Mr. SCOTT'S velocity-time curve, we cannot accept the view that three-phase traction must necessarily go with it. All that can be said at present is that the irregular curve favoured by the best locomotive practice makes it all the harder for three-phase engineers to adapt their system to these requirements. If they can surmount all the other difficulties in their way, this one will not be found to be insuperable.

REVIEWS.

Copies of any of the undermentioned works can be had from *The Electrician* office post free, on receipt of published price.)

Central Station Electricity Supply. By ALBERT GAY and C. H. YEAMAN. (London: Whittaker and Co. 1899.) 10s. 6d.

In the preface to this book, which forms another of the publishers' "Specialist's Series," the authors quote the opinion that "a book on electric light should be written by an experienced electric light engineer, not by some one who wants to found a reputation as an engineer on his book on the subject"; and they claim for the present publication that it deals broadly with the matter, and is written by engineers who have for many years been connected with the business of central station design, management, and maintenance.

The authors admit that it is well-nigh impossible to treat exhaustively and in detail, in a single volume, each one of the different points comprised in the equipment of that combination of engineering and electrical plant—the modern central station, and they therefore refer the reader to numerous memoirs, papers, and articles wherein special points of interest are more minutely considered. While such references are of undoubted value, the work suffers from an inequality of treatment in the various sections. The chapters dealing with distribution, and mains and services, among others, might well have been condensed in order to allow the subject of the mechanical equipment, steam generators, and plant to be more adequately dealt with. Auxiliary plant, and such matter as the use of superheaters, economisers, condensers, &c, are most superficially treated, no indication being given as to the circumstances under which it would or would not be economical to add these to the equipment; and indeed, little more is attempted than to state in the briefest manner the purpose for which such plant is intended. Yet these matters are of more importance than consideration of the theoretical size of conductors, based on the very indefinite data obtainable before supply is commenced, which is dealt with at considerable length.

Choice of system receives full treatment, and the relative merits of high and low pressure, continuous and alternating current, are reviewed in a fair and impartial manner; but as many of the larger schemes projected, or now being carried out, will employ extra high pressure, it is surprising that generation on these lines is omitted. It may be that the authors, who show what a profitable field for municipal trading the supply of electricity affords, consider extra high pressure unnecessary for supplying municipal areas; but we should have thought the use of rolyphase systems, of extra high pressure, and the broad subject of supply over extensive areas and "in bulk," worthy of notice, since these matters will surely engage the attention of many central station engineers at no distant date.

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We do not know why the authors state that "When the pressure at which current is generated, or leaves the central station, exceeds 500 volts on a system of parallel distribution, some means must be taken to convert or transform it down to the pressure required by the lamps or other consuming devices"; or again, "It is becoming common to adopt 200 to 230 volts between neutral and outer on the distributors, in which case the pressure on the feeders may reach the limit of 500 volts at the station end." There is nothing in the Board of Trade regulations to prevent a low-pressure direct system being supplied at 1,000 volts at the station end of the feeders, so long as the pressure at the *feeding points* does not exceed 500 volts between the outer conductors of the three-wire system. In one section of the book continual reference is made to buss bars; these are probably identical with 'bus bars.

There are very few matters connected with the subjects coming under the title of this work which have not been touched upon, while most are well, if briefly, treated. As the text is illustrated with numerous diagrams, and the subject is for the most part non-mathematically considered, the book will appeal to many readers desirous of obtaining a knowledge of the salient features of central station supply and also of the powers and regulations under which they operate, while some chapters will be useful to the specialist also.

Chimney Design and Theory. By WILLIAM WALLACE CHRISTIE. (New York: D. Van Nostrand Co.; London: E. and F. N. Spon, 1899.)

This book would be more truly described were the last two words of its title omitted. Chapter II., entitled, "Theory of Chimney Draught," consists almost entirely of formulæ, rules, and tables by various authorities, with little if any explanation of their origin or of the principles upon which they may have been based, the opening chapter of the book being devoted to the history of chimneys. When giving Rankine's result, wherein he showed that with an outside temperature of 60°F. the theoretically most effective temperature for the gases (for maximum duty of the chimney) was about 600°F., the present author gives no hint of the desirability, in most cases, of designing for a much lower temperature in the gases, in view of a better utilisation of their heat—a consideration now of greater importance, in these days of economisers, than formerly.

As in the chapter immediately preceding, in Chapter III., on "Chimney Formulæ," the author has collected rules and formulæ from apparently every available source. Nothing is said as to how these were arrived at, or to what extent the constants, or even the rules, are empirical. With the next chapter, however, the more valuable portion of the book commences, and the author gives a wealth of data respecting actual practice, which is sure to make the book welcome to engineers.

Two interesting diagrams, showing the influence of rate of combustion (respectively of anthracite and bituminous coals) on the evaporation, give results expressed in pounds of fuel per horse-power hour. In order to facilitate the design of chimneys, the author has drawn up some useful tables, which appear to fall in well with average practice.

Perhaps the best portions of the book are those dealing with foundations and the practical design of steel and brick chimneys; but why does the author begin the "Theory Pertaining to Steel Chimneys" with a "Rule of Thumb" for "Finding Diameter of Guy Wires for Steel Chimneys"? Other valuable data which engineers will appreciate are the records given of the performances of actual chimneys. After a clear detailed description of the method employed to straighten a square brick chimney, 100ft. high, at Waterford, N.Y., and a chapter on house chimneys, there follows a generally practical and accurate chapter on "Lightning Protection"—the authorities being well chosen. For a book specially devoted to a subject like this, the treatment of the thermodynamic and other principles which govern the production of draught is much too scanty and indefinitely stated. At the same time, the mass of practical data and details of design will commend the book universally, more especially as the published literature on the subject of chimney draught is not wanting in its theoretical treatment by good writers.

ON ELECTRIC *TOUCH* AND THE MOLECULAR CHANGES PRODUCED IN MATTER BY ELECTRIC WAVES.*

BY PROF. JAGADIS CHUNDER BOSE, M.A., D.SC.

In the various investigations on the properties of electric waves, one property has not yet attracted as much attention as it deserves—the action of long ether waves in modifying the molecular structure of matter. Apart from the interest attached to the relation between ether, electricity, and matter, the subject is of importance, as affording not only a very important verification of the identity of visible and electric radiation, but also establishing the continuity of all radiation phenomena. These phenomena occupy the borderland between physics and chemistry, and their study may therefore be expected to throw much light on several subjects at present imperfectly understood. The study of the action of electricity and of ether waves on matter in the form of solids presents many difficulties, owing to the great complexity of atomic and molecular aggregation which characterises the solid state of matter. But the phenomenon often met with in theory and practice is, unfortunately, in reference to matter in a solid state. The means of investigation are almost wanting: chemical tests give us no information, for they tell us (and that in a few cases only) of the ultimate change in a mass as a whole, and not of the protean transformations that are constantly taking place in it under the action of ever-varying changes in physical environments. In the following investigations the difficulties mentioned above were constantly present, and the attempts made to meet them may be of some interest.

The present investigation is the outcome of an attempt to reduce the very anomalous action of contact-sensitiveness of metals to a systematic behaviour. The anomalies are numerous. It soon appeared that the observed effect is not due to a single cause, but to many causes. An observer studying the dilatation of a gas, and ignorant of the effect of temperature, will doubtless encounter many anomalies. In the phenomenon of contact-sensitiveness the variables are, however, far more numerous, and the different possible combinations are practically unlimited. It therefore became necessary, by a long and tedious process of successive elimination, to find out the causes which are instrumental in producing the observed effect: the results obtained throw much light on this intricate subject.

In my former Paper† it was shown that though many substances exhibit a diminution of contact-resistance, there are others which show an increase of resistance—an increase which in certain cases lasts only during the impact of electric waves, the sensitive substance automatically recovering its original conductivity on the cessation of radiation. There are thus produced two opposite effects, either an increase or a diminution of resistance, depending on the nature of the substance. The effect of the increase of contact resistance is not an exceptional or isolated phenomenon, but is as normal and definite under varied conditions as the diminution of resistance noticed in the case of iron filings. These two specifically different effects have to be recognised, and it would be advisable, to avoid misunderstanding, to use a single term to indicate both these effects and distinguish them from one another, by calling the one positive and the other negative. The term coherence applied to the normal diminution of resistance exhibited by certain metals by the action of electric waves cannot be applied in all cases, as there is another class of substances which exhibits, under normal conditions, an increase of resistance. The term "decoherence" has been used to indicate the effect of mechanical tapping on fatigued substances: this produces an increase of resistance, and at the same time restores the sensitiveness. The action of tapping on the fatigued specimen of the latter class is, however, a diminution of resistance.

* An abstract of a Paper read before the Royal Society.

† "On a Self-Recovering Coherer, and the Study of the Cohering Action of Different Metals." *Proc.* Roy. Soc., Vol. LXV. *The Electrician*, July 21, 1899.

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I have shown in a former Paper that the seat of sensitiveness is confined to the surface layer of the sensitive substance, and that the nature of the substratum has little or no effect on the sensitiveness. Thus, a substance which exhibits a strong diminution of resistance, if coated with an extremely thin layer of a substance of the other class, will now exhibit an increase of resistance. It is seen that the action is one of the bounding layer or skin of the sensitive substance. There is a simple Sanscrit word, *twach*, which means the skin; and as the phenomenon dealt with in the present Paper is one of sensitiveness of *twach*, I shall use the expression "electric touch" in the restricted sense of contact sensitiveness to electric stimulus, the touch being regarded as *positive* when electric oscillation produces an increase of conductivity or diminution of resistance, and *negative* when the contrary effect is produced. Substances which exhibit a decrease of resistance will be called positive, and those which show an increase will be regarded as negative. The above terms are to be regarded merely as convenient substitutes for long descriptive phrases.

In order to find out the principal factors of electric sensitiveness, the following are some of the directions in which a systematic inquiry has been carried out:—

A. On the difference between the mass action and the molecular action, with reference to the phenomenon of contact sensitiveness.

B. On the change of sign of response in a receiver due to a variation of the radiation intensity.

C. On the physico-chemical changes produced in a sensitive substance by the action of electric radiation, and on the radiation products.

D. The phenomena of electric reversal, and of radio-molecular oscillation.

E. On "fatigue," and the action of mechanical tapping and other disturbances by which the sensitiveness of a fatigued receiver may be restored.

F. On the nature of the passage of electricity through imperfect contacts, and the effects of various physical agents on the conductivity.

G. On the systematic study of the contact-sensitiveness exhibited by metals, non-metals, and metalloids.

H. On the contact-sensitiveness exhibited by alloys and compounds.

I intend to treat the above subjects in some detail, and in the present Paper will deal specially with the first five lines of investigation. These, it is hoped, will afford an explanation of some of the most perplexing anomalies. All the subjects mentioned above are inter-dependent, and their treatment in one Paper would make the subject very complicated. It would be easier to take a more generalised and complete view of the subject as a whole, after each of the above-mentioned inquiries has been separately considered.

Mass Action and Molecular Action.

Of the attempts made to explain the action of contact-sensitiveness, Prof. Lodge's theory of coherence has been the most suggestive. The coalescence of water and mercury drops in Lord Rayleigh's experiments, and Prof. Lodge's observation of the welding of two metallic spheres by a powerful oscillatory discharge in the neighbourhood, lend much support to the theory of electric welding, which explains in a simple manner the diminution of contact-resistance of various metallic powders when subjected to electric oscillation. On this theory it follows that *all* imperfect contacts should exhibit a diminution of resistance. I have, however, found that there are substances, of which potassium may be taken as a type, which exhibit an increase of resistance. Potassium is not a solitary instance: I have found a large number of elements exhibiting this action; the number of compounds which exhibits a similar action is also numerous. Other phenomena will be presently described which would show that the theory of coherence is inadequate. From the above it would appear that the phenomenon is far more complex than was at first supposed. From various considerations, it would be best to distinguish between two different classes of actions, which may conveniently be described as mass action and molecular action.

Mass Action.—By this is meant the general action, say, between any two masses when placed in a strong electric field: under the given circumstance sparking may take place, and the two bodies may thus be welded together. The action is *non discriminative*—that is to say, it will be the same whatever the chemical or physical nature of the substance may be. The best way of showing this action is with drops of liquids with surface contamination, for any incipient welding will be at once exhibited by the complete coalescence of the drops. The non-discriminative nature of the action is shown in a striking manner in the following experiment. It may be mentioned here that fragments of solid potassium exhibit an increase of contact resistance. Potassium heated under melted (hard) paraffin wax was stirred by a glass rod till the molten metal was broken up into numerous spherical drops. These coalesced when placed in an intense alternating electric field. It is, however, to be borne in mind that in this experiment the substance is in the form of a liquid, and that in this particular condition certain molecular changes, to be presently described, cannot very well take place.

Molecular Action.—By this I mean the allotropic modification produced in a substance by the action of electric waves, the allotropism being due to the difference in the atomic or molecular aggregation. It will be shown that such molecular action does take place by the action of electric radiation, and that all the observed effects of the variation of resistance in a sensitive substance may be explained by the theory of allotropic modification due to the above cause. Experiments in support of the view described above will be presently given. The effect due to molecular changes is also expected to be modified by the chemical nature of the substance: thus the molecular action due to radiation, giving rise ultimately to the variation of conductivity of the sensitive substance, will be *discriminative* in contradistinction with the mass action. I have obtained numerous proofs, which will be described in a future Paper, that the nature of the reaction given by a sensitive substance depends on its chemical nature.

On the Change of Sign of Response in a Receiver due to a Variation of the Radiation Intensity.

After finding the increase of resistance exhibited by a certain class of substances, I wished to see whether these exhibited any further difference as compared to substances which exhibit a diminution of resistance. In my determination of the index of refraction of sulphur for the electric ray (*Proc.* Roy. Soc., 1895) I used the method of total reflection. I often noticed that just before total reflection, when the intensity of the transmitted beam became comparatively feeble, the receiver indicated an increase instead of the usual diminution of resistance. Prof. Lodge mentions in one of his Papers that an iron filings coherer exhibits an increase of resistance when acted on by feeble intensity of radiation. Thus, if positive substances like iron give a negative reaction with the diminution of radiation intensity, negative substances may be expected to give a positive reaction with feeble radiation. Very sensitive substances are not well adapted for an exhibition of this reversed action, possibly because the range of sensibility is comparatively great. But it is not difficult to demonstrate this property in the case of moderately sensitive substances. The following experiments with a moderately negative substance (arsenic) and a moderately positive substance (osmium) will bring out the interesting peculiarity in a clear manner. The intensity of radiation may be varied in two ways—(1) by removing the radiation farther and farther from the receiver; (2) by using polarised radiation whose intensity is varied by the rotation of an analyser. In the following experiments the first method was used.

Experiments with Arsenic Receiver.—A receiver was made of freshly-powdered arsenic. A radiator was used which emitted radiation of great intensity. It was at first placed close to the receiver, and there was produced a moderate increase of resistance in the receiver. It was then removed farther and farther, the increase of resistance produced becoming less and less. When the distance was increased to 25cm. the action was reduced to zero: this was found to be the *critical* distance, for when the distance was increased to 30cm. there was now

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produced a *diminution* of resistance. The receiver continued to exhibit a diminution until the radiator was removed to a distance of 70cm., when the radiation intensity was too feeble to affect the receiver.

Now, this critical distance may approximately be regarded as a measure of the sensibility of the substance under the given conditions. In this particular case the electric touch has a negative sign. If by any means (some of which will be described later on) the substance becomes more sensitive—*i.e.*, more negative—the critical distance will be increased. On the contrary, if the sensibility becomes less (the substance tending towards positive direction), the critical distance will be decreased. The application of this principle is of importance, as affording a means of determining the variation of sensibility under different conditions.

Experiments with Osmium Receiver.—Substances which are positive give a diminution of resistance when the radiator is close to the receiver, and an increase of resistance when the radiator is beyond the critical distance. Thus, the critical distance of an osmium receiver whose normal action is feebly positive was found to be about 250cm. At a distance of 300cm. a galvanometer in the receiver circuit gave a deflection of −3 divisions, but at a distance of 200cm. the deflection became +4 divisions, and at a reduced distance of 50cm. the deflection increased to +150 divisions.

In order to avoid confusion, we may choose to call the effect due to very intense radiation as the normal action. The sign of the normal action might further be verified by obtaining a reverse action with a feeble radiation intensity.

Molecular Changes Produced in Matter by the Action of Electric Waves.

A sensitive receiver, made say of iron powder, becomes suddenly conducting by the action of electric radiation; but the sensitivenee of the receiver is lost after the first response, and it is necessary to tap it to restore the sensitiveness. On the theory of coherence, the loss of sensitiveness is explained by supposing that electric radiation brings the particles nearer and welds them together, and that the sensitiveness can then only be restored by the mechanical separation of the particles. This supposition, however, fails in the case of substances which exhibit an increase of resistance by the action of radiation. It may, however, be supposed that by some process little understood the particles are slightly separated by the action of electric waves, thus producing the observed increase of resistance. On this view, however, the restoration of sensitiveness by tapping remains unexplained. Again, if the increase of resistance is due to a slight separation of particles, suitable small increase of pressure ought to restore the original conductivity, as also the sensitiveness. It is, however, found that a considerable pressure is required to restore the original current, as if the outer layer of the particles were rendered partially non-conducting by the action of radiation, and had to be broken through before the original current could be re-established. It is also found that, though the sensitiveness is restored by this expedient of increasing the pressure, yet the restoration is only partial, and that after a repetition of this process the receiver loses its sensitiveness almost completely.

I have attempted to find out an explanation of this obscure "fatigue" effect. This subject will best be treated in connection with the anomalous behaviour of silver, which I find is also in a manner connected with the fatigue effect. Silver, as indicated in my last Paper, sometimes exhibits an increase and at other times a diminution of resistance. The anomaly cannot be explained on the supposition of the different effects due to variations of radiation intensity, for the anomaly persists even when the intensity of radiation is kept constant by keeping the radiator at a fixed distance.

In order to explain these actions, I assume provisionally the following hypotheses, which, with the necessary deductions, are given below:—

(1) That electric radiation produces molecular changes or allotropic modification in a substance.

(2) That, starting from the original molecular condition A, the effect of radiation is to convert it, to a more or less extent, into the allotropic modification B (the latter condition will be designated as the "radiation product"). It follows that this change from one state to the other must be accompanied by a corresponding change in the physical properties of the substance.

(3) As one of the properties of a substance is its electric conductivity, any allotropic changes produced by radiation should be capable of being detected by a variation in the conductivity of the substance.

(4) That, after the molecular change from A to B condition has reached a maximum value, the further action of radiation would be to convert, to a greater or less extent, B to A. If such molecular reversal does take place, there ought to be (see No. 3) a corresponding electric reversal.

(5) That the ultimate loss of sensitiveness, known as "fatigue," is due to the presence of the "radiation product" or B variety along with the A variety, the opposite effects produced by the two varieties neutralising each other.

The justification for the above hypotheses is to be sought for: (1) From analogy with other known radiation phenomena, which give rise to allotropic modifications of a substance: (2) from experimental proofs (*a*) of the allotropic transformation being attended with changes of the conductivity of the substance; (*b*) of the existence (and, if possible, the production by chemical means) of an allotropic modification of a substance analogous to the radiation product (or B variety) whose reaction should be opposite to that of the substance in a normal condition (A variety); (*c*) of the assumption that, when by the action of radiation the form A has been transformed into the form B, to a maximum extent, the further action of radiation is to reconvert to a more or less extent the form B into the form A, such transformations giving rise to electric reversals; (*d*) of the existence of the radiation product in a fatigued specimen.

The above-mentioned hypotheses will obtain still stronger support if further deductions from the above theory are borne out by crucial experiments.

I will now describe investigations on the lines sketched above.

(To be continued.)

MOSCOW ELECTRIC TRAMWAYS.

The recently opened electric tramway in Moscow was described by Herr Erich Krannhals in the *Elektrotechnische Zeitschrift* of February 8th. It is a converted horse tramway, three lines out of a total of 53 miles having now been electrically equipped. The first of these starts at about three-quarters of a mile from the centre of the town and runs outwards for a distance of 2 miles. The second line is an extension of the first, and has a length of 1½ miles; while the third is about parallel to the second line for 1½ miles, and then bends round at right-angles for a distance of three-quarters of a mile and joins the first line, the length of the whole system at present being therefore 5¾ miles. All is double-track with the exception of the last-mentioned ¾-mile section of the third line, which is single-track. The distance between the centres of the tracks is 12ft., and the gauge is 5ft. Phœnix girder rails, weighing 61lb. per yard, are employed on lines 1 and 3; Vignole rails, weighing 41lb. per yard, and laid on wooden sleepers, on line 2. The smallest curve has a radius of 56ft., and the steepest gradient is 2·32 per cent. for a distance of 100 yards.

The energy for working the tramways is supplied from a sub-station in the centre of line 2, this being in connection with the electric supply station of the lighting company 4·9 miles distant. Two thousand volt three-phase current is brought from the latter by underground three-core cables and transformed into 550 volt continuous current by four 85 kw. Siemens and Halske motor-generators, the motors of which receive the current at 2,000 volts pressure, and are coupled by insulated flexible couplings to the internal pole continuous current dynamos. A battery of 1,000 ampere-hours capacity, at a discharge rate of 400 amperes, is employed, which is charged independently in two sets every one or two months, it being otherwise connected simply in parallel with the bus bars. The switchboard, although simple, has some interesting features, and a diagram of its connections is given in Fig. 1.

The feeders are overhead as well as the trolley-wire, but they are to be replaced shortly by underground cables armoured with iron ribbon. Each is led through an automatic cut-out, according to usual practice. In connection with these is a simple means of test-

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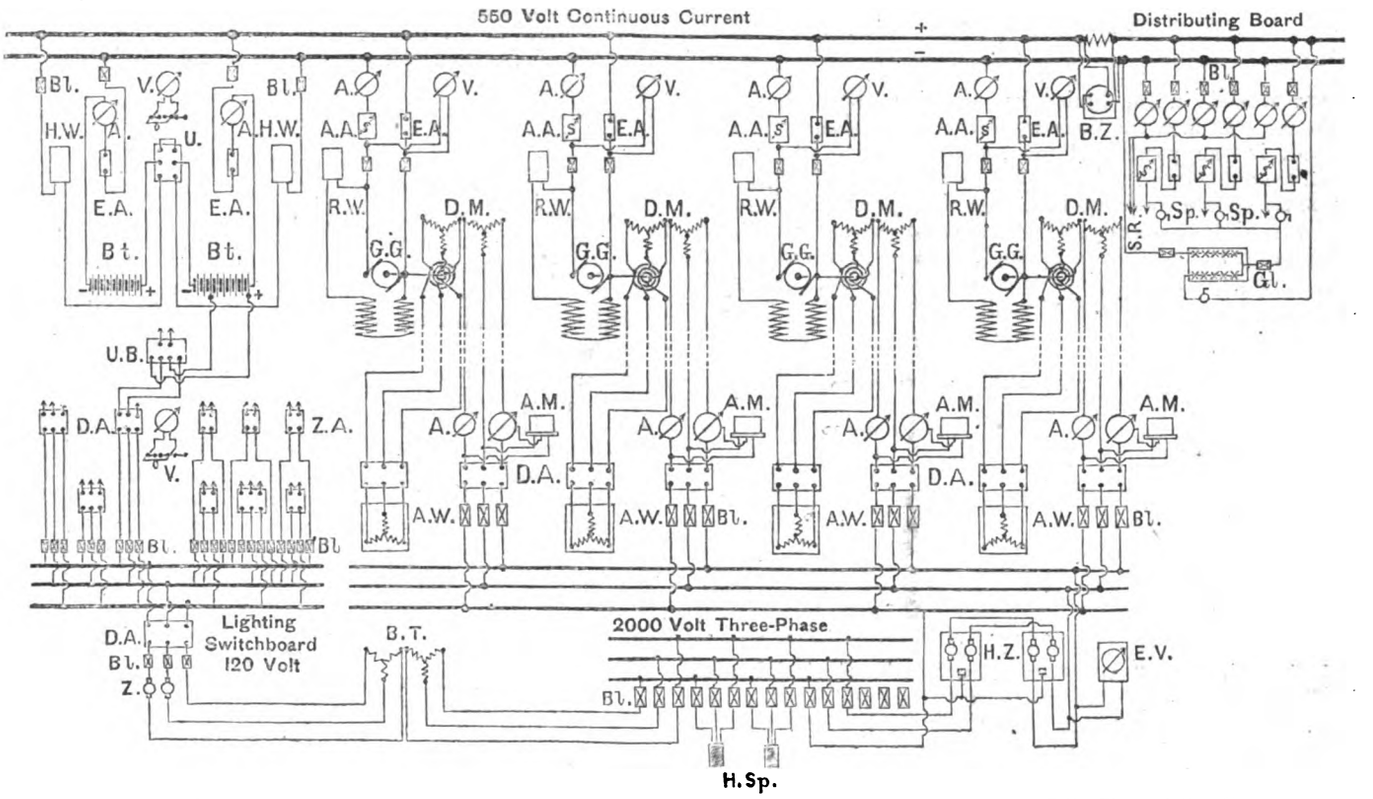
ing. A series of two sets of incandescent lamps are arranged as shown in the figure. If one of the automatic cut-outs falls, the lamps burn at 110 volts pressure; if the insulation is perfect they will burn a dull red; and in the case of a short-circuit on the line, one set will burn brightly and the other dull red.

There is also a main switch in the sub-station, which switches off the battery with one movement, and the high-pressure line with a second, thus cutting off the current from the line. The trolley wire is divided into sections in the usual manner, and supported 18ft. above the track by double-bracket poles, from 115ft. to 130ft. apart.

The motor cars number 23, of which 10 are equipped with two motors of 20 H.P. rating each, and the remainder with a single motor. The old horse cars are employed as trailers. A motor car full weighs 10·7 tons, and a trailer, also full, 4·7 tons. As an experiment, a battery car is being tried on line 2, fitted with 200 Tudor cells, having a capacity of 30 ampere-hours and a weight of 28 tons. This car is fitted with a trolley as well, so that the cells are charged from the overhead line. The seating capacity of the cars is 20, and there is room for eight on each platform; there are no roof seats. As trolley a Siemens sliding bar is employed. A short-circuiting brake is usually made use of, supplemented by a mechanical and a reversing brake.

There are usually 18 or 19 motor cars on the road, from 7.30 a.m. until midnight, in summer with trailers and in winter without. The standard speed is 6·6 miles an hour within the town, and 8 miles an hour outside. Stopping places are from 270 to 330 yards apart, and the cars run at a 4-minutes headway, except in winter, when a 10-minutes service suffices outside the town.

Originally three motor-generators of the size already indicated were estimated to be necessary for this work, with a fourth in reserve; but so great is the levelling effect of the battery—whose erection was only decided upon after the original plans had been made—that actually one motor-generator usually suffices, and two are only required at the very greatest load. During four weeks in August, 46,700 car-miles and 33,400 trailer-miles were traversed, equivalent to 63,400 car-miles if one trailer-mile be taken as equivalent to half a car-mile. The consumption of energy was 43,764 kw. metered from the continuous-current terminals, and 53,534 kw. from the three-phase terminals, showing a transformation efficiency of 81 per cent., and a consumption per car-mile of 844 watt-hours three-phase current, or 690 watt-hours continuous current.



H.Sp.—High-pressure cable.
Bl.—Fuse.
B.T.—Lighting transformer.
Z.—Meter.
D.A.—Three-pole switch
V.—Voltmeter.

Z A.—Two-pole switch.
U.B.—Switch for lighting.
Bt.—Storage battery.
E.A.—Single-phase switch.
U.—Throw-over switch.
A.—Ammeter.

H.W.—Main circuit resistance.
A.A.—Automatic cut-out.
R.W.—Regulating resistance.
G.G.—Continuous-current generator.
D.M.—Three-phase motor.
A.W.—Starting resistance.

E.V.—Electrostatic voltmeter.
A.M.—Wattmeter.
B.Z.—Meter for tramway current.
Sp.—Feeders. Cs Single-pole switch.
S.R.—Rail return.
Gl.—Lamp rheostat.
H.Z.—High-pressure meter.

Switchboard Connections for Moscow Tramways.

The building of the line was commenced in August, 1898, and part of the line outside the town was working in March, 1899. Consent was only obtained to erect an overhead wire inside the town on June 16, 1899, and yet the whole system was completed and thrown open to the public by July 27. All the work was executed by the Russian branch of Messrs. Siemens and Halske.

CORRESPONDENCE.

THREE-PHASE RAILWAYS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Published in your last issue I find a letter from Mr. Kilburn Scott, under the above heading, in which that gentleman states that I implied by my remarks on the "Swiss Visit," at the Institution of Electrical Engineers, that "the Swiss firms did not understand the continuous-current series motor and the series parallel controller." I wish to say that this is a misstatement on the part of Mr. Kilburn Scott, and if he will refer to the remarks I *actually* made he will find that I neither said or implied anything so foolish. If Mr. Scott's "impression is that America cannot teach Swiss electrical engineers anything," I am afraid his impression is wrong. Swiss engineers can learn much from America, and America from Switzerland.

At the meeting above referred to I compared the probable velocity-time curves of the Central London Railway and of a mountain railway, and showed how one might form an idea of the relative motor losses from the shapes of the two curves. Now, Mr. Kilburn Scott tells us that the shape I sketched for the velocity-time curve of the Central London Railway was quite wrong, and he shows what the shape ought to have been. I reproduce this in Fig. 1. I would like to ask Mr. Scott if he is serious in imagining that it would pay best to work with such enormous accelerations, run at constant velocity, and absorb practically the whole kinetic energy of the train in the brakes when the train is stopped, for this is what his diagram shows. And yet this is what he seems to imply by saying "it seems an essential for keeping a good

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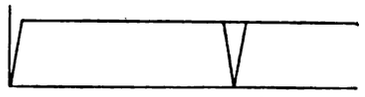
time schedule . . . . that the maximum speed should be kept as constant as possible."

In the first place, the area of a velocity-time curve represents space passed through; hence, if we draw any number of curves on the same base line, each of which includes the same area, each curve represents one possible method of covering the same distance in the same time.

In Fig. 2 three curves are drawn, all having the same maximum velocity, all including the same area, hence all representing the same space passed through in the same time. A glance at the diagram shows that in the different cases the



"Stops at 920 yards interval . . ."

FIG. 1.

power wasted in the brakes on stopping the train is very different. In fact, the more rapid the initial acceleration, the greater is the portion of the kinetic energy of the moving train available for *coasting* before the brakes are applied. The tendency should therefore be to obtain rapid accelerations up to the maximum velocity, then to shut off current completely, coast as far as possible, utilising to the best advantage the kinetic energy of the train, so that when the brakes are applied the velocity is comparatively small.

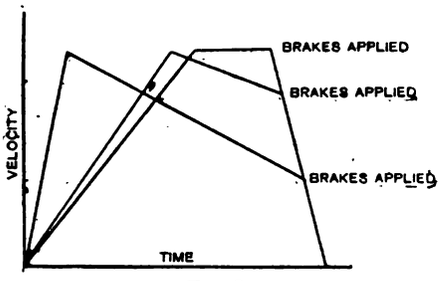


FIG. 2.

I show in Fig. 3 an actual case for the Central London Railway between the stations Queen's-road and Notting Hill-gate. I also show the programme Mr. Scott proposes—viz., to accelerate for $\frac{1}{20}$th time between stations, run at constant velocity for $\frac{8}{20}$ths, and reserve the remaining $\frac{1}{20}$th for bringing the train to rest by the application of the brakes—if, indeed, such a heavy braking effect could be produced.

The area of the two curves is the same, so the same schedule time is maintained.

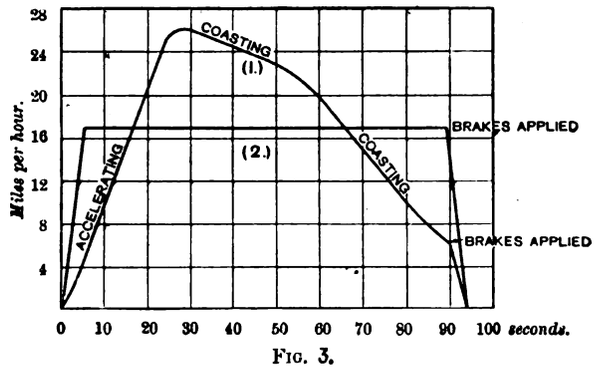


FIG. 3.

In case (1) the mean acceleration, while the current is on, is 1·52ft. per second per second, requiring therefore 105lb. draw-bar pull per ton of train, irrespective of friction and gradients. In case (2) the acceleration is 5ft. per second per second requiring 345lb. per ton of train. Now, even assuming the locomotive heavy enough to give this draw-bar pull (which, by the way, is very far from being the case), what advantage do we get? We have to make our motors capable of exerting a tractive effort three times as great in (2) as in (1), we have to put up with the enormous current fluctuations caused thereby, and we waste about nine times as much energy in the brakes, since in (2) they are applied at 17 miles and in (1) at 6 4 miles per hour. Let us see what energy is wasted in the brakes. In case (1), after deducting an allowance for overcoming friction and grades up to end of journey, we have a balance when the brakes are applied of 2,100 ft. lbs. per ton of train. To form some idea of the amount of this, consider it spread out over the whole journey of 94 seconds; we get then as the equivalent of the energy absorbed by the brakes a continuous expenditure of 6 H.P. for the 94 seconds.

In case (2), after making allowance for energy required to carry the train to the end of the journey after the brakes are applied, we still have a balance of 18,500 ft. lbs. per ton, which is equivalent to an expenditure of 54 H.P. during the 94 seconds of the journey.

It is not necessary to go on showing the absurdity of case (2).

The moral of all this is that the velocity-time curve for the Central London Railway will not be flat, but peaked; the train will be accelerated for from one-third to half the time occupied for the journey between two stations, it will run at its maximum velocity for but one instant, so that a three-phase motor would be running continually very inefficiently, whereas with series-parallel controllers and series motors the latter would be in one or the other of the "running" positions (*i.e.*, with all resistance out) for a large proportion of the time; moreover, when this is not the case the efficiency of the combination is manifestly higher than could be the case with induction motors.

Of course, this argument only applies to railways where a quick time schedule is required and the stations are very near together. On a mountain railway, on the other hand, where the maximum velocity is five miles per hour and where the distance between stations is say one mile, an acceleration ot 1ft. per second per second would be ample, arriving at the final velocity of five miles per hour in 7·3 seconds. In this case the tractive effort per ton necessary for accelerating is 70lb., whereas the tractive effort at constant speed on a 25 per cent. grade is 575lb. per ton. The main point is that, whereas on the Central London the accelerating forces are about twice those required for overcoming friction and gradients, and the acceleration lasts for about one-third of the journey, on the mountain railway the accelerating force may be about one-eighth of the tractive effort required for friction and grades, and is exerted for say $\frac{1}{100}$th of whole journey between stations. In fact, in the former case the acceleration is the all-important point, in the latter it is the least important.—Yours, &c.,

M. B. FIELD.

London, E.C., Feb. 19.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Mr. E. Kilburn Scott, in his letter in your last issue, has criticised some of my remarks on the above subject at the Institution of Electrical Engineers in a manner which seems to show that he does not fully appreciate my meaning, or even the conditions of the problem.

That the engineer getting out his quantities and arranging the line would take into account the greatest traffic that could possibly be expected is surely self-evident. What I pointed out was that, given all reasonable foresight, it is yet the unexpected that always happens, and the advantage is with the system which is least likely to be deranged by conditions *not* foreseen in the design. It is here, I submit, that the continuous current is superior to multiphase for working traction motors.

My suggestion to increase the tension on continuous current lines to 750 volts was, of course, based on the fact that multiphase lines (viz., the Engelberg and Burgdorf-Thun railways) have already been equipped for that voltage. An increase of voltage will reduce the amount of copper required in about equal proportion with either system, while with any given voltage, length between feeding points and percentage loss, the advantage will be with continuous currents, owing to the fact that two out of the three conductors must be of copper for the three-phase line.—Yours, &c.,

A. E. LEVIN.

London, S.W., Feb. 19.

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AN ELECTROLYTIC CENTRIFUGAL PROCESS FOR THE PRODUCTION OF COPPER TUBES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: My attention has been drawn to the two letters appearing in your issue of Feb. 16.

I quite agree with Mr. Henry Wilde that there is nothing new in revolving a cathode, as this has been practised for a great number of years. Mr. Wilde's letter makes it quite clear that his process has no feature in common with my centrifugal process. What I claim to have discovered is that if the cathode is revolved at a sufficiently high speed so as to generate an appreciable amount of centrifugal force, remarkably smooth deposits can be obtained at very high current densities, and the voltage is considerably reduced. I have also observed that there is a critical speed at which excellent copper deposits can be obtained which cannot be obtained at a lower speed.

I am well acquainted with Mr. Henry Wilde's patent, in which he claims imparting a rapid whirling or rotating motion to a depositing solution either by means of paddles or revolving the electrodes. I am not aware that Mr. Henry Wilde had discovered that by rotating the cathode at a certain speed smooth deposits of copper could be obtained at remarkably high current densities, even when a very large percentage of free acid is present in the electrolyte. If Mr. Wilde had appreciated the advantages of centrifugal force, why does he state in his patent that a paddle revolved in the electrolyte is a good substitute for revolving the electrodes? The American patent authorities, after carefully studying Mr. Henry Wilde's patent, have decided to grant me a patent for my centrifugal process.

With reference to Mr. W. Stepney Rawson's letter, I should like to state that I have made tubes 12in. in diameter on a practical scale by my process, which are better than any tubes made by the Elmore process, as there is no tendency to exfoliate. It might interest readers of your paper if Mr. Stepney Rawson would give some particulars of the process that was tried, and also state whose process it was and what speeds were used, the composition of the electrolyte, &c.—Yours, &c., SHERARD COWPER-COLES.

INGLETON WATER POWER ELECTRIC SUPPLY WORKS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In connection with your article on the Ingleton electric lighting works last week, we shall be glad as a matter of fairness if you would point out that not only were we the pioneers of this work, having reported and prepared schemes some twelve months ago, but that we have also heavily financed the present company and are contractors for the whole of the electrical equipment.

Messrs. Callenders are sub-contractors for the street wiring, and Messrs. Gilkes contractors for the turbines.—Yours, &c.,

London, Feb. 20. DRAKE AND GORHAM.

[We have been asked by Messrs. Gilbert Gilkes and Co., of Kendal, to correct a misstatement, viz., that they "were the principal contractors." They inform us that they were the engineers for the whole electrical work as well as contractors for the water power part.—ED. *E.*]

THE ELECTRICAL ENGINEERS (R.E.) VOLUNTEERS "SEND-OFF" DINNER.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The Dinner Committee have the gratification of announcing that Lord Kelvin has most kindly consented to remain in London a week longer than he had originally intended in order to preside at the "send-off" dinner on March 3rd.

In order that the final arrangements for the dinner may be completed without loss of time, the hon. treasurer (Mr. Henry Edmunds, 2, Queen Anne's-gate, London, S.W.) would be glad to receive remittances (£2 each) as soon as possible from those gentlemen who wish to be present (or to act as hosts without attending), but who have not yet communicated with him on the subject.—Yours, &c., W. G. MCMILLAN,

London, Feb. 20. Hon. Sec. to the Dinner Committee.

CITY ELECTRIC LIGHTING.

At yesterday's meeting of the Court of Common Council the Streets committee reported that they had had under consideration letters from the Charing Cross and Strand Electricity Supply Corporation with regard to the manner in which the company proposed to carry out the financial arrangements for dealing with the City of London Electric Lighting Order, 1899. The first letter states that the directors think that the best course will be to make arrangements for vesting the provisional order in a new company, as, apart from the question of capital adjustments, intricate accounts would have to be kept, which in a separate company would be wholly avoided. The time for purchasing the undertaking by the City Corporation is considerably earlier than the time provided in the company's other orders, and this, if the capital is part of the Charing Cross and Strand company's, would cause serious difficulties. It is therefore proposed to register a new company with a nominal capital of say £1,000,000, and with borrowing powers for £500,000. The directors of the Charing Cross and Strand Co. would ask their shareholders for powers to invest say £200,000, to be lent to the new company at 4 per cent. interest under certain conditions.

A second letter reports the result of an interview which the chief engineer and the secretary of the company had with the assistant engineer-in-chief of the Postal Telegraph Department, at which suggestions were made by the Post Office authorities that it might be possible for the works contemplated by that department and the works requisite under the provisional order to be carried out simultaneously. Arrangements would then be made for jointly carrying out the excavation and preliminary reinstatement and the laying and jointing of the Post Office distributing pipes and the company's mains, and the Post Office suggest that the undertakers of the provisional order should do all this work. The very great advantages of such a course being pursued to all concerned, including the City Corporation, should they eventually purchase, are insisted upon. It is doubtful (the letter continues) whether, if the Charing Cross and Strand Co. carry out the works, they would feel quite justified in undertaking this extra responsibility, but if the suggestion for the incorporation of a new company were adopted, special powers could be taken to deal with the question.

On this correspondence the Streets committee recommended "That the company be informed that, provided they obtain the sanction of the Board of Trade to the formation of a new company, the Corporation will offer no objection, on the express understanding that it will in no way prejudice the Corporation or electric light consumers, and on an undertaking being given under the seal of the company that the expenses in connection with the formation and the carrying on of such new company shall form no part of the purchase money in the event of the Corporation deciding to purchase the undertaking."

Mr. A. C. MORTON moved to omit from the recommendation the words "and the carrying on." There would be an advantage to the Corporation in the proposed arrangement, as the City supply would be kept entirely separate and the accounts simplified, but to say that the expenses of carrying on the company should not be charged against the purchase money was absurd, as under the present agreement the company had power to make the charge with reference to the existing company.

Mr. WALLACE asked why a new company was to be formed? The Charing Cross Co. undertook if they were granted the order to perform certain duties. Immediately they obtained their concession they came to the Court with a proposal to form a new company with £1,000,000 nominal capital and borrowing powers for another £500,000. This was exactly repeating the course which had caused the City so much trouble in the past. If the proposal were agreed to it would be possible for the City of London Electric Lighting Co. to purchase shares in this new concern, and by-and-by practically to control it. If that happened there would be no real competition in the City. Unless the City were to receive something substantial in return, he hoped the Court would refuse to have anything whatever to do with this proposal.

Mr. H. O'BRIEN reminded the Court that one of the strongest arguments in favour of the Charing Cross Co. having the order was that they had a large night demand, and therefore by working the City day demand the City would get the light much more cheaply. If a new company were formed it would of course be in exactly the same position as the City of London Co., and the City would get absolutely no benefit.

Mr. J. H. LILE contended that had there been the slightest idea that the Charing Cross Corporation were to form a new company to carry out their concession, the Court would never have consented to their receiving the order.

Mr. F. McCARTHY suggested that if the company required more money, instead of promoting a new concern it should have come to the Court and allowed the City Corporation to take a number of shares.

The CITY SOLICITOR (Mr. H. Homewood Crawford) said the Charing Cross Co. undoubtedly gave Sir Courtenay Boyle the assurance that they had ample capital for carrying on the concern, and on a subsequent occasion, when the City attempted to insert words in the order to prevent any assignment to another company, the assurance was repeated. He therefore was personally much surprised when the suggestion was put forward that they had not sufficient capital without forming a new company. The idea of the committee was that it would be extremely unfair that the Corporation should give any assent whatever unless they were absolutely certain that the formation and the carrying on of the new company would not in any way increase the purchase money in the event of the Corporation exercising its option.

Mr. HUDSON, replying, expressed surprised at the discussion. This was simply a formal arrangement for obtaining the necessary additional capital to carry out the works. The words of Sir Courtenay Boyle's report were: "They propose to spend £800,000 on the City undertaking, and to

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raise the necessary money by increasing their authorised capital." Very good reasons were shown why the formation of a new company was the best form of raising the additional capital. The Corporation would be absolutely protected from additional charges, and there would be no promotion money to be paid.

Mr. Morton's amendment, having been seconded, was then negatived.

The original report was then voted on, and also rejected.

The Streets committee in a further report reminded the Court that on Nov. 2 last the site secured by the Charing Cross and Strand Electricity Supply Corporation for a generating station at Marsh Gate-lane, Bow, was approved, subject to certain conditions (see *The Electrician*, Nov. 3, 1899, p. 54).

This decision was communicated to the company, who objected to the proposed conditions as being beyond the scope of the Corporation's power under the order. Correspondence on the subject had followed, the company pointing out that if the suggestion that the approval of the plans for the generating station is to be a condition precedent to the Corporation giving its consent to the proposed site, there is no such stipulation in the provisional order, and the company therefore ask that they should be left with an unfettered discretion in the construction of the station. With regard to the requirement that the Corporation should be at liberty to purchase the whole of the 7¼ acres of land at Marsh Gate, instead of five acres, as proposed by the company, the company expressed a readiness to give way on this point, except that a portion of the land might be required for the purpose of joining up the company's system and the possible supply of electric current in bulk to the local authorities, for which purpose a certain portion of the land would have to be retained by the company. The Streets committee now recommended that the conditions agreed to by the Corporation on Nov. 2 last, in approving the site for the generating station, be modified to meet the views of the company on the distinct understanding that the exact position of the City generating station on the site is to be agreed to and defined on a plan to be mutually approved by the Corporation and the company, and that the station is to be self-contained and complete in every respect for the purposes of the City undertaking.

Mr. M. WALLACE moved that the report be referred back, as the price to be paid for this site was three or four times its real value.

Mr. A. C. MORTON asserted that all the opposition to these reports really came from the friends of the City of London Electric Lighting Co., who were endeavouring to destroy the competition offered by the new company. If the company built the generating station with the approval of the Court, they would be under no obligation to sell it when the City desired to purchase, and then where would the City Corporation be with all its cables, &c., but no generating station?

Mr. HUDSON (chairman of the committee) explained that the arrangement was a fair and proper one for the continuance of the work of the company, and the amendment having been negatived, the report was agreed to.

The committee also recommended that the company be permitted to lay mains in the western district of the City, under the direction and to the satisfaction of the engineer and electrical engineer, and this was agreed to.

On Oct. 5 last the Court agreed to comply, on certain conditions (see *The Electrician*, Oct. 6, 1899, p. 851), with the application of the City of London Electric Lighting Co. for permission to alter the standard pressure from 100 volts to 200 volts. These conditions were objected to by the company, but the Court on Nov. 2 (*The Electrician*, Nov. 3, 1899, p. 54) decided to adhere to the conditions, whereupon the company appealed to the Board of Trade. The Streets committee now submitted the decision of the Board of Trade on the matter, dated Dec. 12, 1899. This decision confirms the conditions laid down by the Corporation, with further condition—"That no change shall be made in the pressure of the supply to any premises which on June 16, 1896, were supplied with energy by the undertakers, except with the consent of the consumer."

TRADE NOTES AND NOTICES.

[Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.]

NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers, or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London:—

READY.

(Price 12s. 6d., by post, 13s. 3d.; Colonies, 14s.; abroad, 14s. 6d. (United States, 15s.)

"The Electrician" Electrical Trades' Directory and Handbook for 1900 (corrected to January 31st, 1900).—In addition to the well-known features of this Directory and Handbook (all of which have been carefully revised and brought quite up to date), a large addition has been made to the Handbook Division, including a Digest of the Law of the Telegraph and Telephone, for the use of municipalities and companies contemplating applying to the Postmaster-General for a Telephone Licence. This section of the book now includes the new model form of Licence issued by the Postmaster-General in January, the Telegraph Acts and Orders passed by Parliament in 1899, and other information in connection with this the latest development of electrical enterprise. The huge sheet tables of Electric Light and Power and Electric Railway and Tramway undertakings of the United Kingdom have been made complete up to the 31st January. These sheets form a most complete record of electrical engineering progress in connection with electricity supply and power and traction applications. The Directory Division has been carefully extended and corrected up to Feb. 2, and is the most reliable list of firms and persons engaged in the electrical and allied industries ever compiled. A number of additional sketches of the careers of well-known electrical experts have been added to the Biographical Division, together with many new portraits. The new volume is, we claim, the most complete and correct book of its kind ever published in any language. An analytical digest of the contents of this volume can be obtained post free.

"Localisation of Faults in Electric Light Mains."—By F. C. Raphael. Price 5s., post free. The book deals with the important subject of localising faults in electric light and power cables; and the various methods of insulation testing are here collected and discussed.

"Wireless Telegraphy: Signalling across Space without Wires by Electric Waves." A Review of the Work of Hertz and his Successors.—By Dr. O. J. Lodge, with a large number of illustrations. New and Enlarged Edition, 5s. nett. *Now ready.*

TENDERS INVITED.

The *Great Central Railway Co.* invite tenders for the supply of stores and materials during the twelve months ending April 30, 1901, including telegraph and electric light materials, wire, fog signals and signal materials, screws, asbestos packing, indiarubber, brass sheets and tubing, &c. Patterns can be seen (from 26th inst. to March 5) on application to the storekeeper (Mr. A. W. Longden), Junction-street Mills, off Ducie-street, London-road, Manchester; and specifications may be obtained after same date from the secretary (Mr. Oliver S. Holt), London-road station, Manchester. Further particulars are set out in an advertisement, and tenders must be sent to Mr. Holt not later than 10 a.m. on March 6.

The *Glasgow* Corporation require tenders for the reconstruction of the Glasgow tramways and the construction of new tramways, as detailed in specification to be obtained of the general manager (Mr. John Young), 88, Renfield-street, where plans can be seen and further information obtained. Tenders must be lodged with the town clerk (Sir J. D. Marwick), City Chambers, Glasgow, not later than 5 p.m., March 2. An advertisement contains further particulars.

The Visitors committee of the Lancashire County Asylum, *Rainhill*, invite tenders for the supply and erection of (1) three Lancashire boilers and superheaters and a Green economiser; (2) three 175 B.H.P. steam dynamos, with booster, switchboard, feed pumps, piping, tanks, cranes, and other accessories; (3) storage battery of 1,200 ampere-hour capacity and accessories; (4) feeder mains (solid system); and (5) wiring of buildings. Specifications, &c, can be obtained from the consulting engineer (Mr. Thomas L. Miller, M.Inst.C.E.), 7, Tower-buildings, Water-street, Liverpool. Further particulars are set out in an advertisement. Tenders must be delivered at the Asylum, addressed to chairman of committee, by noon of March 22.

The *Leeds* Tramways committee invite tenders for one, two, or three steam dynamos. Specifications, &c., can be obtained at the offices of the city engineer (Mr. Thomas Hewson, M.Inst.C.E.), Municipal Buildings, Leeds, or of the consulting engineers (Messrs. Hopkinsons and Talbot), 26, Victoria-st, Westminster, S.W., and 29, Princess-street, Manchester. Further particulars are given in an advertisement, and tenders must be delivered at the town clerk's office, Town Hall, Leeds, by March 21.

The *Wigan* Corporation invite tenders for steam piping, steam feed pumps, and steam circulating pumps (Weir), feed water heaters, feed water piping, &c. Specifications from the borough electrical and tramway engineer (Mr. H. Collings Bishop), to whom tenders must be sent before March 3. An advertisement contains further particulars.

The *Burton-upon-Trent* Corporation invite tenders for providing and erecting a complete electric lighting installation at their sewage pumping station at Clay Mills. Specifications, &c, may be obtained of the borough engineer and surveyor (Mr. George T. Lynham). Further particulars are given in an advertisement, and tenders must be delivered at Mr. Lynham's office by 10 a.m. of March 5.

The *Farnworth* Urban District Council invite tenders for the supply and erection of (1) Lancashire boilers, economisers, condensing plant, feed pumps, steam exhaust pipes, &c.; (2) three 120-kw. steam dynamos; (3) lighting switchboard; (4) traction switchboard; (5) accumulators; (6) underground cables; (7) travelling crane; (8) re-cooling tower. Specification, &c., can be obtained from the consulting engineers (Messrs. Lacey, Clirehugh and Sillar), 2, Queen Anne's gate, Westminster, S.W., and 78, King-street, Manchester. An advertisement gives further particulars, and tenders must be

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delivered to the clerk (Mr. David Crossley), Council Offices, Farnworth, Lancs, by March 7.

The *Edinburgh* Corporation invite tenders for an electric lighting installation at Shrubhill power station. Specification can be obtained of the resident electrical engineer (Mr. F. A. Newington), 5, Dewar-place, and tenders must reach the town clerk (Mr. Thomas Hunter, W.S.), City Chambers, Edinburgh, by March 5. An advertisement gives further particulars.

The *Keighley* Corporation invite tenders for the supply and erection of the following plant at their electricity works: Switchboard and balancer, 10-ton overhead traveller, storage battery, mains, conduits, arc lamps and posts, ejector condensers, exhaust pipes and tanks, main, steam, and feed water pipes. Tenders, addressed chairman of Electricity committee, Bridge street, Keighley, by 10 a.m. March 1.

The New Tramways committee of the *Newcastle-upon-Tyne* Corporation require tenders for the supply of 130 car bodies, trucks for same, and for electrical equipment. Tenders to town clerk (Mr. Hill Motum), Town Hall, Newcastle-upon-Tyne, by March 2.

The *Sunderland* Corporation require tenders for the supply of (*a*) steam exhaust, feed, and other pipes, and (*b*) two steam-driven induced draught fans and accessories. Tenders, addressed chairman of Lighting committee, Town Hall, Sunderland, by noon March 2.

The Corporation of *Durban* (Natal) invite tenders for the supply and delivery at Durban of: 1,900 tons steel girder rails, 64 tons fish plates, the necessary fish bolts, nuts, tie bars, and electric bonds; 407 lots Australian hardwood stringers, with the necessary dog spikes. Specifications and tenders (in duplicate) to Messrs. Webster, Steel and Co., 5, East India-avenue, London, E.C., by March 8, or to town clerk, Durban, by mail delivery on or about April 2.

The *Poplar* (London) District Board of Works invite proposals for the fitting up of consumers' premises for the electric light free of initial cost to the board or the consumer. Schemes must be lodged with the clerk (Mr. Leonard Potts), 117, High-street, Poplar, London, E., by March 1.

The Vestry of *Shoreditch* (London) invite tenders for stores for the electricity department, including electric cables and sundries, engineers' stores, ironmongery, tools, &c., wiring and fittings materials. Tenders to Dr. H. Mansfield Robinson, Town Hall, Old-street, London, E.C., before 3 p.m. 27th inst.

The *Salford* Corporation invite tenders for the supply and erection of electrically-driven mechanical stokers, economisers and fittings, jet condensers and pumps with steam exhaust and water pipes, electrically-driven feed pumps and feed pipes, and travelling crane. Tenders to town clerk (Mr. L. C. Evans) by 10 a.m. 28th inst.

Tenders are invited for the supply of electrical fittings, &c., for the *Norfolk County Asylum*, Thorpe. Tenders to clerk (Mr. P. E. Hansell), The Close, Norwich, by 27th inst.

The *Bournemouth* Corporation require tenders for cables, arc lamps, wiring, &c., for the electric lighting of the pleasure grounds. Tenders by March 3.

The *Aberdeen* Tramways committee invite tenders for the supply of four electrically-equipped tramcars and other material. Tenders to town clerk, Town House, Aberdeen, by noon 28th inst.

The *Gloucester* Corporation invite tenders for wiring the Guildhall, public baths and electricity works, and for supplying the necessary fittings. Tenders to Mr. G. Sheffield Blakeway, Guildhall, Gloucester, by Feb. 27.

Newcastle-upon-Tyne New Tramways committee invite tenders for a 50 ton, a 25 ton, a 6 ton, and a 2 ton electric crane. Tenders to town clerk by noon, March 5.

The *Manchester* Corporation invite tenders for stores, including electrical goods, for 12 months from April 1. Tenders to town clerk by March 5.

The *Blackburn* Corporation invite tenders for feeder cables. Tenders to town clerk (Mr. Robert E. Fox) by 26th inst.

The *Rochdale* Corporation invite tenders for the supply and delivery of electricity meters. Tenders to town clerk by 26th inst.

The *Birkenhead* Corporation require tenders for feeder and distribution mains. Tenders by March 1.

The *Huddersfield* Corporation invite tenders for steel tramway (girder) rails, fishplates, &c. Tenders to town clerk by March 12.

The *South Shields* Corporation require tenders for high and low-tension cables and ducts. Tenders to town clerk by March 12.

Tenders are invited until March 8 by the *French* Post and Telegraph authorities for the supply of 229 kilometres of gutta-percha insulated electric cables in six lots. Tenders to le Sous Secretariat d'Etat des Postes et des Telegraphes, Rue de Grenelle 103, Paris.

The *Prussian* State Railway authorities, Cologne, invite tenders until March 2 for the supply of 258 tons of galvanised iron wire, 19½ tons of copper-bronze wire, 6½ tons of insulated wire, and 74,350 porcelain insulators. Particulars from and tenders to the Königliche Eisenbahn Direction, Cologne.

TENDERS RECEIVED AND ACCEPTED.

The following tenders have been accepted by the Barnes District Council for their electricity supply works:—

Callender Co. (cables, &c.)	£9,648	7	8
Siemens Bros. and Co. (steam dynamos and switchboard)	6,880	0	0
Babcock and Wilcox (boilers and superheaters)	1,802	15	0
E.P.S. Co. (storage batteries)	882	0	0

Seven tenders were submitted for the boilers, eleven for the steam dynamos, five for the batteries, and seven for the cables.

The Hackney (London) Vestry have considered the report of their consulting engineer (Mr. Robert Hammond) on the tenders received for the accumulators required for the municipal electricity works. The following is a list of the tenders received:—

Tudor Accumulator Co. (*accepted*)	£7,665	Hart Accumulator Co.	£10,823
Chloride Elec. Storage Syn.	12,567	E.P.S. Co.	9,918
		D.P. Battery Co.	8,733

The following tenders have been received by the Glasgow Corporation for the Ruchill Fever Hospital:—

Messrs. M'Aulay, Clark and M'Laren (electric motors and shafting for laundry machinery)	£665	0	0
T. and T. Vicars (electric motor and shafting for mechanical stokers, elevator, and conveyor)	255	4	0

The Tunbridge Wells Corporation have accepted the tender of Messrs. Battley, Sons and Holness for extending the electricity supply station at £2,249.

The Birkenhead Corporation have accepted the tender of Mr. W. H. Forde for the erection of a tramway power station at £10,426. 17s. 6d.

The Bermondsey (London) Vestry have received the following tenders for the supply and erection of a six-cell refuse destructor, three water-tube boilers, fans and motors for providing forced draught, flues, economiser, &c.:—

* Hughes and Stirling (*accepted*)	£10,242	0	0
* Horsfall Destructor Co.	11,952	12	0
* Manlove, Alliott and Co.	11,300	0	0
† J. Baker and Sons	8,199	7	9
‡ Heenan and Froude	7,400	0	0
§ Willoughby Destructor Syndicate	6,250	0	0
* W. F. Mason (Ltd.)	6,123	10	0

The water evaporated per pound of refuse was given in the tenders marked * at 1lb.; in † at 1¼ to 1½lb.; in ‡ at 1 to 1½lb.; and in § at 1½lb.

The tender of Messrs. James Allan, sen. and Son for the supply of 50 electric lamposts with brackets at £6. 2s. each has been accepted by the Bexhill Council.

The tender of the Horsfall Destructor Co. has been accepted by the Southport Corporation for the erection of a refuse destructor at £9,960.

The West Ham Corporation have accepted the tender of the British Thomson-Houston Co. for the supply of 25 enclosed arc lamps at £355.

The St. Pancras (London) Vestry have accepted the tender of Messrs. Fraser and Son for the supply of condensing plant at the Regent's Park electricity station at £6,309.

The Newcastle upon-Tyne Corporation have accepted the tender of the British Westinghouse Co. for the supply of one 2,000 H.P. generator and two 1,000 H.P. generators at £32,600. The tender of the British Schuckert Electric Co. was £3,780 below this figure, and an unsuccessful attempt was made to induce the Council to accept that company's offer. The tender of the British Westinghouse Co. was accepted on the recommendation of the consulting engineer (Mr. Charles Hopkinson).

APPOINTMENTS VACANT AND FILLED.

The Pembroke (Dublin) Urban District Council invite applications for the position of resident engineer to take charge of their electric lighting and refuse destructor works, at a commencing salary of £150 per annum. An advertisement gives further particulars, and applications must be sent to the clerk to the council (Mr. J. C. Manly), Town Hall, Ball's Bridge, Dublin, by 3rd prox.

A mains superintendent and assistant-in-charge are required for the West Ham electricity department. An advertisement contains some further information, and full particulars and forms of application may be obtained at the offices of the borough electrical engineer (Mr. J. K. Bock), Abbey Mills, West Ham, London, E. Applications to town clerk (Mr. Fred E. Hilleary), Town Hall, West Ham, E., by March 8.

The County of London and Brush Provincial Co. require an engineer as district superintendent of the southern districts. An advertisement contains full particulars, and applications must be sent to the chief engineer (Mr. Charles P. Sparks), Moorgate-court, Moorgate-street, London, E.C., on or before 28th inst.

The British Electric Traction Co. require a district superintendent for North Lancashire, Westmorland, and Cumberland. An advertisement contains further particulars, and applications should be sent to the secretary (Mr. Geo. Stevens), Donington House, Norfolk-street, Strand, London, W.C.

A switchboard attendant is required for the Chester electricity department. Applications to city electrical engineer (Mr. F. Thursfield), New Crane-street, Chester. See advertisement.

The Swinton and Pendlebury District Council require an electrical engineer for carrying out an electric lighting scheme. Applications to clerk by March 3.

Mr. W. E. Baker has been appointed manager in Rosario of the United River Plate Telephone Co., *vice* Mr. H. S. Chappell resigned. Mr. Parker, who has hitherto been manager to the company in Buenos Ayres, will be appointed general manager.

The Southampton Corporation electricity department have appointed Mr. J. Shepherd outdoor assistant, at £130 per annum.

BUSINESS NOTICES.

We are informed that Mr. Frederick Theodore Eggers has resigned his position as managing director and secretary of the British Schuckert Electric Co. (Ltd.). Mr. Arthur George Seaman has been appointed manager and Mr. H. J. Clement Wells secretary to the company.

Mr. W. J. R. Thomas, A.M.I.E.E., who was for some years outdoor inspector of works for the St. Pancras (London) Vestry electricity department and late electrical engineer and inspector to the Birmingham Corporation, has commenced practice as a consulting electrical engineer at 19, Woodstock-road, Moseley, Birmingham, with a London office at 12, Wood-street, Cheapside, E.C.

BANKRUPTCIES, LIQUIDATIONS, &c.

A first and final dividend of 20s is payable at the official receiver's, 33, Carey-street, London, W.C., in the liquidation of the London Provincial Electrical Co. (Ltd.), 110, Cannon-street London, E.C.

It has been decided to wind up the Electro-Chemical Co. (Ltd.) voluntarily for the purpose of reconstruction, and the liquidator (Mr. R. Shaw, St. Helens) has been authorised to consent to the registration of a new company, to be called the Electro-Chemical Co. (1900), Ltd.

The Continental Water and Electrical Power Syndicate (Ltd.) is to be wound up voluntarily, and Mr. H. Meredith, 95, Finsbury-pavement, E.C., has been appointed liquidator. Claims by March 25.

A. R. Earle, electrical engineer, 7, Theatre-street, and Dial-yard, St. Miles, Norwich, has been adjudicated bankrupt.

Benjamin Symmons, electrical engineer, 2, North-street, Quadrant Brighton, and 15, Holland-road, Hove, has been adjudicated bankrupt. The first meeting of creditors takes place on 28th inst., at 24, Railway Approach, London Bridge, S.E., and the public examination on March 1, at the Court-house, Church-street, Brighton.

The trustee in the bankruptcy of F. Griffin (trading in partnership with F. L. Berners), electrical engineer, &c., 315, Regent-street and 14, Little Portland-street, W., has been released.

The examination of Alexander MacTavish, electrical engineer, &c., James-street, Exeter, took place at Bath last week. Debtor started business with £100 borrowed capital. Examination concluded.

Sale by Auction.—Particulars will be found in an advertisement of an unreserved sale by auction by Mr. J. A. Y. Matthews, on Wednesday and Thursday, March 7 and 8, of the valuable nearly new fixed plant and machinery at the North Wilts Engineering and Electrical Works, Swindon, Wilts. The plant, in addition to a large stock of engineers' tools, includes a quantity of electric lighting appliances and other machinery and apparatus, a portion of which is detailed in the advertisement. All further information and copies of the catalogue (which will be ready shortly, price 6d.) can be obtained from Messrs. Townsend, Jones and Wood, solicitors, Swindon, or at the auctioneer's offices, Park House, Swindon. The sale commences each day at 11 a.m.

Plant for Sale.—Messrs. Albright and Wilson (Ltd.), Oldbury, near Birmingham, have for sale three Babcock-Wilcox boilers and a Crompton steam dynamo. See advertisement.

For Disposal.—An advertisement on another page announces for disposal the patent rights of "a new accumulator," for which certain advantages as to weight and solidity are claimed.

Condenser Contracts.—During the past month the Wheeler Condenser and Engineering Co. have secured the following contracts:—

Surface condensers for the new Stanhope Line, Aldershot, for the War Office.

Cooling tower and condenser contract for the Charing Cross and Strand Electricity Co. (covering a plant of 3,000 H.P.).

Cooling tower and condensing plant for Chadwell Heath Asylum of the West Ham Corporation.

Duplicate order for a plant having a condenser with 2,000 sq. ft. of cooling surface, for the St. Helens Corporation.

Condensing set for the new Birkenhead electricity station.

Two large condensing sets for the Camps Bay and Capetown Power Tramways, consisting of compound steam-driven air and circulating pumps with condensers.

Two condensing sets for the Cardiff and Milford Cold Storage Co.'s refrigerating plant.

Duplicate order for a set similar to the outfit required for the Great Fingall Mines.

Large condensing set of 1,000 H.P. capacity for the Sheepbridge Coal and Iron Co.'s hauling engine at Glapwell Colliery.

Obituary.—We are informed anonymously that there has just died (on Feb. 10), at Ladywell Park, Lewisham, Mr. William Watkins, who has been connected with telegraphy since its introduction in England in 1837. He was born in 1823, and in 1836 was a boy in Sir William Fothergill Cooke's garden, and assisted him in all his early experiments. In 1844 he was employed in the construction of the first permanent line of poles and wires erected to Portsmouth for the Admiralty and the London and South Western Railway. He remained as inspector of that line in the service of the Electric Telegraph Co., and in 1870 was pensioned by the Post Office, and passed into the service of the South Western Railway Co., from which he retired in April, 1899. He was quite an historical figure on the South Western line, and was a very fine-looking man. He was on Sir William Preece's staff from 1856 to 1870, and on that of Mr. Goldstone from 1870 to 1899. He thus reckoned 63 years continuous service in telegraphy.

Presentation.—Mr. A. J. Lawson, who recently resigned his position as engineer-in chief and manager of the County of London and Brush Provincial Electric Lighting Co., has been presented by his former staff with a silver inkstand as a token of their esteem.

B.T.H. Plant.—Pamphlet No. 54 issued by the British Thomson-Houston Co. deals with electric traction plant, and give views of the tramways at Bristol, Dover, Dublin and Colombo (Ceylon), as well as interior views of Middlesbrough and Dover stations.

Continuous Current Plant Catalogue.—The pocket list of continuous current dynamos, motors, &c., sent out by Messrs. Thomas Parker (Ltd.) has reached its third edition. Admirably arranged and well printed, it forms a useful and handy index of the manufactures of this company. The particulars given include the prices of a great proportion of the articles listed and illustrations of the most important items of plant described.

"Stellite" Fittings.—The British Electric Works Co., of Aston, Birmingham, have sent us samples of electric light fittings. The most noticeable characteristic of the fittings is the low price at which they are offered, and contractors to whom low initial cost of fittings is a first consideration may be recommended to try them. Perhaps the most interesting among the samples is the lampholder illustrated. The illustration speaks for itself, and it need only be added that the parts are all of metal or porcelain. A switch lampholder has the advantage of a sliding knob instead of a tap-shaped handle, two dummy knobs being provided on either side of it to facilitate switching on and off with one hand. Some of the ceiling roses and fuse-holders sent appear to be very serviceable; others are fitted with an eccentric jamming screw contact for the leading-in wire, not likely to prove of permanent value, especially on alternating-current circuits.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Feb. 14 to Feb. 20, with the ports of destination:—

Africa—Alexandria, £297 (including £271 telegraph cable); Durban, £402 (including £361 telegraph material). *Argentina*—Buenos Ayres, £235 (including £200 telegraph material). *Australasia*—Adelaide, £300 (telegraph apparatus); Fremantle, £670 (including £272 telegraph material); Melbourne, £113; Otago, £126; Perth, £402 (telegraph cable); Port Chalmers, £42; Sydney, £85; Wellington, £727 (including £431 telegraph material). *Belgium*—Ostend, £32. *Brazil*—Pernambuco, £3,000 (telegraph cable). *Ceylon*—Colombo, £242 (including £66 telegraph material). *Chili*—Boca, £500 (including £231 telegraph material). *China*—Shanghai, £309. *Denmark*—Copenhagen, £285 (telegraph cable). *Germany*—Hamburg, £445 (including £300 telegraph material). *Gibraltar*, £20 (telegraph apparatus). *Hong Kong*, £344. *India*—Bombay, £70; Calcutta, £1,788 (including £233 telegraph wire). *Japan*—Kobe, £36; Nagasaki, £26,750 (telegraph cable); Yokohama, £84. *Siam*—Bangkok, £140. *Straits Settlements*—Singapore, £173 (including £130 telegraph material). *Sweden*—Gothenburg, £237 (telegraph wire); Stockholm, £73 (telegraph wire). *Turkey*—Constantinople, £48. *West Indies*—Trinidad, £24. Total £37,999, against £37,858 in the corresponding week last year (Feb. 15 to 21).

MUNICIPAL, FOREIGN, AND GENERAL NOTES.

Alleged German Cable Enterprise.—The report that the German Government has under consideration the laying of a submarine cable from Kiau Chou to the Philippines is semi-officially denied.

Barnsley.—The Corporation electricity department commenced to supply current on Saturday last. There are at present about 70 consumers, representing an equivalent of 8,000 8 c.p. lamps, connected.

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Bath.—The Electric Lighting committee recommended the Council at the meeting on Tuesday to include the net balance of £1,937. 11s. 6d. against the electricity undertaking for three years' working, after providing £3,593. 1s. 3d. on the sinking fund account, in the next annual estimates, and to make a uniform charge of 4½d. per unit for current for lighting, with a discount of 10 per cent. on all accounts of £100 per annum and over, the revised tariff to take effect from June 30 next. The chairman of the committee (Ald Taylor) supported these recommendations, and contended that the sum of £900 was not required to meet the loss in connection with the undertaking. They had not lost anything, but, on the contrary, had made a net profit, after interest and all borrowed money had been paid, of £1,655. What was now required was a 1½d. rate towards paying what was equivalent in value to the authority to a 3½d. rate. Last year the revenue account showed a gross value of profit on working of £2,165. 15s. 11d., interest on loans amounted to £1,732. 3s. 9d., leaving a balance towards the reduction of capital expenditure of £433. 12s. 2d. This balance was shown, notwithstanding that they had been working their new plant only five months of that time. For 2½ years out of three the works had been in a transitory state. He did not think any cutting down of expenses or any reduction of plant would have been of the least service to them. They had one of the best installations, according to its size, in the country. The proposed uniform charge for current was the best course to adopt. He did not know any other place where current was supplied all round at 4½d. After some discussion the recommendations were agreed to.

Battersea (London).—The Vestry have been obliged to expend a further £2,000 on the foundations of the electricity supply station, owing to the nature of the soil. A loan of £5,147 is to be taken up for arc lamps and posts.

Belfast.—A sub-committee has been appointed to consider the question of reducing the charge for electric current.

Bermondsey (London).—Tenders are set out in another column which have been received and accepted by the Vestry for the supply and erection of a six-cell refuse destructor plant. The consulting engineers to the Vestry (Messrs. Kincaid, Waller and Manville) accompany these tenders with a lengthy and interesting report on the various types of destructor plant tendered for.

Bradford.—An inquiry was held on Wednesday into the application of the Corporation to borrow £10,000 for electric lighting extensions. The town clerk (Mr. F. Stevens) stated that the amount was required for the extension of buildings and for providing additional machinery and plant to enable the supply of electricity to be extended. There was an increasing demand for current for both lighting and motive power, and the works also supplied current for the two new tramways operated on the overhead system. The new buildings were estimated to cost £4,700, and the machinery and plant £5,100. The inspector inquired with respect to the financial position of the undertaking, and the city treasurer (Mr. G. Thorpe) said that since the undertaking was commenced the profits had amounted to £23,606. 15s. 5½d., and £10,556. 12s. 3d. had been written off for depreciation. Technical details were given by Mr. A. H. Gibbings, who stated that the proposed extensions were necessary. The steam power and generating machinery were inadequate to meet the demands upon them, and at present there were no facilities for executing repairs, which had in consequence to be sent out. There was no opposition.

Bury St. Edmunds.—Sanction has been obtained to a loan of £800 for public electric lighting of the roads on the Brown estate.

Chatham.—The question of purchasing the undertaking of the Chatham, Rochester and District Electric Lighting Co. has been referred by the Council to the Highways and Works committee for consideration and report.

Chester.—An additional sum of £35,000 is to be expended in electric lighting extensions, and sanction to the borrowing of this sum is being sought. The chairman of the Lighting committee (Councillor B. C. Roberts) stated at the Corporation meeting on Wednesday, that exhaustive reports had been prepared by the engineer and the architect. The additional plant would cost over £11,000 and the building £7,200. By obtaining a loan of £35,000 it would probably preclude the necessity of again approaching the Local Government Board for two years. Owing to the increasing demand for current it was impossible to do without the additional capital.

Comparison of Mechanical Traction Systems.—In the course of an interesting report to the County Council of Surrey by Messrs. Preece and Cardew (elsewhere abstracted in this issue) the following remarks are made concerning various systems of mechanical traction :—

The advantages of electric traction over other systems are now so thoroughly recognised that it is adopted by at least 90 per cent. of all such new lines throughout the world, while existing lines which have hitherto been worked by other means are being rapidly converted to electrical working. It is only in a few cases, where the traffic is very light and the service infrequent, that other modes of traction deserve consideration.

A tramline worked by horses is naturally repugnant to English feeling. It is degrading a noble animal into an inferior machine, and it is destructive to its life. On an extensive system horse traction would be very much more expensive than electric and not nearly so convenient and popular.

Other methods of traction in use are :—

1. A separate steam engine—very cumbrous, destructive to other traffic and hideous in appearance. It is in use at Leeds and other places, and has been condemned utterly.

2. A gas engine contained under the car, which is offensive from noise, vibration, and smell. It is in use on the Blackpool-Lytham line and has not been satisfactory.

3. Cable traction—which is very expensive both in first cost and maintenance, and wanting in freedom of movement. It is in use at Edinburgh and Brixton, and for severe inclines it may be used with advantage, but the motive power may be electrical.

4. Compressed-air motors on the cars. These have been employed in Paris, New York, and in Berne, but their use has not been extended. This system has, however, advantages, and in the opinion of high authorities is preferable to any other system except electricity. It involves, however, a recharging of the air reservoirs on the cars after runs of from 12 to 16 miles, and delay is caused by this operation. Numerous charging stations would be required with a staff of men at each station, and the efficiency is decidedly low ; in fact, it would require about twice the energy taken for electric working. This system is really only suitable for short lines of tramway.

Competition between Electric Tramways and Steam Railways.—The directors of the Cork, Blackrock and Passage Railway Co., in a report just issued, attribute a decrease in the receipts to the extension of the Cork Electric Tramways Co.'s line to Ballintemple. As the Cork Electric Tramways Co. are applying for powers for extending their system into the centre of the Blackrock district, the directors feel that such an encroachment on their rights sanctioned by Parliament should be opposed.

Electrical Engineers (R.E.) Volunteers.—The Council has adopted a recommendation of the Building Acts committee to sanction the erection of a drill hall and headquarters at Regency-street, Westminster, for this corps.

Electric Tramway at Aden.—We learn from the *Indian and Eastern Engineer* that Messrs. Bienenfeld and Co. have recently applied for a concession to build an electric tramway at Aden, connecting the Crater with Steamer Point. This was refused, apparently because the proposal met with anything but a favourable reception at the hands of the military authorities, who look askance on a railway or tramway to Shaik Othman having a branch through the Isthmus to the Crater. It is considered that the project should, from its very nature, be owned by the Government.

Enfield.—The Urban Electric Supply Co., who are applying for a provisional order, recently asked the Board of Trade to dispense with the sanction of the District Council. The Council, however, demur to this. The members think that there is no evidence to show that there is a demand for electric current in the district, and at the same time the Council have informed the Board of Trade that they are at present in consultation with an expert on the subject—the two statements are somewhat contradictory in character.

Exeter.—At the Corporation meeting on Wednesday the Electric Lighting committee reported that the number of consumers had greatly increased during the past year. The working expenses had not appreciably increased, while the income showed an increase of about £1,000. The year was commenced with an adverse balance of £1,276, which had now been reduced to £500.

Factory Lighting.—Messrs. Mitchell and Schofield have just completed the second instalment of complete plant for electrically lighting Messrs. Armitage Bros. two factories at Milnsbridge, near Huddersfield. The first plant to be fixed consisted of a 110 volt 300 ampere dynamo, with main, switchboard, &c. The second instalment consisted of a 110 volt 400 ampere "Alliance" dynamo and a 110 volt 100 ampere "Pilot" dynamo, main, switchboard, &c. Ten Johnson and Phillips 5 ampere enclosed arc lamps have been put in for lighting the dyehouses. The whole of the work has been designed and carried out by Mr. E. Wilks, manager to Messrs. Mitchell and Schofield.

For the Front.—The third annual concert of the traffic department of the Eastern and Associated Telegraph Cos. was given on Tuesday evening at Winchester House, Old Broad-street, E.C., the proceeds being devoted to the Mansion House Fund for Disabled Soldiers and Sailors About 250 persons were present. A subscription made during the evening on behalf of the "Absent-Minded Beggar" Fund realised about £6. 10s.

Mr. G. Colson (son of Mr. A. Colson, engineer-in-chief of the Leicester Corporation electricity works) and Messrs. Arthur and George Charlton, technical assistants at the works, all three of whom are members of the Electrical Engineers (R.E.) Volunteers, have volunteered for the front, and have been provisionally accepted, as have also Lieut. A. H. Pott, Sergt. W. S. Entwistle, Sergt. H. F.

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Bigge, and Sappers H. B. Tilly, J. Rook, C. H. R. Thorn, Roberts, Peart, and Williams, of Chelmsford.

An interesting ceremony took place on Friday last at the Northampton Institute, Clerkenwell (London), when Mr. Kenelm Edgcumbe, who holds a commission in the Electrical Engineers (R.E.) Volunteers detachment proceeding to South Africa, received the good wishes of his numerous friends in the institute. Mr. Edgcumbe has for two sessions been senior demonstator in the electrical engineering department, and his colleagues and the students combined to present him with a Goerz binocular field glass and a prismatic compass. The presentation was made by Dr. Wafmsley, principal of the institute.

Glasgow.—The Corporation cannot, apparently, acquiesce in the result of their appeal to the Railway and Canal Commission from the order of the Sheriff giving the Postmaster-General authority to lay underground telephone wires on behalf of the National Telephone Co. A sub-committee has been dispatched to London to endeavour to influence the Postmaster-General to vary the order.

Great Grimsby.—The Council have applied to the Local Government Board for a consent order to issue £60,000 Corporation 3 per cent. stock for electric lighting and other works. An inquiry was held here on Monday into the application of the Corporation to borrow £11,500 for electricity supply. The deputy town clerk (Dr. Grange) supported the application, and said there was a deficiency of £551 on the original estimate, and the balance (£10,949) was required for extensions. The original loan authorised was £43,500. The borough engineer (Mr. M. Petree) said the additional expenditure would include a 350 H.P. steam dynamo, boilers, &c., at £6,000, and £1,677 was required for consulting electrical engineer's charges.

Great Yarmouth.—The salary of the borough electrical engineer (Mr. Gordon Bryant) has been increased from £200 to £250 per annum. The last quarterly statement of the electricity department showed gross income £2,216. 5s. 9d., expenditure £1,189. 16s. 2d. After allowing £650 for interest, sinking fund, &c., there was a net profit of £376. 9s. 7d., making a total profit for the past three quarters of £466.

Guildford.—The Council have adopted Mr. C. H. Brown's motion to invite the Guildford Electricity Supply Co. to state their terms of sale of their undertaking.

Hebburn.—The Council are applying for a provisional order, and an electrical expert is to be appointed to advise the Council in connection with the application, and also in opposing the bills of the Walker and Wallsend Gas Co., the Tyneside Electric Power Co., and the County of Durham Electrical Power Distribution Co., all of which affect the district.

Huddersfield.—As recommended by the Electricity committee the balance profit of £2,828. 16s. on the working of the electricity department for the year ended Dec. 31 has been transferred to depreciation and contingencies account. The chairman of the committee (Ald. Calvert) remarked at the Council meeting on Wednesday that the net profit was equal to 2½ per cent. on the capital expenditure, and very satisfactory progress had been made during the past year.

Ilford.—The gauge of the electric tramways is to be altered from 3ft. 6in. to the standard, which is the gauge adopted by East Ham and other adjoining Councils. The Local Government Board has intimated their sanction to the loan for electric lighting, but further information has been asked for.

Islington (London).—We recently fully reported particulars of the friction which has arisen between the Islington Vestry and the Finance committee of the London County Council on the subject of the details demanded by the latter regarding an application by the Vestry for a loan for electric lighting extensions. The loans originally applied for amounted to £13,200 and £56,231 respectively. A further stage has been reached in the dispute, and the Vestry now decline to accept the proferred loans of £10,000 and £38,000 which the Finance Committee has recommended the County Council to sanction. Mr. Albert Gay, the electrical engineer to the Vestry, has presented a lengthy report covering the whole subject. Mr. Gay states that "every statement made in the Council's letters respecting lengths of cable and cost of material is incorrect," and he proceeds to very roughly handle the particulars prepared by the Council's officials, particularly as to the quantity of material required for carrying out the works for which the loans were sought. Mr. Gay concludes as follows:—

I repeat most emphatically that the sum asked for by the Vestry is in no way excessive, and it would be interesting to know upon what assumption the Council's officials base their statement. There is not, to my knowledge, in London any similar system of cables and conduits as at Islington. Considerable care has been taken in the working out of this system with a view to avoiding serious breakdown on the cables and mains, and providing facilities for rapid repair in the event of accident. I can only assume, therefore, that the Council are comparing the system at Islington with that of some other parish, and if this is the case, I say there can be no comparison . . . . . With respect to the offer of the Council to sanction a portion of the sums asked for, the committee will remember that the Vestry some time since passed a resolution that no money was to be spent for any material until the sanction of the Council to the borrowing of the necessary funds had been received. In face of this resolution, I fail to see how the Vestry can accept a portion only of the amount required to carry out certain work. The Council make no specific statement as to which item or items in the application is, or are, in their opinion excessive, and as far as the sum of £13,200 is concerned, the quotations received show that the Council's statement that the estimate is excessive is incorrect. If the sanction to a portion only of the amount required is accepted, I should like to know how the money is to be spent. If the Council had objected to the sum of £4,000 for condensing plant, for example, and had granted £9,200 only, the matter would be very simple, as we could delay the erection of the condenser until the matter was settled. The balance, however, of £3,200 means nothing at all, and I do not see how it is possible to erect a portion of a steam pipe, or a portion of a pump. . . . If instead of making general statements, which have been proved to be incorrect, the Council would supply forms requiring more definite information in the first place, or if the Council's officials, when unable to interpret the specification, would ask me direct for explanations, there would be less loss of time in putting the matter right, notwithstanding which I consider the specifications and plans sent are sufficiently clear and intelligible to anyone with a knowledge of the business.

Kandy (Ceylon).—The electric light works were inaugurated on the 29th ulto. The works are owned by the local gas and water company, and have been erected under the superintendence of their electrical engineer (Mr. J. S. Addyman).

King's Lynn.—Application for a further loan of £10,000 for electric lighting extensions has been made.

Leatherhead.—The Council have received proposals from Messrs. Handcock and Dykes for the transfer of their provisional electric lighting order.

Leicester.—An inquiry was held here last week into the application of the Corporation to borrow £100,000 for electric light extensions. The inspector (Col. H. T. Turner) stated that in 1897 the Corporation asked for sanction to borrow £33,719 for electric lighting. Of this sum £3,526 was to cover an excess expenditure of a previous loan, and £30,193 represented capital expenditure proposed to be incurred. On the present occasion an excess expenditure of £13,732 had been incurred. The engineer and manager of the gas and electricity works (Mr. A. Colson) explained that the works, &c, amounting to £30,193, had all been duly carried out, and with regard to the £13,732 excess, it was made up as follows: Machinery £3,871, cables £6,907, transformers £2,637, meters £215, instruments £102. Mr. Colson gave particulars of the progress of the undertaking. In 1890 the Corporation obtained its provisional order, and in September, 1893, the Local Government Board sanctioned a loan of £42,574. In the same year contracts were entered into for the erection of plant and laying of cables, and a supply of current was first given on Dec. 19, 1894. The demand for current was so satisfactory that a second application had to be made in 1897 for additional borrowing powers, and authority was obtained for £33,719, making a total of £78,207. The whole of this money had been spent, and the present application for £100,000 was for extending the central station and providing the plant and cables required to cope with the rapidly increasing demand for current. The capacity of the present central station was equal to 1,400 kw., or, allowing for a spare machine, 1,050 kw. The maximum demand for electricity this winter had reached 880 kw., leaving a margin of only 170 kw. He submitted the following figures to show the growth of the undertaking:—

	Meters fixed.	8c.p. lamps installed.	Max. load. kw.	Total output.	Increase per ann.
Dec. 1894	42	5,310	66	1,587 units	—
Dec. 1895	158	7,554	176	92,101 do.	—
Dec. 1896	250	16,690	359	147,421 do.	60%
Dec. 1897	344	27,578	514	204,084 do.	38%
Dec. 1898	479	38,490	662	302,531 do.	48%
Dec. 1899	632	52,526	880	437,943 do.	45%
Feb. 1900	702	54,222	—	—	—

Since 1897 the demand for current had more than doubled. At that time 5d. per unit was being charged, but from June 30 last this was reduced to 4d. for lighting and 2d. for motors. The latter reduction had resulted in 31 motors being fixed, and there was reason to anticipate a rapid increase in the number. In view of the increasing number of lamps installed, together with the strong feeling in favour of the electric light throughout the town, it was clear that a substantial increase of plant and cables must be provided before next winter. He had therefore recommended a considerable extension of the central station, which when completed would contain four additional alternators of 1,000 kw. each. To meet the immediate probable requirements he had advised the erection of two of these machines and five boilers, together with the necessary auxiliary apparatus. This would bring the capacity of the station up to 3,400 kw., with an equivalent amount of boiler power. Extensions of the high and low-tension mains, together with the necessary sub-stations, transformers, &c., would also be made. The present length of cable laid amounted to 36 miles (high-tension 17, and low-tension 19 miles), all concentric. Follow-

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ing is Mr. Colson's estimate of the cost of the works to be carried out :—

Engine and dynamo room—superstructure	£6,461	Switchgear	£2,500
Boiler house—superstructure	2,322	High-tension mains into town	4,200
Foundations for building and machinery	8,430	High and low-tension distributing cables	10,200
Chimney stack and flue	770	Pipes and trenching	4,764
Engines and alternators (two sets)	20,429	Services	2,500
Exciters (two sets)	1,200	Joint and fuse boxes	1,900
Boilers (five), steam pipes, &c.	4,500	Meters	2,625
Pumps	421	Sub-stations & transformers	7,190
Economisers	2,280	Switchgear for chambers	1,049
Steam, exhaust & water pipes	1,577	Overspent to June 30 last	13,732
Travelling crane	950	Total	£100,000

The financial result of the working of the Corporation's electricity department from the commencement showed a total loss, up to June 30, 1897, of £1,819, after making provision for interest and sinking fund. Set off against this loss was the profit since June 30, 1897, of £1,477, leaving the total net loss to June 30 last of £342, but the profits (Mr. Colson stated) for the half-year to Dec. 31 last would more than equal this amount, being £1,089, showing therefore a net gain of the working on the undertaking from Dec. 19, 1894, of £747. He knew of no undertaking occupying so enviable a position as regards capital outlay as the Leicester works, or which obtained such eminently satisfactory results as regarded expenditure. The capital outlay worked out at only £55 per kilowatt capacity, and there was not another electricity undertaking in the country that showed anything like so favourable a figure for capital expenditure. The new station would work out at a still less cost per kilowatt. The town clerk (Mr. Bell) and the chairman of the Gas and Electric Lighting committee (Ald. Lennard) also gave evidence, and the inquiry terminated.

Light Railway.—The Light Railway Commissioners have held an inquiry into the application to construct the Leicester, Ansty, and Newtown Linford light railway, and after hearing evidence granted an order for the construction of the line as far as Ansty, reserving their decision as to the Newtown Linford extension. The total length is about six miles, and the authorised line five miles. Electric traction will be adopted.

Londonderry.—A report on the question of giving a supply of electricity for private purposes has been prepared for the Corporation by Sir Wm. Preece. The report (which may be recommended to the reading of other Corporations than Londonderry) states that Corporations have the sole right to supply electricity in their districts, and while denying themselves the opportunity of extending the great comforts and conveniences of electricity to the ratepayers in Londonderry, the Corporation had prevented others from doing so. It was a duty imposed upon local authorities by Parliament to see that their ratepayers were supplied with cheap and pure light, and to undertake to supply them with electric current for other purposes. That electricity was a pure light admitted of no question. If the Corporation had started private and public lighting simultaneously from the commencement of its starting supply, the undertaking would have been in a most flourishing condition. The opponents of the scheme did not, surely, imagine that large electric contracting companies would venture to start undertakings which were doomed to failure. If financiers and experts saw money in Londonderry, surely the members of the Corporation ought to be satisfied that its financial aspect required their serious consideration. Londonderry, like other towns which feared to take the final plunge, had had a canvass. That was invariably a waste of time. It was no criterion of business at all. You could not force people to make up their minds to take a supply of current until the mains were at their doors, and even then half the would-be consumers wanted to see what the other half was going to do. At Tunbridge Wells the canvass produced a promise of 1,500 lamps. After four years they had now 30,000 lamps. At Wimbledon a promise of 3,000 lamps was obtained; now (three months after starting) there were 11,000 lamps. It had been suggested that they might postpone the introduction of private lighting for three or four years, pending the expiration of patents and the chance of labour and materials becoming cheaper. There were no patents to expire, and the market was open, and labour and materials were far more likely to become dearer than cheaper. Londonderry was a flourishing town, approaching 40,000 inhabitants, and it might look forward to having in the future some 30,000 lamps, with a considerable motor load in the factories and some 500 H.P. at least in electric trams. The success of such an undertaking was assured, and it appeared to be futile to start tinkering and spending money in buildings, in machinery, in opening streets (the same streets once open would not be reopened), which might be practically repeated in five years' time. Tunbridge Wells accumulated a gross profit of £9,942 in four years, and the original loan was only £13,000; and unlike Tunbridge Wells, Derry was a business and industrial town. Other towns and districts where large electric lighting schemes are in progress are cited, and Sir Wm. Preece concludes by strongly urging the Council to take the broadest view of the question, and to be prepared to serve all their area with a comprehensive system. The report has been discussed in committee, but further consideration has been deferred for a fortnight.

Long Eaton.—The principle of municipal electric lighting has been adopted by the Council. An expert is to be called in to report on a draft scheme which has been submitted to the Council.

Mirfield (Yorks.).—The Council recently invited the Huddersfield Corporation to take a lease of their provisional electric lighting order, and a canvass of the district is being made on behalf of the Huddersfield authority.

Municipal Telephony.—A sub-committee has been appointed by the Cheltenham Corporation to obtain information as to the progress made by other local authorities in establishing municipal telephone exchanges.

Mr. A. R. Bennett has been appointed consulting telephone engineer by the Brighton Corporation, at a fee of 21 guineas and out-of-pocket expenses, to prepare a report upon the advisability of establishing a municipal telephone exchange.

Nuneaton.—An extension of the electric light cables was authorised by the Council at their meeting last week.

Pocket Telephones for the New York Fire Brigade.—The *Railway and Engineering Review* of Chicago states that the battalion chiefs of the New York fire department have been supplied with pocket telephones, so made that, by hanging the case on the door of an ordinary fire alarm box and inserting a brass plug in a slot cut for the purpose inside, the headquarters can be called up and the operators on duty talked to over the line.

Private Bill Legislation.—The second reading of the five bills (the South Wales Electrical Power Distribution, the Lancashire Electric Power, the Tyneside Electric Power, the County of Durham Electric Power, and the Dublin Electric Lighting schemes) for power to supply electricity "in bulk" has been postponed until March 9. The schemes are arousing considerable opposition, and the Association of Municipal Corporations has issued a statement of the objections to the bills to members of Parliament.

The North Metropolitan Electric Power Supply Bill was read a second time in the House of Commons on Monday.

The Standing Orders committee of the House of Commons have decided to allow the Shannon Water and Electric Power Bill to proceed, on condition that no generating stations be erected on lands other than those specified in clause 37 of the bill.

Projected Light Railway Scheme for Surrey.—An interesting report by Messrs. Preece and Cardew on the proposal to construct a system of 17 light electric railways was considered by the Surrey County Council last week. The report stated that the Council were well advised in undertaking to supply the pressing demand for better facilities for locomotion in the county, and especially in its northern part, which had now become practically a vast suburb and residential district of the metropolis. The convenience of street railways, with a frequent service of well-equipped, well-lighted, and comfortable cars propelled by electricity, was certain to be thoroughly appreciated, and no doubt could exist as to the financial success of the undertaking if properly carried out. There was no question of competition with existing railways, as the street railways would to a large extent act as feeders to the main lines, and would in addition create for themselves a traffic which would not interfere in any way with any possible development of the regular railway service. Messrs. Preece and Cardew urge the County Council to acquire powers to construct the lines, and the operation should be effected either by the Council themselves or by a company under agreement. The Council should retain controlling powers as regards traffic arrangements and fares. So far as could be judged, the scheme before the Council appeared to be suitable to meet the immediate requirements. The cost per mile for permanent way is given at about £6,500 for single line. The cost of construction per mile would be about £2,000 for single line with passing places, exclusive of cost of purchase of land, levelling and preparing road bed, and fencing. It would not (continues the report) be possible to lay out any practically useful system of light railways in the northern portion of the county without risk of objection from railway companies on the ground of competion; but it is unlikely that any railway company could make out a case for the Board of Trade refusing to confirm the order for the construction of the proposed system on that ground. It is recommended that the lines be worked by electricity, and, except possibly in one case, on the overhead trolley system. Other systems of working are then reviewed, but all are declared inferior to electricity. Taking electric traction as decided upon, Messrs. Preece and Cardew recommend the overhead trolley system for use on all but two of the lines. These two lines terminate very close to the Kew Observatory, and the Kew authorities had succeeded in obtaining the insertion of a protective clause in all tramway and light railway orders where the lines approach the Observatory. Under these powers they would certainly prevent the use of the ordinary overhead system. To meet this objection it is proposed that the cars on these lines should carry a light set of accumulators, which would be charged from the trolley

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wire on the run between Hammersmith Bridge and Mortlake, and would supply power for traction between Mortlake and Richmond, where the trolley would cease. On this branch of the subject the report concludes: "The underground conduit system is unsuitable, partly on account of its great expense, but chiefly because of the difficulties encountered in dealing with large pipes and other underground structures, crossing bridges, &c., and of the danger of the conduit becoming flooded in Kingston and other portions of the route in proximity to the river Thames."

The report recommends that three sites for generating stations should be scheduled, although, if powers could be obtained to lay the necessary connecting mains, one station would be more economical. The approximate cost of the proposed three generating stations for the 17 lines (exclusive of the price of land) is set out as follows:—

For lines 1 to 6	£8,500
For lines 7 to 12, 16 and 17	8,500
For lines 13 to 15	11,000

Should one generating station for the whole system be adopted, the cost of the station would be approximately £20,000, and in that case about £10,000 would be required in addition to provide the the necessary sub-stations and plant, and about £26,000 for the connecting mains. Besides the expense of generating stations, £2,000 per mile for single track, and £2,500 per mile for double track should be included for electrical equipment of track, bonding rails, and feeder cables. For the proposed lines the number of cars and sheds should be as follows:—

Nos. 1, 2 and 3	8	motor cars	—	trailer cars	1	car shed.
4, 5 and 6	8	do.	3	do.	1	do.
7 to 12, 16 and 17	16	do.	6	do.	1	do.
13, 14 and 15	16	do.	6	do.	1	do.
Total	48		15		4	

The estimated cost (exclusive of land) would be approximately as follows:—

32 ordinary motor cars, at £700 each	£22,400
16 accumulator „ „ £1,000 „	16,000
15 trailer cars „ £200 „	3,000
4 car sheds and repair shops	14,000

The total capital outlay should therefore be approximately £360,000, made up as follows: Permanent way, £200,000; electrical equipment, £46,000; cars, £41,000; car sheds, £14,000; generating stations (3), £28,000; land (estimated), £20,000; contingencies, £11,000.

The number of car miles to be operated per diem would be about 2,000 on the average, or say 750,000 per annum. This would require the production of nearly 1,000,000 units of electrical energy at the generating station, and if one station be used, the cost would be approximately as follows:—

750,000 car miles at 5½d. per car mile	£17,200
Interest and sinking fund at 5½ per cent. on an outlay of £360,000	19,800
	£37,000

Should the Council be able to generate at one station, the cost would be increased by something like ½d. per car mile. A revenue of 1s. per car mile (which should be easily obtained) would produce £37,500.

After fully considering the whole subject, the Council unlike their Middlesex and Hertfordshire *confrères*, decided to abandon the project, on the ground that such undertakings should be left in the hands of the urban local authorities.

Railway Carriage Lighting.—At the meeting of the London and North-Western Railway Co. last week the chairman (Lord Stalbridge) said that the increase in the cost of lighting was due to a certain extent to the lighting of their railway carriages by electricity. They had not moved too fast in that direction, because it was an enormous undertaking to alter all their stock in any single particular. He thought, however, that no railway carriages were better lighted than those of the North-Western, but they must go slowly and cautiously into the question of electric lighting.

Ramsgate.—Applications for provisional orders have been lodged by the Ramsgate Corporation and the Isle of Thanet Electric Tramways and Lighting Co. The company's application is to be strenuously opposed by the Corporation.

Shannon Electric Power Scheme.—In order to allay opposition by the Limerick Corporation to this scheme the promoters have submitted, and the Corporation have accepted, an offer to obtain a report from an expert at a fee of 100 guineas on the question of the apprehended damage to the Corporation waterworks.

Southampton.—During January the number of units of electrical energy sold amounted to 68,171, an increase of 77 per cent. over January last year. The equivalent of 1,539 8 c.p. lamps was connected during the month. Several large institutions have been, or are about to be, connected to the mains. Included in these are the new isolation hospital, the infirmary, the Ordnance Survey Office, and the Shirley car depot.

On the recommendation of the consulting engineer (Mr. E. Manville), the charge for current for the tramways has been fixed at 2d. per unit up to 300,000 units per annum.

The salary of the borough electrical engineer (Mr. F. H. Chaplin) has been increased by £25 per annum, for services in connection with the electric tramway department, and a further £25 will be added as soon as the reconstruction of the existing tramways has been completed.

South Bank.—The clerk has been instructed to report upon the procedure and cost of obtaining a provisional electric lighting order.

Street Railways in Japan.—The Tokyo Municipal Council recently granted a concession for laying 200 miles of street railway in that city. The motive power is to be either compressed air, storage battery, or single or double overhead trolley. The royalty to be paid to the city authorities is one-third of the surplus after allowing for a 7 per cent. dividend to shareholders and making proper deductions on account of reserve, sinking fund, &c.

Stirling.—It is anticipated that electric current will be available in about a fortnight.

Strike of Telephone Hands.—The wiremen and labourers in the National Telephone Co.'s Leeds and Hull districts, numbering nearly 100, are reported to have struck work yesterday (Thursday) for an all-round advance in wages. The company have expressed their willingness to discuss the matter with their actual employés, but resent the interference of the Workers' and General Labourers' Union in the dispute. On the plea that "one man's misfortune is another man's opportunity," the men appear to have selected a time for their turn-out when the company's service is in particular need of attention owing to the ravages of the late storm.

Swansea.—The Corporation decided on Wednesday to apply to the Light Railway Commissioners for authority to construct the system of light (electric) railways set out in our last issue. An arrangement has been made with the National Electric Wiring Co. for wiring premises in the district on the "easy" system.

Telephone Trunk Communication.—The Post Office authorities have decided to construct an additional through trunk line from Cardiff to London.

West Ham.—At the Corporation meeting last week the Electric Lighting and Tramways committee submitted correspondence with Messrs. Drake and Gorham on the question of their contract for arc lamps. The Council, on the advice of their consulting engineer (Mr. Steinitz), rejected the lamps and required the substitution of others. The contractors had issued a writ to recover the balance of the amount of their contract, with an extra claim, totalling £1,514. The committee now recommended that the Council accept the lamps, and that the contractors be asked to take £1,049 in full settlement of all claims. The electrical engineer (Mr. Bock) recommended the adoption of Thomson-Houston enclosed arc lamps for the High-street extension. The proposal was adopted.

Wolverhampton.—The purchase price of the local tramways has been fixed by consent at £22,500 by the Board of Trade arbitrator (Sir F. Bramwell). The Corporation will take over the tramways on May 1.

Concert.—A ladies' night concert of the Electro-Harmonic Society will be given at the Café Monico, Piccadilly-circus, W., this (Friday) evening, at eight o'clock.

COMPANIES' MEETINGS AND REPORTS.

Westminster Electric Supply Corporation (Ltd.).

The ordinary general meeting of the shareholders of this Corporation was held on Wednesday, the Right Hon. Lord SUFFIELD presiding.

The SECRETARY (Mr. Frank Iago) read the notice calling the meeting, and the report of the Directors was taken as read.

The CHAIRMAN said: In moving the adoption of the report and accounts I think I may congratulate you and ourselves on the steady and satisfactory progress the Corporation is still making. I believe at the meeting last year I stated that the board had no reason to expect a falling off in the demand for supply, and, as you will see from the report, not only has there been no decrease, but the number of lamps added last year has been greater than in any year since we commenced our business. Although the cost of steam coal has been and is still, owing to the great demand, very high—which is apparent to everyone—the profit for the past year shows a large increase, and the Directors have therefore felt justified in recommending an increase in the dividend of 1 per cent. They have also added largely to the sinking fund and depreciation account, and have been able to carry forward a sum of £3,773. 8s. 2d. The works costs, as well as the management expenses, compare very favourably with the previous years, owing to the increased output. You will notice that in his certificate Mr. Pearson, the Government auditor, has taken exception to an item of £1,582. 5s. 9d. which we have taken credit for in the net revenue account. This is for interest on the advances the Corporation has made to the Central Electric Supply Co. (Ltd.), and the auditor is of opinion that, as that company is owned by the St. James's Co. and ourselves, and is not at present earning any income, it would have been better not to take into account the amount of interest accrued. Your Directors are, however, of opinion that if they had not taken into account the interest accrued to the 31st December last, which is to be paid hereafter, the accounts would not have shown the correct position of the Company at the end of

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the year 1899. This amount has not been expended in dividend, but is included in balance carried forward. You will no doubt have observed that we have come to the end of our capital, and the Directors have now under consideration the question of the provision of future capital. When we have decided as to the best means of providing for future requirements due notice will be given to the shareholders of the proposals of the Directors.

Mr. BOULNOIS, M.P., seconded the motion.

Sir MARK STEWART, Bart., M.P., wished to know if the Corporation had any contracts for the future supply of coal, or whether coal was being bought according to market rates?

The CHAIRMAN: We have a considerable store on hand, and there is a contract running to the end of May at last year's prices.

Mr. H. F. MAKINS inquired how the balance of the depreciation, sinking fund and reserve funds were invested.

Mr. R. W. WALLACE, Q.C.: The Chairman has asked me to reply. Part of these amounts is invested in the business—principally in freehold property, which we hold ourselves—part is in the general capital of the business; and we also hold some Government stock and railway stock which is for the sinking and reserve funds.

Dr. DES VŒUX asked if anything had been done to stop the nuisance, caused by the Company's chimney on the Embankment. As far as he could hear, it was one of the very worst chimneys in London for emitting volumes of black smoke. The other chimneys of the Company were not so bad, but the one on the Embankment was almost every day reported on for the emission of black smoke. He saw an item in the revenue account of £92, "Experiments and cost re smoke abatement," and he asked if any favourable result had been obtained from these experiments? He also wished to know whether there had been any other complaints from consumers since the 200 volt system had been brought in. His experience was that the lamp did not give so good a light as the old 100 volt lamp. He believed that every lamp maker and many of his (the speaker's) friends said the same thing; and electrical engineers had told him that there was not a good 200 volt lamp in the market. He thought that if this were the case considerable dissatisfaction would be felt in the long run.

Mr. GRIMSHAW (assistant engineer-in-chief): We have been making a great many experiments and have expended a large amount of money in endeavouring to stop the smoke at Millbank-street. I think we are only troubled with it now when we are getting up the fire at night; I do not think there is any trouble at other times. But the smoke is not as bad at the Embankment as it is at many other works. We get the best coal we can buy, and expend any money that is necessary for preventing smoke; in fact, we are always looking out for patents with that object, and are quite ready to experiment with them.

Capt. EDMUND J. BAX: With reference to the question about 200 volts, there is no doubt that we have had a great many complaints of the 200 volt supply as against the 100 volt, but I think myself that that is only because we have made a change from 100 volts to 200 volts. In other companies where they have started by giving the energy at 200 volts these complaints are not heard, but the moment you begin to change one lamp for another, no matter what the lamp may be, the consumer complains because you go into his house and alter his wires, and so on. As to the efficiency of the 200 volt lamp, I think that it is not perhaps quite so efficient as the 100 volt lamp. I do not, however, think that there is any great difference. The reason I say that is that in a very large block of buildings with a great many thousand lights we have made experiments extending over a year when they had the 100 volt lamp and for another year when the 200 volt lamp was in use, and we found that the amount of the consumer's bill with the supply at 200 volts was not appreciably greater than it was at 100 volts. I do not think that there is any reason really for complaint, and we make an allowance of 8 per cent. in order that consumers may take their energy at 200 volts instead of 100 volts. We think that in doing that we more than meet the complaint as to the efficiency of the 200 volts.

Mr. MAKINS: Do they get double the light for the same amount?

Capt. BAX: No, the same light for the same amount; the pressure is at 200 instead of 100 volts.

The motion for the adoption of the report and accounts was then carried unanimously, as was also a resolution declaring a dividend for the half-year at the rate of 16 per cent. per annum, less tax, making (with the interim of 10 per cent.) 13 per cent. for the year.

Mr. J. Browne Martin and Lord Ampthill were re-elected Directors, and a cordial vote of thanks to the Chairman terminated the proceedings.

British Insulated Wire Co. (Ltd.).

The fourth ordinary general meeting of this company was held at Prescot on Friday, Mr. W. MARRINER BRIGG, chairman of the company, presiding.

The CHAIRMAN proposed that the report (which appeared in our issue of the 9th inst.) be adopted, and congratulated the shareholders on the continued growth and success of the business. He thought that perhaps the shareholders hardly realised what this continued growth and increase had been; but he wanted them to grasp this particular fact, because it brought them to the point of the holding of this meeting and asking for an increase of capital. Since the company started in 1892 the increase had been on the average 50 per cent. on each previous year. Now, they would quite imagine that when that got up to say £1,000,000, and suddenly found they had reached £1,500,000, it made a considerable difference in their calculations and in the working of the business; and that had been their case up to the present, which he thought a remarkable fact in connection with any industry. It might go on for one year or two years, but to go on continuously as their business had done showed the business in itself was good—that the material sent out was good, and that the demand was gradually increasing. He thought the orders which they had in hand justified them in thinking that their increase for the present year was going to be after the same rate. The profit for the year under review was £92,000, against £72,000 for 1898. The administration expenses, legal expenses, &c., were necessarily higher, because they were doing a much larger business; but the directors did not think those expenses were abnormally extended, or were beyond the ratio in which they should be extended according to the business which had been done. They could not tell till the end of the year what the increased capital had done for them, but they had every reason to believe that the money which they asked for to-day could be very profitably spent. The orders they at present had on the books were equal to the whole of their turnover for a year, or a little more than a year or two ago. He hoped that 15 per cent. and the bonus of 5 per cent. would be agreeable to the shareholders, and that they would sanction the directors' action.

Mr. E. K. MUSPRATT seconded the resolution, and said that during the last two years the price of nearly every article had increased. That was owing to the prosperity of the country and to the enormous increase of the industry. The price of copper, for instance, had gone up from £50 to somewhere about £76 or £77 a ton—an enormous increase in the price of a material of which they used a great quantity. The consequence was that the increased business they had been doing had entailed a larger quantity of copper being used in the business, and had therefore caused them to require more capital to carry on the business. The same thing applied to lead. The quantity of lead they used for covering cables had enormously increased on account of the increased business, and the price of lead had gone up from about £11 to about £16 or £17 a ton. They did a remarkably safe business so far as bad debts were concerned, because the greater portion of their business was with Corporations, and they had the rates to fall back upon as security. But although Corporations were good payers, they did not always pay cash down, and insisted that a certain amount should be held in hand to meet any contingencies of bad work or anything that might arise. The consequence was that in the large transactions they had with Corporations it was necessary for a large amount of money to be locked up for a considerable time. That was another reason why they required additional capital, and the only question really was, in an enormously growing business like theirs, whether they were going to ask enough, or whether it would not be necessary in two or three years to ask for a further increase, because they were all aware that the electrical industry, in this country at any rate, was of comparatively recent growth. Now, however, it had taken a firm hold, and there was no question but that it would increase to a far larger extent in the future. He therefore anticipated a large increase in their business.

The motion was unanimously adopted, and a further dividend of 10 per cent. on the ordinary shares (making 15 per cent. for the year), together with a bonus of 5 per cent. on the ordinary shares, was declared.

Messrs. J. B. Atherton and E. K. Muspratt were re-elected as directors, and the auditors were also reappointed.

In thanking the shareholders for the reappointment of his firm as auditors, Mr. D. L. CHALMERS said that he had had occasion to meet the directors on the question of depreciation and investments, and he found the board not only prepared to adopt any recommendation proposed on the subject of writing down assets, but they went much further than he (the speaker) considered necessary. The balance-sheet presented to the shareholders was therefore of a most conservative character.

A cordial vote of thanks to the chairman and directors for their services was proposed by Mr. H. Martin, and unanimously adopted.

At an extraordinary meeting which followed a resolution authorising the increase of the capital of the company to £1,000,000 by the creation of 120,000 new £5 shares (60,000 ordinary and 60,000 6 per cent. cumulative preference) was unanimously approved. The chairman stated that he did not know that it was intended at present to issue the whole of the new capital—possibly not more than one-half. They required and must have more money to conduct the business, and he thought there was a fairly good prospect of paying a good dividend on the additional capital.

In connection with the above resolution, the directors have issued 30,000 6 per cent. cumulative preference shares and 30,000 ordinary shares, both of £5 each. The former have been issued at £5. 10s*. and the latter at £10.* The issue has been made to shareholders only. The issue, with the premiums, provides additional working capital of £465,000, which the directors are satisfied can be profitably employed.

National Telephone Co. (Ltd.).

The twenty-fifth ordinary general meeting was held yesterday, Mr. J. S. STAATS FORBES (president of the company) in the chair.

The SECRETARY (Mr. Albert Anns) having read the notice convening the meeting, and the report and accounts being taken as read,

The PRESIDENT said: My experience is that when a directors' report is a bad one the attendance is large, and I think this is the very smallest attendance I have ever seen at a meeting of this company, from which I deduce immediately that you will agree with us in thinking the report extremely satisfactory. I am never at a loss at a meeting, except when the report is a good one. I want the stimulus of failure to enable me to find words, which I can always find when the report is bad. Therefore my remarks to-day will be very few. Our income has increased by £89,815, the working expenses by £46,840; the net result leaves a profit balance increase of £33,155; the rentals carried forward for unexpired terms amount to the very large sum of £631,000, being an increase of £94,900. A really remarkable feature in these reports is that the character of the business should be such that, in anticipation of

* The ordinary shares are quoted on p. 641 at 13—14 and the preference shares at 6—6½.

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periods beyond a particular half-year, we have these large sums of money paid in advance in respect of services following the period of that particular half-year. This £631,000 is a tolerably good slice to have in advance of services rendered. Out of that balance we propose to pay the dividends as stated—5 per cent. on the first and second preference, 5 per cent. on the third preference, and 6 per cent. per annum (free of tax) on the ordinary shares. Having met these charges, we have a surplus income—£80,000 of which is to go to reserve, and the balance (£6,199) is to be carried forward. Compared with the corresponding period of 1898, the increase in gross income amounted to £89,815, the Post Office royalties increased by £9,819 (as to which I shall have to say a word presently); and, subject to that deduction, the net income has increased by £79,996. The working expenses have increased by £46,840, and there is a net result to the good for the half-year of £33,155. The ratio of working expenses has fallen from 60·16 to 59·91 per cent.—a very small thing when taken on £100, but a very important one when taken upon these very large sums of money. The amount brought forward has increased by £9,893. Debentures and other interest shows an increase of £15,136, arising from the fact that between Dec., 1898, and Dec., 1899, we had issued a considerable amount of additional debenture stock, which of course came in for dividend from the time it was placed. Now comes the question, What are we to do with the balance? We propose to place £80,000 to reserve, an increase of £30,000 over the corresponding half-year, and to carry forward—well, £6,199 instead of £8,287. The rentals paid in advance I have already referred to—£631,590, or £94,936 in advance of the corresponding period. In matters of this sort the year is a more satisfactory and certain comparison than the half-year, and satisfactory as the half-year is, the year is a record one. We have made a much greater advance in the year under review than in any preceding year in the history of the company. The capital revenue, net revenue account, and the balance-sheet are all shown clearly, and anybody who is fond of analyses, or wishes to be satisfied upon any of the various items, can if he pleases ask any question and an elicit answer upon any point which interests him. But unless that is specially called for, I will ask you to take the assurance of my distinguished colleagues and myself and our auditor—the most eminent in London—that the accounts are properly stated. There is one thing I should like to comment upon a little, and that is the Post Office. We have achieved these results over a great many years in the face of many difficulties. When we started with this science, which has been carried to its present state, not of absolute perfection but of great utility, leaving much to be desired which may be achieved in the future, we went through the preliminary stages, which involved many failures, many trials, and we found ourselves in very serious corners many times. But we kept pegging away; and if we can only get fair play, as we entirely believe we shall (for the anxiety of the Government, and particularly of the head of this Post Office business—Mr. Hanbury—was that we should be dealt with upon principles of scrupulous fairness), we shall continue to succeed in our operations. But what I should like to put to you is this: We have paid the Post Office during the year a sum which amounts to 21 per cent. on our net income. Now, is not that a monstrous tax? An invention not thought of before, taken over by the Post Office on a legal interpretation, accepted on the theory of being fairly treated. A tax of 10 per cent. of the gross revenue! All our risks, all our difficulties, all our losses are taxed in the inception by this terrible charge. A tax of 10 per cent. seems pretty stiff, but it must not be forgotten that you have to take the risk of the working of this thing—all the labour, responsibility, and risk of bringing about good results in money; and then 21 per cent. of what you get, after running all the risks, goes into the pocket of the Post Office. Now, I wonder if these people who howl about our extortion, extravagance, &c., &c., ever take into account that they might have their telephone so much less if the Government gave up their claim to this 21 per cent. of the net income? Well, now you know what is going on. The Post Office, having a perfect right, have now determined that in London, among other places, they will work the service themselves. Well, we do not object to that at all; we are not in the least concerned about anything of that kind, and I dare say we shall get along. We feel, under all the circumstances, pretty comfortable, and think, with the experience we have got and the footing we have got, that we shall continue to make large advances in our business, and, we trust, in securing you profits.

There is one point in the accounts to which I should like to advert. Some feeling has been expressed as to whether it is right that income tax should be deducted in the case of some proprietors and not in that of others. We have paid out of the surplus profits of the company income tax upon the dividend on the ordinary shares, and have paid the preference subject to income tax. I suggest whether it will be possible in the face of the anomaly, so to speak, to continue that practice. On another matter: We are charged sometimes with being slow-going coaches, that we do nothing, that it is all very bad, and that anything else would be so much better. We read every day what poor creatures we are in commercial enterprise and science—and, in fact, in everything else—compared with the Germans, who have got a telephone service which has been held up to us here in England, from time to time, as a model. My vocation takes me to Germany sometimes. Judge of my surprise, then, when I read the statement made in the German Parliament, "Look how much better this thing is done in England." I thought there must be some mistake; that they must have got the English newspaper remarks on the National Telephone Co. Now, this is a most irritating business; it never can be otherwise. When a man is using the telephone he thinks the whole property is his. He does not think of the other 140,000 fellows who are waiting all over the place. No doubt the service has greatly improved, and the service is becoming from day to day more indispensable. Now, with that little bit of introduction I will tell you what we have done. In the year ending 1894—not very long ago in the history of a great enterprise—we had 73,000 lines, in 1895 82,000, in 1896 94,000, in 1897 106,000, in 1898 120,000, and in this, the record year, 140,600. Therefore, between 1894 and 1899 we have had an increase of 67,000 subscribers. Ordinary people cannot apparently understand what that means in labour, in anxiety, difficulties overcome, &c., and in money. I now move—

"*That the report and accounts be received and adopted, and that dividends be paid for the six months ending Dec. 31, 1899, at the rate of 6 per cent., less income tax, on the first and second preference shares, at the rate of 5 per cent., less income tax, on the third preference shares, and at the rate of 6 per cent. per annum, free of income tax, on the ordinary shares of the company.*"

Lord HARRIS (vice-president) seconded the resolution.

Mr. HEATH asked if the reserve fund was brought into the business or invested in outside securities?

The PRESIDENT: It is brought into the business, and is charged with interest to the amount of £10,000. We can get a larger average return upon the money in our business than by deposit investment. Against that we have large amounts locked up. I have no doubt, if we took a valuation now of the properties standing in our books at £353,285, they would be found to be well worth that valuation. Therefore the reserve funds afford ample security. This is not the first time the matter has been discussed, and we have come to the conclusion that, so far at all events, we have acted wisely and greatly in the interests of the concern in locking up our excess profits in the business.

The resolution was then carried.

Mr. WARNFORD DAVIS proposed a vote of thanks to the president and the directors for the magnificent results of the year's working.

Mr. CHAPMAN seconded, and added that it might be extended to the various officials of the company.

The resolution was carried unanimously.

The PRESIDENT, in reply, said the directors thanked the proprietors for their continued confidence. Quite properly the officials were embraced in the vote, and indeed their workmen, too. They could not put the services of their workmen nor their devotion to duty too high. They ran tremendous risks. He would take the opportunity of saying something of interest to them all. The directors thought it prudent to make early arrangements for an issue of capital, and very shortly a prospectus would be out inviting £500,000 in ordinary shares at par. It would gratify the directors to find that the existing shareholders took up the larger part of this issue.

The meeting then terminated.

Central London Railway Co.

The ordinary general meeting of this company was held on Wednesday. In moving the adoption of the report and accounts, the chairman (Sir Henry Oakley) said that the whole of the share capital was paid up. They had not raised any loan capital, because they were advised that they would get a much better price for their 4 per cent. bonds after the railway was open than before, and the arrangement with the contractors provided that the payment they were to take in bonds should not bear interest until the railway was open. There was a large sum due to the contractors on that account, and it was one of the greatest possible incentives to the contractors to get their work done as quickly as possible. They had expended £10,028 for additional land at the Marble Arch for the improvement of their station, and had now practically 11 sites for booking offices, all in admirable positions. He had hoped that before that they would have had their railway open, but that had not been achieved; but every possible effort was being made to ensure the completion. Difficulties of construction, and the impossibility of reaching the line beneath the surface except through shafts sunk at the stations, made the operations slow. The underground work from the Mansion House to Shepherd's Bush was practically complete, except the laying of a third rail. That was in hand. The ordinary running rails in both tunnels and the stations were practically finished, and the work of connecting the lower premises with the outer air was going on as rapidly as possible. He was assured by the representative of the contractors for the electrical machinery that no time would be lost, and that there was a speedy prospect of their being completed and ready for opening. The third rail was in the tunnel, but it had to be insulated and bonded. When that was completed practically the whole of the underground work would be finished. The lifts at each of the stations were in hand. Six or seven of them are completed, and there was no doubt that when the electrical contractors had got their heavy work done the completion of the lifts would shortly follow and the railway be brought into practical use. The huge engines at the depot at Shepherd's Bush were about 12,000 H.P., and were erected, and three of them had been practically tested. He hoped to be able to run an electric train very shortly after the end of the month. All the work was progressing satisfactorily. As soon as the machinery had been tested, and if it realised expectations, it would not be long after the trial before they could utilise the line commercially. By the original Act they were bound to run three trains in the morning and three at night with a penny fare in each direction. They proposed to adopt the principle that had been accepted by all the authorities—viz., to issue a workman's ticket before 7:30 in the morning at a return fare of 2d., and available for the return journey by any train. The board had appointed Mr. Granville Cunningham general manager. The report was adopted.

Newcastle-upon-Tyne Electric Supply Co. (Ltd).

The ordinary general meeting of this company was held yesterday (Thursday). The directors' report for the year ended Dec. 31 states that the units sold show an increase for the year of 163,309, the total being 967,098, against 803,789 in 1898. The total profits of the year's

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trading amount to £8,177 16s. 10d., against which have been written off special expenditure on the reconstruction and enlargement of dynamos (£800 9s. 11d.) and costs incurred on Parliamentary matters (£875 16s. 12d.), leaving a balance of £6,501 10s.; and after adding to this the balance from last year (£994 0s. 2d.), there is a sum to be dealt with of £7,495 10s. 2d. Out of this amount an interim dividend of 4 per cent. was paid in July last, and the directors now propose to pay a further dividend at the same rate, making in all 8 per cent. per annum, and absorbing £5,341 12s. 8d., and to increase the reserve and depreciation account by £342 16s., carrying forward a balance of £1,811 1s. 6d. The reserve account now stands at £20,000.

The necessary expenditure on capital to keep pace with the demand for current during the year and to provide for a continuous-current service has amounted to £28,518 1s. 2d. The continuous-current service referred to in last year's report is nearing completion. A bill is being promoted for further powers as to the extension of the company's operations. A provisional order for supplying Gosforth with electricity is also being applied for. In order to meet the expenditure already incurred, and that which will be required to carry out the above schemes, the sanction of the company will be asked to increase the nominal capital by £200,000.

We learn that the report was adopted on the motion of the chairman, Mr. T. G. Gibson.

Mersey Railway Co.

A meeting of debenture-holders was held last week, by order of Mr. Justice Stirling, to consider the company's bill now before Parliament. The chairman (Sir Allen Sarle) presided, and a majority favoured the expenditure of £1,500 in promoting the bill for powers to adopt electric traction, &c. It is therefore probable that Mr. Justice Stirling will authorise the receivers and managers to proceed with the bill. The circular convening the meeting stated that the receivers and managers were of opinion that it was essential to the successful working of the line that electric traction should be adopted. In connection with this view the directors stated that they had consulted several experts with regard to electric traction, including Sir W. Preece and Major Cardew, who had reported strongly in favour of electric traction and recommended the adoption of a system by which the train service would be greatly increased and accelerated. It is estimated that a saving would be effected in working expenses by the adoption of electric working of £11,540, and that the increased gross receipts at end of first year would be £18,943, a total increase of £41,873, less interest on maximum new capital (£428,750) at 4 per cent., £17,150. This would leave a net improved revenue of £24,723. Messrs. Preece and Cardew further estimated that in three years after the adoption of electric working the net revenue would be increased to £41,666, and that this improvement by no means exhausted the possibilities of the altered system. It is pointed out in their report that the obtaining of parliamentary powers this session is urgent, as the schemes for working the Birkenhead Corporation tramways and the Wirral railway electrically should serve to feed the Mersey Co.'s undertaking in an important degree.

W. T. Henley's Telegraph Works Co. (Ltd.).

The annual report of the directors for the year 1899 states that, of the £120,000 additional preference capital authorised in 1899, £90,000 was taken up by the shareholders or their nominees at par, and £30,000 by the holders of the old 7 per cent. preference shares, with the sum of £30,000 paid to them out of reserve as compensation for the reduction of the dividend on those shares to 4½ per cent. in accordance with the resolutions passed in 1899. During the past year the net profit amounted to £46,037. 9s. After payment of debenture interest and income tax, and making ample allowance for depreciation of buildings, plant, machinery, &c., there remains £40,311. 12s. 4d., making (with £14,528. 14s. 3d. from last year) £54,840. 6s. 7d. available for distribution. The directors have transferred £10,000 to reserve, and recommend the payment of the following dividends—viz., on the preference shares at the rate of 4½ per cent. per annum (less tax); on the ordinary shares at the rate of 15 per cent. per annum (less tax), including interim dividend of 4 per cent. paid in September last. These payments absorb £35,986. 19s. 3d., leaving £18,853. 7s. 4d. to be carried forward. The directors regret to record the death of Major-General George Hutchinson, C.B., C.S.I., and refer to the election of Sir Henry M. Stanley, G.C.B., M.P., to fill the vacancy.

Notting Hill Electric Lighting Co. (Ltd.).

The tenth annual report of the directors now issued covers the period to Dec. 31 last. Expenditure on capital account at Dec. 31, 1898, stood at £128,003 19s. 4d., and during the past year a further £9,346. 14s. 3d. has been expended, of which £7,850. 10s. 6d. was on new mains and meters, and £1,000 in the acquisition of the buildings erected on the freehold land belonging to the company in Victoria-gardens. This brings the total expenditure to £137,350. 13s. 7d., which is £6,350. 13s. 7d. in excess of the capital received. The only additional sum received on capital account was the £5,000, balance of instalments due on debentures issued in 1898.

The progress of the company is shown by the following table:—

1891	.....	Lamps	6,056	.....	Loss	£554	18 6
1892	.....	Do.	9,438	.....	Profit	112	6 1
1893	.....	Do.	12,153	.....	Do.	1,481	7 1
1894	.....	Do.	15,669	.....	Do.	2,101	17 8
1895	.....	Do.	20,307	.....	Do.	3,227	14 10
1896	.....	Do.	25,716	.....	Do.	4,736	9 8
1897	.....	Do.	33,000	.....	Do.	6,854	1 2
1898	.....	Do.	46,066	.....	Do.	7,251	13 7
1899	.....	Do.	59,154	.....	Do.	10,360	17 4

The number of consumers is now 1,012, and of these all but 15 per cent. are supplied at 200 volts.

The cost of coal shows an increase of £430, or 30 per cent. over last year, and the amount realised by sale of current shows an increase of 35 per cent. The pressure of the current at the same time has been kept up its proper standard and uniformly steady throughout the year.

An Act authorising the company, in conjunction with the Kensington and Knightsbridge Electric Lighting Co., to purchase land and erect a joint station for the purpose of economically generating electricity in bulk, received royal assent on July 13, 1899, and the necessary arrangements for the erection of buildings and their equipment with the most modern description of machinery have been made. It is estimated that the expenditure on these joint works will amount to between £80,000 and £100,000, and it is proposed to raise the necessary capital by a loan to be redeemed by a sinking fund in the year 1931, when the property of this company is liable to be purchased by the local authority. The two companies have entered into a mutual agreement to take current from the station in accordance with their several requirements, and to contribute each year, in proportion to the current taken, such amount as may be required for the working expenses and upkeep, together with the interest and sinking fund of the borrowed capital. In the year 1931 the property will revert, free of encumbrances, to the two companies in proportion to the respective amounts contributed. The directors anticipate that the result will be not only a greatly increased power in the production of electricity, but also that the shareholders will possess a reversion of considerable value, to accrue at the time when their present property is liable to expropriation, thereby constituting a large reserve fund, securing them against possible loss in case of under-valuation. In conjunction with the new works the directors propose to make considerable extensions in districts in the company's area not hitherto supplied, where they have every reason to believe that remunerative business will be obtained. Should it be possible, as anticipated, to make these extensions during the current year, additional capital will be required, and as the present powers of the directors in this direction are limited to the issue of £19,000 of debentures at present unissued, it will be advisable to provide for an increase of capital.

Of the £10,360. 17s. 4d. profit, the directors have set aside £1,500 for depreciation and reserve, bringing the total to £6,000. This they consider sufficient, partly in consequence of the arrangements detailed above, but especially in view of the fact that the whole of the capital expenditure of the company, with the exception of the £3,833. 19s. (representing the cost of provisional order and the purchase of patents, &c.), is entirely represented by visible assets at prime cost. All repairs and renewals have been paid for out of revenue. After paying debenture interest and 6 per cent. on preference shares, there is a balance of £5,827. 18s. 7d., out of which the directors recommend a dividend of 6 per cent. on the ordinary shares, amounting to £3,871. 4s., leaving a balance of £1,956. 14s. 7d. One-half of this balance is credited the founders' shareholders, and out of the other half it is proposed to pay a further dividend of 1 per cent. on both preference and ordinary shares, making 7 per cent. for the year and leaving £64. 14s. 9d. to be carried forward. An interim dividend of 3 per cent. was paid on July 1, and the balance 4 per cent. will be paid forthwith, together with a distribution of £1. 16s. per share to the founders' shares.

The directors place on record their appreciation of the services of the engineer and manager, secretary, and staff generally.

Charing Cross and Strand Electricity Supply Corporation (Ltd.).

The report of the directors for the year ended Dec. 31 states that the progress of the business has been very satisfactory. The Maiden-lane, Lambeth, and Short's-gardens stations, and the plant and machinery, have been maintained in a high state of efficiency. The equivalent of 48,453 additional 8 c.p. lamps (nearly double the number added in 1898) have been connected up to the mains during the year, making a total of 182,689 lamps now connected. There have been 24½ miles added to the mains laid, making altogether 125¾ miles. The sales of current from the stations of the Corporation have increased by 615,897 units during the year. The further extension of the Lambeth station is being carried out, and will shortly be completed, affording accommodation for an additional 2,500 H.P., and the requisite machinery and plant have been ordered. The installation in Short's-gardens is being proceeded with, and supply is now being given from that station.

The large increase in the business during the past year, and the prospective requirements of the several districts supplied, will necessitate an increase of capital. A special meeting of shareholders to consider this will therefore be convened at an early date. The provisional order for the City of London, referred to in the last report, has been confirmed by Parliament. Some mains have already been laid in the western portions of the City, and supply given from the existing stations of the corporation. The directors have made arrangements for acquiring 7½ acres of freehold land at Bow. The greater portion will be devoted to the purposes of the City provisional order, which provides that a separate station shall be erected for supplying the City. Sufficient space will be reserved to enable them to erect a separate installation should they find it expedient to do so. A bill is being promoted for statutory powers to lay mains from Bow to the City, and to enable the corporation to connect up with the existing stations, and to supply electrical energy in bulk to such of the local authorities *en route* as may desire it. As the City provisional order provides that separate accounts should be kept of all receipts and expenditure, the directors are taking measures to comply with these requirements, and to enable them to do so satisfactorily it will probably be necessary either that separate capital be created in the existing company for the purposes of the order, or that another company be registered.

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The debenture debt has been reduced from £70,000 to £24,200, and the temporary loan of £57,500 has been paid off. The total reserves of the corporation now amount to £137,267, nearly 40 per cent. on the total share capital. The net earnings amounted to £27,677. 17s. 11d. A sum of £3,451. 5s. 7d. has been paid in respect of interest on debentures and temporary loans up to Dec. 31, and £6,708. 9s. 5d. was distributed as interim dividend (8 per cent.) for the half-year ended June 30. There remains a sum of £17,518. 2s. 11d., which, added to £3,292. 1s. 5d. from preceding year, makes £20,810. 4s. 4d., which the directors propose to deal with as follows:—

To provide for dividend on 4½ per cent. preference shares	£4,500	0	0
To pay a dividend at rate of £10 per cent. for half-year ended Dec. 31 on ordinary shares (making, with interim dividend, £9 per cent. for year)	11,768	10	6
And to carry forward	4,541	13	10
	£20,810	4	4

Telegraph Construction and Maintenance Co. (Ltd.).

The annual report of the directors states that the accounts for the year show a net profit of £82,828. 4s. 1d., after charging interest on debentures. To this sum must be added £38,205. 2s. from last year, making a total of £121,033. 6s. 1d. After deducting the interim dividend of 5 per cent. paid in July (amounting to £22,410), there is a balance of £98,623. 6s. 1d. to be dealt with. Of this sum the directors propose to distribute a dividend of £1. 4s. per share (absorbing £44,820), being at the rate of 10 per cent, and making, with the amount already paid, a total dividend for the year of £1. 16s. per share, or 15 per cent. (tax free), leaving £53,803. 6s. 1d. to be carried forward.

The business of the company has been satisfactorily maintained during the past year. The factories have been fully occupied in the manufacture of submarine telegraph cables and of insulated wire, whilst the company's steamships have been actively engaged in the laying of cables, as well as on repairing operations. The factories at East Greenwich and Wharf-road and the company's steamships are in a thoroughly efficient condition. The directors propose to add a further sum of £5,000 to the pension fund established last year for the benefit of the company's staff.

The retiring directors (Sir Robert G. W. Herbert and Sir James Pender, Bart., M.P.), being eligible, offer themselves for re-election, as do the auditors, Mr. John Gane (Messrs. Gane, Jackson, Jeffreys and Wells) and Mr. Patrick A. Slegg (Messrs. Welton, Jones and Co.).

Oxford Electric Co. (Ltd.).

The report of the directors for the year ended Dec. 31 states that the revenue account shows a profit (including £85. 3s. 5d. from last year) of £5,553. 1s. 2d. After providing £1,741. 11s. 2d. for debenture and other interest, writing off £184. 19s. 11d. on account of hire-purchase installations, and £53. 0s. 1d. from office furniture account, the available balance is £3,573. 10s., which the directors propose to appropriate as follows: £2,500 in payment of dividend at rate of 5 per cent. per annum on the share capital, and £1,000 to be added to the reserve and renewal of plant account (which will then amount to £1,750), leaving £73. 10s. to be carried forward.

Since the last report the equivalent of 3,638 8 c.p. lamps have been connected to the mains. This increase compares favourably with the average progress in previous years. The hire-purchase system of installing the light continues to give satisfactory results. To meet the increased demand for current a sub-station has been established at New College and an additional transformer installed in Ship-street. The distributing mains of the company have been extended in several additional thoroughfares, and the whole plant has been maintained in efficient order.

ARGUS PRINTING CO. (LTD.)—At the annual meeting of this company, last week, the chairman called attention to the increase in the company's gas bill for 1899 over the previous year, and congratulated the shareholders upon the decision of the directors to instal the electric light throughout the extensive printing works of the company adjoining the Victoria Embankment. The increase in the gas bill for the year represented £563, and the electric lighting installation would save considerably more than this sum in the course of the year. They found that an actual net saving of £8. 15s. 6d. per week had been made since the installation had been completed and in full working order.

CAMBRIDGE ELECTRIC SUPPLY CO. (LTD.)—The annual meeting of this company was held at Cambridge on Friday. Mr. D. Munsey presided, and said that during the year the equivalent of over 3,000 8 c.p. lamps had been added, and the output in units had been 38,000 more than in the previous year. The company had been increasing its output and consequently had increased its machinery, so as to be in a position to meet any demand. A large new machine (capable of taking the whole of the load) and a new boiler had been put in. They had also extended their mains, and had spent during the year £12,000 on capital account. They had written £250 off preliminary expenses. They had to pay £250 more, which they hoped to pay off during the present year. They had allowed discounts to the consumers to the extent of £969 during the past year. Instead of receiving 7d. per unit, they had received only a trifle over 6d. Although they had turned out 38,000 more units, their coal bill was not as much as in the previous year, a result arising to a certain extent from the care taken in respect of the transformers. The report and accounts were adopted, and a dividend of 7 per cent. was declared. The managing director (Mr. A. A. Campbell Swinton) announced that the directors would shortly issue a circular setting forth arrangements whereby wires and fittings would be put into houses and shops without any first charge to the consumer. There would be an extra charge of 1d. per unit, and a minimum charge of 2s. per lamp per annum. They proposed to adopt the system tentatively.

CITY OF YORK TRAMWAYS CO.—At the meeting last week the chairman (Mr. Joseph Kincaid) referred to the question of the purchase of their undertaking by the City Council, and said that in 1896 the company obtained power to use electric traction, but the Council had refused their consent. The proper development of the tramway system in York and vicinity would cost quite £100,000. The purchase of the present lines under the provisions of the Tramways Act of 1870 could be exercised by the Council in 1900 and 1902—that was to say, two expensive arbitrations would have to be undertaken at the cost of the Council to acquire some three miles of line, and for three years at least the improved facilities of street traction were postponed. The result would be a loss to the company, but a much greater one to the Council.

EDISON AND SWAN UNITED ELECTRIC LIGHT CO. (LTD.)—A meeting of this company will be held on 27th inst., to authorise the directors to create and issue 5 per cent. debenture stock amounting to not more than £300,000 for the purpose of providing funds to carry on the rapidly-increasing business of the company in lamps, fittings, and accessories for electric lighting. The circular calling the meeting states that the profit-making power of the company is increasing from year to year in a very satisfactory manner, and bids fair to expand even more rapidly with the introduction of additional capital. The necessities of trading on a much larger scale than formerly—more workshops and plant—considerable variety and quantity of articles required in the business—as well as the necessity of giving reasonable credit to the numerous traders and installers who are customers of the company—all entail the temporary lock-up, so to speak, of a considerable sum, so that the existing capital does not afford a sufficiently broad base to work upon. The directors have just had before them the accounts for the half-year ended Dec. 31 last, which show the steady advance the company is now making, notwithstanding severe competition and the absence of any special patent privilege.

NATIONAL ELECTRIC SUPPLY CO. (LTD.)—The annual meeting was held at Preston last week. The chairman (Mr. J. Booth) moved the adoption of the report, which stated that considerable progress had been made during the past year. A number of new consumers had been connected to the mains and considerable extensions of machinery and plant had been made. The motion was carried unanimously, and the following dividends declared: 4 per cent. on the preference, 4s. 6d. per share on the ordinary shares for the last half-year, which, with the interim already paid, made 7s. per share for the year.

NORTHAMPTON ELECTRIC LIGHT AND POWER CO. (LTD.)—The annual report of the directors states that the policy of reducing the price of current has been fully justified. During the year the additional lamps fixed (in 8 c.p.) were 5,667 and motive power supplied equalled 1,035 lamps, or 6,702, against 1,977 for the previous year. There is at present the equivalent of 19,763 lamps fixed. The balance of the revenue account was £1,714. 5s. 8d., compared with £1,258. 10s. 7d. The tariff for motive power has been reduced to 1½d. per unit for current used after a three hours' daily maximum demand. The company's mains have been extended in various directions (2¼ miles having been laid during the year), making a total of six miles 18 yards. It has been decided to raise the pressure of supply. £350 has been carried to depreciation account, making a total of £2,000, and £43 has been written off preliminary expenses. Dividends on he preference shares will be paid for the year ended Dec. 31st—viz., 6 per cent. fixed (£232) and 5 per cent. fixed (£261. 11s. 8d.). It is proposed to pay 2 per cent. on all the ordinary shares, which will require £368. 17s. 9d., and to carry forward £178. 13s. 6d.

SCARBOROUGH ELECTRIC SUPPLY CO. (LTD.)—At the annual meeting, held on Monday, the report which appeared in our last issue was approved, and a dividend at the rate of 6 per cent. (tax free) was declared. The chairman (Mr. G. Alderson Smith) said that the equivalent number of 8 c.p. lamps connected had increased from 12,788 in 1898 to nearly 30,000, and the receipts from £3,466 to £6,235. At the extraordinary meeting which followed a resolution increasing the capital of the company to £100,000 by the creation of 5,000 new shares of £10 each was adopted.

CITY NOTES.

MEMORANDA.—Bank rate 4 per cent. (since Jan. 25, 1900). Price of silver 27⅞d. per oz. (Feb. 22). Consols (2½ per cent.) 100¾—101⅛ for money, 100⅞—101⅛ for account; 2½ per cent. 98—98⅛ (Feb. 22). Stock Exchange Settling Day: Consols, Mar. 1; Stocks and Shares Continuation Day, Mar. 12; Ticket Day, Mar. 13; Pay Days, Feb. 23 and Mar. 14; Mining Share Carry-over Days, Mar. 10 and 26.

BRUSH ELECTRICAL ENGINEERING CO. (LTD.)—The directors of this company, after placing £2,500 to depreciation reserve, have decided (subject to audit) to recommend payment of a dividend at the rate of 6 per cent. on both preference and ordinary shares of the company for the half-year ended Dec. 31, carrying forward about £5,000.

BUENOS AYRES AND BELGRANO ELECTRIC TRAMWAYS CO. (LTD.)—Applications have been invited for £120,000 5 per cent. second debenture stock (part of a total authorised issue of £200,000) at £97. 10s. per cent

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The money is required to complete the conversion of the company's lines to electric traction. The company hold concessions for 36 miles of single track, of which 20 miles are already operated electrically.

CAPE ELECTRIC TRAMWAYS (LTD.).—An extraordinary general meeting will be held on the 7th prox. to confirm the resolution passed on the 14th inst. altering the articles of association.

IMPERIAL TRAMWAYS CO. (LTD.)—The directors have decided to recommend a dividend for the half-year ended Dec. 31 at the rate of 8½ per cent. per annum.

KNOTT END RAILWAY CO.—The committee of shareholders who are promoting a bill for the conversion of the line to electric traction have called a meeting of the proprietors for the 5th prox., in order to pass resolutions removing three of the existing directors, and also for approving the bill now before Parliament, and for other purposes in connection with the project.

LONDON PLATINO BRAZILIAN TELEGRAPH CO. (LTD.)—The half-yearly coupons, due March 1, of the £100,000 6 per cent. debentures will be paid by Messrs. Glyn, Mills, Currie and Co., 67, Lombard-street, London, E.C.

NORWICH ELECTRIC TRAMWAYS CO.—A meeting of this company will be held on the 27th inst. The lines are not yet in operation, and the meeting will be a formal one.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee has appointed 28th inst. as a special settling day in 6,360 £5 fully-paid ordinary shares (Nos. 1 to 2,652, 2,853 to 4,416, and 4,471 to 6,614), 8,038 £5 fully-paid 5 per cent. cumulative preference shares (Nos. 1 to 5,330, 5,431 to 6,000, 15,763 to 10,912, and 16,918 to 17,905), 5,433 vendors' £5 fully-paid ordinary shares (Nos. 6,615 to 12,047), and 9,862 vendors' £5 fully-paid 5 per cent. cumulative preference shares (Nos. 5,331 to 5,430 and 6,001 to 15,762) of the *Hampstead Electric Supply Co. (Ltd.)*. The committee has ordered the further issue of £150,000 4 per cent. first mortgage debenture stock (redeemable) of the *London Electric Supply Corporation (Ltd.)*, and the further issue of £670,529 3½ per cent. debenture stock of the *National Telephone Co. (Ltd.)* to be quoted in the official list. Application has been made to the committee to appoint a special settling day in and to grant a quotation to the 5 per cent. first mortgage debenture stock of the *British Aluminium Co. (Ltd.)*, and to also allow 15,000 7 per cent. cumulative preference £10 fully-paid shares (Nos. 1 to 15,000) of the company to be quoted in the official list.

TELEGRAPH CONSTRUCTION AND MAINTENANCE CO. (LTD.)—The transfer books of this company are closed from 19th to 27th inst. inclusive, preparatory to the payment of dividend to shareholders on the register on 19th inst.

WEST AFRICAN TELEGRAPH CO. (LTD.)—Notice is given that the half-yearly interest, due March 1, on the 300,000 5 per cent. mortgage debentures in this company will be paid by the National Bank of Scotland, 37, Nicholas-lane, London, E.C.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	1900	£	£		£	£
*Birmingham Tramways.	Feb. 17	3,569	– 356	7	27,023	+ 816
Blackpool Corporation...	„ 15	97	– 31	46	21,592	+ 4,411
Blackpool and Fleetwood	„ 17	99	– 79	7	969	– 91
Bradford Corporation ...	...	...	...	...	...	...
Brisbane Trams	Jan. 3	1,855	+ 516	14	30,761	+ 9,377
*Bristol Trams & Carriage	Feb. 16	2,217	– 378	7	17,914	+ 664
*Buenos Ayres & Belgrano	Jan. 21	2,337	+ 737	3	7,272	+ 2,117
City & South London Ry.	Feb. 18	1,160	+ 73	7	7,898	+ 40
Dover Corporation	„ 17	131	– 16	46	9,227	+ 1,028
Dublin United	„ 16	2,758	+ 79	7	19,199	} + 1528
Dublin Southern Dist....	„ 16	529	– 111	7	3,877	}
*Glasgow Corporation ...	„ 17	7,781	– 277	...	...	...
*Liverpool Corporation...	„ 10	5,912	+ 159	6	39,008	+ 4,552
Liverpool Overhead Rly.	„ 18	1,243	– 54	7	10,140	+ 1,087
*Sheffield Tramways	„ 18	1,643	+ 368	7	12,393	+ 3,550
*South Staffs. Trams.....	...	...	...	...	...	...

* Partly electrical.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Feb. 14.		Price Wednesday, Feb 21.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Feb. 21.	
			TELEGRAPHS.					£ s. d.		Highest	Lowest
£110,900	100	4%	*African Direct Telegraph 4% Mort. Deb. (red.)	99	103	99	103	3 17 8	January and July.....	...	...
25,000	10	...	Amazon Telegraph.....	3	4	3	4	...	June and December ...	...	...
£125,000	100	5%	Do. 5 per Cent. Debentures	85	90	85	90	5 11 1	...	...	...
£875,520	Stock	28/6	Anglo-American	63	66	63	66	5 11 5	Feb., May, Aug., Nov.	64	63½
£3,062,240	Stock	30/0	Do. Preferred	114	115	114	115	5 4 4	„ „	115	114
£3,062,240	Stock	27/0	Do. Deferred	14⅛	15	14½	15	8 14 2	...	14⅞	14¾
$10,000,000	$100	$2½	Commercial Cable Capital Stock	165	175	165	175	...	Jan., Apr., July, Oct.	...	...
£1,563,078	Stock	4%	* Do. 4 per Cent. Debenture Stock	102	104	103	105	3 16 8	„ „	...	...
16,000	10	8/0	Cuba Submarine Ordinary	9	10	9	10	8 0 0	February and August	...	...
6,000	10	10/0	Do. Preference 10 per Cent.	19	20	19	20	5 0 0	„ „	19	...
12,931	5	2/0	Direct Spanish Ordinary.....	4	5	4	5	4 0 0	April and October.....	...	...
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference	9	10	9	10	5 0 0	„ „	...	...
£30,000	50	4½%	Do. 4½ per Cent. Debentures	101¾	105¾	101¾	105¾	4 5 9	January and July.....	...	...
60,710	20	3/0	Direct United States Cable	11½	12	11½	12	5 16 8	Jan., Apr., July, Oct.	11⅞	...
£120,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red.)	99	102	99	102	4 8 3	June and December ...	...	...
£4,000,000	Stock	5%	Eastern Ordinary	154	159	155	160	4 7 6	Jan., Apr., July, Oct.	159	156
£1,795,000	Stock	3½%	Do. 3½ per Cent. Preference Stock	98	101	98	101	3 9 3	„ „	...	...
£1,432,268	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.)	116	121	116	121	3 6 8	May and November ...	119	116
250,000	10	2/6	Eastern Extension	15½	15¾	15½	16	4 7 6	Jan., Apr., July, Oct.	15⅞	13½
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	115	120	115	120	3 6 8	February and August	115½	...
£16,200	100	5%	* Do. 5% (Austln. Gov. Sub.) Deb.,1900 (reg.) ...	99	103	100	103	4 17 1	January and July.....	...	...
£64,400	100	5%	Do. (Bearer)	100	103	100	103	4 17 1	„ „	...	...
£300,000	100	4%	*Eastern and S. African 4% Mort. Deb., 1909.....	100	103	100	103	3 18 5	February and August	...	...
£200,000	25	4%	Do. 4 per Cent. Mauritius Sub. Debs.(red.) ...	101%	104%	101%	104%	3 16 10	May and November ..	...	...
180,227	10	1/9	Globe Telegraph and Trust	11¼	11¾	11¼	11¾	4 9 4	Jan., Apr., July, Oct.	11⅝	11½
180,042	10	3/0	Do. 6 per Cent. Preference	15½	16	15½	16	3 15 0	„ „	15⅞	15⅝
150,000	10	5/0	Great Northern of Copenhagen	30	32	31	33	3 15 9	January and July.....	...	...
£86,300	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb.(red.) ...	99	102	99	102	4 8 3	...	...	...
17,000	25	12/6	Indo-European.....	49	53	49	53	4 14 4	May and November ...	52	...
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904 ...	106	109	106	109	5 10 1	March and September	...	...
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.)	101	104	101	104	3 16 11	June and December ..	...	...
11,839	8	4/0	Reuter's.....	7	8	7	8	5 0 0	April and October.....	...	...
3,381	£100 Cert.	6%	Submarine Cables Trust	124	129	124	129	4 14 6	„ „	...	...
15,609	10	...	West African Telegraph	2½	3½	2½	3½	4 9 3	December and July ...	...	...
£200,000	100	5%	* Do. 5 per Cent. Debentures (red.)	98	101	98	101	4 18 9	March and September	...	...
30,008	2½	...	West Coast of America.....	½	1	½	1	...	...	...	...
£150,000	100	4%	* Do. 4 per Cent. Debentures	100	103	100	103	3 17 8	January and July.....	...	...
88,321	10	6d.	West India and Panama	⅞	1⅛	⅞	1⅛	...	May and November ...	1	...
34,563	10	6/0	Do. 6 per Cent. 1st Preference	9¼	9¾	9¼	9¾	6 3 1	„ „	9½	9¼
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	7	8	7	8	7 10 0	„ „	...	...
£80,000	100	5%	* Do. 5 per Cent. Debentures	104	107	104	107	4 13 6	January and July.....	...	...
£389,731	Stock	4%	Western & Brazilian 4 per Cent. Debenture Stock ...	100	104	100	104	3 16 11	June and December ...	...	...
207,930	10	3/0	Western Telegraph (late Brazilian Submarine)	14¼	15⅛	14¾	15⅛	4 11 10	Mar., June, Oct., Dec.	15⅛	14⅝
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1900)	106	109	106	109	4 11 9	June and December ...	...	...
£158,100	100	6%	*Western Union 6 per Cent. Sterling Bonds (red.) ..	98	103	98	103	5 16 6	March and September	...	...
			TELEPHONES.								
44,000	£5	3/0	Chili Telephone (fully paid)	2	3	2	3	6 13 4	August	...	...
224,850	10s.	0/1½	Consolidated Telephone Const. & Manufacturing ...	⅛	¼	⅛	¼	4 15 3	July	...	...
72,680	1	2½%	Monte Video Telephone Ordinary	½	⅝	½	⅝	5 0 0	November	...	...
86,492	1	1 0	Do. 5 per Cent. Preference	¾	1	¾	1	5 0 0	„ „	...	...
490,000	5	3/0	National	5⅝	5⅝	5¼	5½	5 9 1	February and August	5½	5 5/16
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Preference ...	14	15	14	15	4 0 0	„ „	...	...
15,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference ...	14	15	14	15	4 0 0	„ „	14⅜	...
250,000	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref. ...	5⅜	5⅝	5⅜	5⅝	4 8 11	„ „	5 5/16	...
2,000,000	Stock	3½%	* Do. Debenture Stock 3½ per Cent. (red.)	98	100	97	100	3 10 0	June and December ...	99	97½
171,504	1	0/4	Oriental	¾	1	¾	1	5 0 0	April and October.....	¾	...
58,000	5	2/6	United River Plate	4¾	5¼	4¾	5¼	7 2 10	July	...	...
16,639	5	1/4	Do. 5% Cumulative Preference	4¾	5¼	4¾	5¼	4 15 3	June and December ...	...	...
£179,947	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	103	106	103	106	4 14 4	„ „	...	...

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Feb. 14.		Price Wednesday, Feb. 21.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Feb. 21.	
								£ s. d.		Highest	Lowest
			ELECTRICITY SUPPLY COMPANIES.								
100,000	1	...	Bl'ckb'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.)	⅞	⅞	⅞	⅞	...		...	...
6,000	10	7/9⅔	Bournemouth and Poole Elec. Supply Ord.	12	13	12	13	3 0 0	...	12½	...
6,000	10	4/6	Do. 4½ per Cent. Cumulative Pref.	10	11	10	11	4 1 10	...	...	...
19,681	5	2/6	Brompton & Kensington Electricity Supply Ord.	7	8	7	8	3 15 0	...	...	...
12,000	5	3/6	Do. 7 per Cent. Preference	8½	9½	8½	9½	3 13 8	March and September	...	...
20,000	5	...	Calcutta Elec. Supply Ordinary (fully paid)	6¾	7¼	6¾	7¼	...		...	...
30,000	5	4/0	Charing Cross & Strand Electricity Supply Corp.	10	11	10	11	3 18 3	February and August	...	...
20,000	5	...	Do. (Nos. 30,000 to 50,000)	10	11	10	11	...		10 7/32	...
20,000	5	2/3	Do. 4½ per Cent. Preference	5¾	6¼	5¾	6¼	3 12 0	,, ,,	...	...
34,000	5	2/6	Chelsea Electricity Supply Ordinary	7⅞	8⅛	7⅞	8⅛	3 10 7	March	...	...
£100,000	Stock	4½%	* Do. 4½ per Cent. Debenture Stock (red.)	110	112	110	112	4 0 11	June and December	...	...
$1,200,000	$1,000	5%	Chicago Edison 1st Mort. 5% 30 year Gold Bonds (red.)	100	110	100	110	4 10 11	April and October	...	...
60,000	10	7/0	City of London Electric Lighting Ordinary	10½	11½	10½	11½	5 4 4	February and August	11	10⅞
40,000	10	6%	Do. 6 per Cent. Cumulative Preference	13	14	13	14	4 5 9	January and July	14	13⅝
£400,000	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	122	127	122	127	3 18 9	June and December	...	...
40,000	10	...	County of London and Brush Prov. Ordinary	9½	10½	9½	10½	...		...	...
20,000	10	6/0	Do. 6 per Cent. Cumulative Preference	12⅝	13⅝	12⅝	13⅝	4 8 11	March and September	...	...
£200,000	Stock	4½%	Do. 4½% Deb. Stock Certs. (all pd.) (red.)	108	111	109	112	4 0 11		110¼	110
15,000	5	10%	Kensington and Knightsbridge Ordinary	12	13	12	13	4 1 6		...	...
10,000	5	6%	Do. 6 per Cent. 1st Preference	7	7½	7	7½	4 0 0	January and July	...	...
110,000	2	...	London Electric Supply Ordinary	1⅞	2⅛	1⅞	2⅛	...		...	...
48,050	5	3/0	Do. 6 per Cent. Preference	4¾	5	4¾	5	6 0 0		...	...
£250,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures	101	103	101	103	3 18 1	Mar., June, Sept., Dec.	...	...
62,500	10	5/0	Metropolitan Elec. Supply Ord. (Nos. 1 to 62,500)	14⅝	15⅝	14	15	3 6 8	April and October	15¼	14⅜
22,500	10	3/7½	Do. (Nos. 62,501 to 85,000)	14	15	14	15	3 5 8		...	...
£220,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage	114	117	114	117	3 16 11	June and December	...	...
£125,000	Stock	2⅜/8	Do. 3½ per Cent. Mort. Deb. Stock (red.)	95	97	95	97	3 12 2		96½	...
6,452	10	6/0	Notting Hill Electric Ordinary	16	17	16	17	3 10 7	March	...	...
10,000	5	5/0	Oxford Electric Ordinary	6¾	7½	6¾	7½	3 9 0	,,	...	...
300,000	1	8%	Rand Electric	⅛	¼	⅛	¼	10 13 4		...	...
£130,070	Stock	5%	River Plate El. Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb.	75	85	75	85	5 18 0		...	...
150,000	$100	$2	Royal Electric Company of Montreal Shares	150	170	150	170	4 14 2		...	...
£123,200	100	4½%	* Do. 4½ per Cent. 1st Mortgage Debentures	104	106	104	106	4 5 6	April and October	...	...
31,980	5	5/0	St. James's and Pall Mall Electric Ordinary	15	16	15	16	4 10 8	February and August	15⅝	...
20,000	5	3/6	Do. 7 per Cent. Preference	9	9½	9	9½	3 13 8	,, ,,	...	...
65,000	5	...	South London Electric Supply Ordinary (fully paid)	4	4½	4	4½	...		...	...
79,900	5	5/0	Westminster Electric Supply Ordinary	14	15	14	15	4 0 0	March and September	14⅜	...
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
125,000	1	7¼d.	Aron Electricity Meter 6 per Cent. Cum. Pref.	⅜	⅜	⅜	⅜	6 17 2		...	...
45,000	1	...	British Electric Works Co. Ordinary	1	1⅛	1⅛	1 1/16	...		...	...
50,000	1	...	Do. 5 per Cent. Cumulative Preference	⅞	1	1	1	...		...	...
£50,000	100	...	Do. First Mortgage Debentures	99	101	99	101	...		...	...
40,000	5	5/0	British Insulated Wire Ordinary	13	14	13	14	3 11 5		...	...
27,500	5	3/0	Do. Preference	6	6½	6	6½	4 12 4		...	...
90,000	2	2/0	Brush Electrical Engineering	1⅞	2	1⅞	2⅛	4 14 1	September	2 1/16	1⅞
90,000	2	1/2⅜	Do. 6 per Cent. Pref. Non-Cumulative	2⅛	2⅜	2⅛	2⅜	4 16 0	,,	...	...
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Deb. Stock	110	115	110	115	3 18 5	February and August	...	...
£50,000	Stock	4½%	* Do. 2nd Debenture Stock (red.)	102	105	102	105	4 5 9	June and December	...	...
20,000	5	5/0	Callender's Cable Construction Ordinary	13½	14½	14	15	5 0 0	,, ,,	14½	14½
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5½	6	5½	6	4 3 4	...	5⅝	...
£90,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb. (red.)	110	115	110	115	3 18 3	November and May	...	...
300,000	1	0/9⅜	Castner-Kellner Alkali Co. (fully paid)	1⅛	1⅜	1⅛	1⅜	5 16 5		...	...
60,000	1	0/7½	Chadburn's Ship Telegraph Ordinary	⅝	1⅛	⅝	1⅛	5 6 8		...	...
60,000	1	0/7⅜	Do. 6 per Cent. Cumulative Preference	⅝	1⅛	⅝	1⅛	5 6 8		...	...
32,098	3	1/9⅜	Crompton and Co. (Nos. 1 to 32,098)	3⅛	4	3⅛	4	4 10 9	January and July	...	...
£100,000	100	5%	* Do. 5 per Cent. First Mortgage Deb. (red.)	98	101	98	101	4 19 0	,, ,,	...	...
60,000	1	0/3	Davis and Timmins 6 per Cent. Cum. Pref.	¾	1	¾	1	...		...	...
99,261	5	1/9⅜	Edison and Swan United ("A" Shares) (£3 paid)	2	2⅛	2	2⅛	7 3 9	February and August	...	...
17,139	5	2/9⅜	Do. (£5 paid)	3⅛	4⅛	3⅛	4⅛	6 13 4	,, ,,	...	...
£344,023	Stock	4%	Do. 4 per Cent. Mortgage Deb. Stock (red.)	93	95	93	95	4 4 3	June and December	93½	...
26,100	5	5/11⅛	Edmundson's Electric Corporation Ord. (fully pd.)	4⅛	5⅛	4⅛	5⅛	5 14 3	Half-yearly	...	...
112,100	2	1/2⅜	Electric Construction Co. (Limited)	2⅛	2⅜	2⅛	2⅜	4 16 0	January and July	2⅜	...
25,000	2	2/9⅜	Do. 7 per Cent. Cumulative Preference	2⅝	3⅛	2⅝	3⅛	4 6 2	July	...	...
182,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	103	106	103	106	3 15 6	January and July	...	...
30,000	5	...	Henley's Telegraph Works Ordinary	13¾	14¼	14	15	...	February and August	14⅜	...
15,000	5	...	Do. 4½ per Cent. Preference	5¾	6	5¾	6	3 15 0	,, ,,	5 1/16	...
£50,000	Stock	4½%	Do. 4½ per Cent. Mortgage Deb. Stock (red.)	111	114	111	114	4 0 0	,, ,,	...	...
50,000	10	10/0	India Rubber, Gutta Percha, &c., Works	21	22	21	22	4 11 10	,, ,,	21¾	...
£300,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	100	104	100	104	3 16 11	March and September	...	...
37,350	12	12/0	Telegraph Construction and Maintenance	37	41	37	41	4 7 9	March and July	39	...
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909	102	105	102	105	3 16 2		103	...
20,000	5	3/0	Do. Manufacturing Ordinary	9	10	9	10	3 10 0		9⅜	9⅛
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5½	6	5½	6	4 3 4		5⅜	...
30,000	5	5/0	Willans and Robinson Ordinary	9½	10½	9½	10½	4 5 9	April and October	10⅛	...
30,000	5	3/0	Do. 6 per Cent. Cumulative Preference	7⅛	7⅝	7⅛	7⅝	3 17 5	,, ,,	7⅞	...
£100,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Debentures	104	106	104	106	4 0 2	May and November	...	...
			ELECTRIC RAILWAYS, TRAMWAYS, &c.								
12,000	10	6/0	Blackpool and Fleetwood Tramways	17½	18½	17½	18½	3 15 8		...	...
£167,900	100	5%	Brisbane Tramway 5 per Cent. Debentures	104	106	104	106	4 14 4		...	...
50,000	10	7%	Bristol Tramways and Carriage Ordinary xd	23	24	22½	23½	2 17 2	February and August	...	...
25,000	10	...	Do. Cumulative Preference (£6 paid)	6½	6¾	6½	6¾	...		...	...
£100,000	Stock	4%	Do. 4 per Cent. Debentures	117	118	117	118	3 7 3		...	...
30,000	10	9/0	British Electric Traction Ordinary (Nos. 1 to 30,000)	16	17	16	17	3 10 7		16⅜	16¼
£15,000	10	...	Do. (Nos. 60,001 to 75,000)	15½	16½	15½	16½	...		15½	...
30,000	10	6/0	Do. 6% Cum. Pref. (Nos. 30,001 to 60,000)	13½	13¾	13½	13¾	4 7 3		13⅜	13⅛
£200,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures	125	128	125	128	3 18 6		...	...
40,000	5	1/9	Buenos Ayres & Belgrano 6% "A" Cum. Pref.	4⅞	5⅛	4⅞	5⅛	5 17 1		5 1/16	...
27,500	5	...	Do. "B"	4	4⅜	4	4⅜	...		...	...
330,000	Stock	5%	Do. 5 per Cent. Debentures	105	108	105	108	4 12 7		...	...
213,553	10	3/0	Central London Ordinary	9½	10	9½	10	3 0 0	June and December	10⅛	9⅞
£855,000	Stock	1½%	City and South London Railway Con. Ordinary	58	61	58	61	3 1 6	January and July	60⅛	59¾
37,000	10	...	Do. (Nos. 22,501 to 60,000) (£5. 10s. paid)	4	5	4	5	...		...	...
£150,000	Stock	5%	Do. 5 per Cent. Perpetual Preference (1891)	140	145	140	145	3 9 0	January and July	...	...
£200,000	Stock	5%	Do. (1896)	132	137	132	137	3 13 0		...	...
£187,701	Stock	4%	Do. 4 per Cent. Perpetual Debenture	125	130	125	130	3 1 11	May and November	...	...
20,000	10	7½%	†Imperial Tramways Ordinary	23	24	23	24	...	March and September	...	...
10,000	10	6%	† Do. 6 per Cent. Preference	15	15½	15	15½	3 16 2	,, ,,	...	...
£300,000	Stock	4½%	† Do. 4½ per Cent. Debenture	113	116	113	115	3 17 11	January and July	...	...
30,000	10	1/3	Kidderminster & District E. L. & Tr'ct'n 5% Pref.	8	8½	10		5 0 0	May and November	...	...
37,500	10	2½%	Liverpool Overhead Railway Ordinary	9 9/16	9 11/16	9 9/16	9 11/16	3 7 0	February and August	...	...
10,000	10	5%	Do. 5 per Cent. Preference	13	13½	13	13½	3 15 6	,, ,,	...	...
125,000	Stock	4%	Do. 4 per Cent. Debenture	105	107	105	107	3 14 11	January and July	...	...
24,000	5	...	New General Traction Ordinary	3⅞	4	3⅞	4	...		...	...
30,000	5	6/0	Do. 6 per Cent. Cumulative Preference	4⅞	5⅛	4⅞	5⅛	5 11 3	May	...	...
4,000	10	...	Oldham, Ashton and Hyde Elec. Tramway Ord.	18	19	18	19	...	February and August	...	...
4,000	10	5/0	Do. 5 per Cent. Preference	10⅜	10⅞	10⅜	10⅞	4 11 11	,, ,,	...	...
13,334	10	...	Potteries Electric Traction Ordinary	11⅛	12⅛	11⅛	12⅛	...		...	...
20,000	10	5/0	Do. 5 per Cent. Cumulative Preference	10	11	10	11	4 10 11		...	...
£540,000	Stock	3%	Waterloo and City Ordinary	101	104	101	104	2 17 8	June and December	104	103

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

† The London Stock Exchange Committee refuses to quote these.

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THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,137. [Vol. No. 19. XLIV.] FRIDAY, MARCH 2, 1900. PRICE SIXPENCE (by post, 6½d.), Abroad, 8d., or 15 cents, or 30fr., or 70pf.

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NOTES.

BETWEEN Saturday and Monday last a considerable number of important changes took place on the City and South London Railway. On Saturday Sir FRANCIS MARINDIN inspected, on behalf of the Board of Trade, the extensions of the railway to Moorgate-street, including three new passenger stations—viz., at London Bridge, adjoining the London, Brighton, and South Coast Railway Co.'s terminus; at Lombard-street, near to the Bank; and at Moorgate-street. On Sunday these extensions were opened to the public, and at the same time the original terminus in King William-street was closed. There was put into force also a new tariff of fares, regulated on a ticket system according to the distance travelled.

SUCH were the changes with which the ordinary passenger was made acquainted. But the opening of these extensions marks other changes of far greater interest to electrical engineers. On Monday the original power station at Stockwell was shut down, except for the hydraulic plant for working the lifts, and the new station close beside the old one operated the whole system. This change-over is of special interest, in view of the fact that the new plant works the railway on the much-debated three-wire system. Mr. P. V. MCMAHON, the engineer to the City and South London Railway Co., has long been convinced of the practicability of this method of working electric railways; and now that he has succeeded in establishing it on his railway and in making it a thorough success, he is to be congratulated on the result of the enterprising experiment. We made a careful inspection of the line and power station on Monday, and were struck with the evident improvement in working produced by the change-over to the new system. Mr. MCMAHON has our hearty congratulations and best wishes for the success of the three-wire continuous-current traction system—a formidable rival to the three-phase system, shortly to operate the Central London Railway. One of the most notable features of the extensions is that, like the original line, they have been carried out solely by means of British capital, British labour, and British plant and equipment.

BUT, though essentially a three-wire system as regards the working conductors, it would probably be more accurate to describe the City and South London Railway system of working as a five-wire system, at any rate as regards a portion of the line. For a fourth and a fifth 500-volt conductor, each at 1,000 volts above earth but 500 volts above the neighbouring feeder, are carried from the power station to the substation at the Bank passenger station, and here operate motor-generators which feed the line at 500 volts above earth. Into the details of this strikingly original traction system it is not now our purpose to enter. When the power station, which is as yet in an unfinished state, is completed we hope to furnish our readers with an illustrated technical description of the new plant; and an opportunity will then arise to discuss the system in detail. Other electrical changes in the railway include the introduction of a three-wire battery of storage cells at the Bank station.

IT speaks volumes for the progress already made by electric traction in this country that important extensions such as those described above should have been thrown open to the public without fuss or ceremony. When the City and South London Railway was opened by the Prince of Wales, the occasion was rightly one of regal pomp and ceremony. Whereas on the former occasion electric railway traction was regarded in the light of a plucky experiment, nowadays it is a commonplace affair of modern engineering. In like manner the opening of a short length of electric tramway was frequently the *raison d'être* for civic festivities in the early days of the trolley system. Nowadays the opening of 10 or 20 miles of electric tramway takes place without any more ceremony than placarding the fact on the cars. The time is not far distant when the opening of electric railways far larger

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than the entire City and South London Railway will be regarded with no more excitement than we now regard the opening of any short steam railway.

In another column of this issue we give in full the specification issued by the Postmaster-General as a condition to the telephone licence granted to the Glasgow Corporation; and this is of especial interest, as it may be anticipated that precisely similar terms will be imposed upon other local authorities obtaining permission to erect and work telephone exchanges. It will be observed that the technical conditions imposed are by no means strict, merely amounting to an enjoinder to employ a thoroughly up-to-date system with metallic circuits, branching jacks on all multiple boards, underground wires from the exchange to distributing points, and automatic signalling on the junction lines. A minimum size for the various conductors is imposed which is by no means excessive—in fact, many telephone engineers may question the expediency of employing wire as fine as 22 S.W.G. in underground cables. The original specification laid down a minimum of 20lb. to the mile (just below No. 20 S.W.G.) for this purpose, but Mr. Bennett, the consulting telephone engineer to the Glasgow Corporation, has now been permitted to employ the smaller size—upon which we believe his estimates have been based.

A condition in the original specification, that the subscribers' calling and clearing should be automatic, has also been removed in response to Mr. Bennett's representations. While the use of automatic signalling throughout is an advantage in actual working, this system is expensive to instal, and reliable figures can hardly yet be obtained as to the cost of its maintenance. It is but fair, therefore, that the local authority should be allowed latitude in this respect. The last paragraph in the specification is interesting. While on the one hand the Postmaster-General will be pleased to consider proposals for the modification of the specification from time to time, in accordance with "the progress of invention," except in the case of trunk junction wires he does not appear to reserve to himself the right of modifying the specification in order that he too may profit by this same "progress of invention."

It did not need a discussion at the Institution of Electrical Engineers to disclose the fact that there is a necessity in the electrical engineering industry of this country for a greater degree of standardisation than at present exists. If the Institution as a body wishes to help towards this desideratum, however, it should act more energetically in the matter. The discussion has been of interest in bringing out the views of various eminent electrical engineers on the subject, and it has shown that the opinions expressed in the short interim report of the Committee on the Uniformity of Electrical Engineering Practice, although covering only a minute corner of the subject, are not shared by some electrical engineers who are particularly concerned; but it has done no more. We cannot but think that the Institution, is not proceeding in the most effective way, if it really intends to promote this standardisation, which is recognised as desirable on all sides. A wiser course would have been for the Council to have divided the subject into its various sections, and then to have called a general meeting for the nomination and election of separate committees to report on these different sections. The reports should then have been discussed and passed, with amendments if necessary, at one or more general meetings, so that the result would represent the opinion of the great body of members. Much energy is no doubt being expended by the Uniformity Committee, and it will be a pity if the result of the committee's labours should be accorded as little attention as the two previous attempts at standardisation—wiring rules and copper standards.

From the discussion, it is evident that the manufacturers are themselves largely to blame for the absence of standardisation. Prof. Ayrton and Mr. Stephen Sellon put the matter very clearly, that the first step towards a thorough standardisation should be made by the manufacturers fixing upon their standards, clearly announcing what they are, and adhering to them until, as the result of experiment (made by the manufacturer at his own expense, and not by the consulting engineer at the buyer's expense), better standards replace the old ones. Manufacturers whose scale of output renders standardisation desirable should let their progress follow a stepped curve and not an irregularly rising one with occasional points of contrary flexure. Successful standardisation on these lines has been carried out in the United States for some time past, and by at least one British firm connected with the electrical industry.

Municipal obstruction to private electric lighting enterprise has been again supported by the House of Commons. The chief objection raised against the bill of the London and Brush Provincial Electric Lighting Co., thrown out on the motion for second reading on Monday, was that trunk feeder mains should not be allowed to pass through parishes which are not supplied by the company in question. The inconvenience to the road authorities in these districts caused by laying a trunk main is practically nil, while on the other hand the advantage of according permission on every reasonable occasion is great. Such mains enable works to be placed outside towns, where a certain amount of smoke and vibration can be permitted and where the cartage of coal offers less inconvenience to the public. These mains, which seem in the municipal mind to be likened to the long arms of an octopus grasping a monopoly which might otherwise fall to the share of the local authority itself, are to the more reasonable recognised as important links which can connect the various generating centres and so ensure a continuity of supply independently of breakdowns. Opponents of this bill should remember that there are already metropolitan companies which last session were granted similar powers to those now sought for and refused. On the other hand, it is satisfactory to note that several bills for electricity supply "in bulk" passed their second reading yesterday—to wit, the Lancashire Electric Power Bill, the Durham (County of) Electric Power Supply Bill, the South Wales Electrical Power Distribution Bill, and the Tyneside Electric Power Bill.

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A WIDER circle than comprises the shareholders of the Wireless Telegraph and Signal Co. will read with much interest the speech of the chairman, Major J. FLOOD PAGE, at the meeting on Friday last, a full report of which appears in our issue this week. Indeed, it is by no means certain that the speech will not seem more satisfactory to the electrical profession in general than to the shareholder, for it points more to distant future developments of wireless telegraphy than to immediate profits for the shareholders. Moreover, more of the interest in Major PAGE's speech lies in what he did not disclose, or in things which were only hinted at, than in the actual direct statements made. As regards the latter, the speech serves as an admirable *resumé* of the progress already made, but in respect of the former it showed that there were under-currents of negotiations deeper than the speaker cared to allow his audience to fathom.

TAKE for example the guarded statements about the negotiations with the Treasury, and the thinly-veiled fear evidently felt that the company might have a difficulty in getting the price it wants. Or consider the complaints about the ingratitude of the Elder Brethren of the Trinity House, or the purblindness of the War Office and the Admiralty, contrasted menacingly as these are with the wonderful things the Germans and other foreign Powers are going to do. The one tangible business fact disclosed by Major PAGE was that the board is anxious to dispose of the "maritime rights" part of its business—the very part which, be it observed, the speaker in an earlier part of his speech described as "the most important—the maritime—which is ready for work."

ALTHOUGH the attempts which have been made to produce a dry secondary battery, or one with a gelatinous electrolyte which will not spill or splash about, have not led to very satisfactory results hitherto, inventors still continue to exercise their ingenuity in this direction, undeterred by previous failures. In theory there is nothing easier than to introduce some porous material between the plates, which will serve to keep them apart and to retain the electrolye; or apparently that some electrolyte like that introduced by SCHOOP should answer all requirements. But in practice it is soon found that short-circuits establish themselves through the porous material between the plates, and that the jelly breaks up; and generally, according to LIEBENOW, the reason for failure is not far to seek in the light of our increased knowledge of the chemistry of the cell.

LIEBENOW deals with the subject of this type of cell very fully in No. 4 of the *Centralblatt für Accumulatoren-und Elementenkunde*, and he points out that in the plates themselves there are electrical concentration currents set up which tend to convey the acid in the pores of the plates from those points at which the concentration of the acid is greater to those at which it is weaker. The effect of these currents, he says, is to equalise the strength of the acid far more rapidly than would be the case were diffusion alone acting. In the case of any non-conducting medium, however, which may be introduced between the plates, there is no such electrical action to assist diffusion through it, and the cell suffers in consequence of the rapid circulation of the electrolyte being prevented, so that it would seem that any attempt to construct a satisfactory dry secondary cell is foredoomed to failure. The acid retained in the pores of the plates is exhausted much more rapidly than is the case when the cells contain the usual electrolyte, and the capacity of the cells soon becomes reduced. As long ago as 1890 the question of the diffusion of the acid and the effects of this on the working of secondary batteries was debated in this country in the discussion which followed the reading of Prof. AYRTON'S Paper at the meeting of the Institution of Electrical Engineers in Edinburgh, and the subject was also under discussion in America. Dr. LIEBENOW apparently is unaware of these facts. Of the effects of concentration of the electrolyte on the life of the plates and on the E.M.F. of the cell we knew much, also that anything interfering with the free circulation of the acid interferes with the proper working of the cell; but the ionic hypothesis was not as fully developed then as it is now, and the theory of concentration currents was little, if at all, understood.

RUMOUR is busy with the details of a possible combine of the leading cable-manufacturing firms. We have, however, been unable to obtain any confirmation of the report.

The Electrical Engineers (R.E.) Volunteers and the War.—We give below the official list of the detachment of the Electrical Engineers (R.E.) Volunteers whose services have been accepted for the war in South Africa. We understand that the detachment will sail as soon as the equipment is completed and a passage has been provided. The detachment is at present quartered at Chelmsford. The R.E.s accompanying the detachment are Capt. F. L. Lloyd, Sergt.-Major G. Brown, and Sergt. C. T. Ruse. Although the fact has not yet been officially announced, it would not surprise us to learn that Major Crompton may be raised to the rank of lieutenant-colonel before going out:—

Major R. E. B. Crompton.
Capt. F. L. Lloyd (R.E.).
Capt. A. Ba'n.
Capt. H. M. Leaf.
Lieut. J. J. F. O'Shaughnessy.
Lieut. A. Pott.
2nd Lieut. J. H. Stubbs.

N.C.O.s.

Sergt.-Major G. Brown (R.E.).
Sergt. C. T. Ruse (R.E.).

Electrical Engineers.

J. H. S. Phillips.
W. S. Entwistle.
T. H. Brown.
A. Charlton.
H. F. Bigge.
H. H. Bicker Caarten.
F. W. Dalton.
J. H. Stone.
A. H. I. Graham.
F. Powell-Williams.

Sappers.

S. W. Melsom.
R. W. Holliday.
J. Bowrey.
G. F. H. Elliott.
F. C. Weakley.
J. Rook.
D. F. Colson.

Sappers—(continued).

G. Charlton.
E. C. Short.
F. J. Wallis.
A. Devonshire.
C. Landon.
W. H. Hossack.
C. F. Love.
R. H. Brander.
H. R. Allen.
M. N. Crawford.
H. A. Paris.
F. J. Young.
C. E. Silverthorne.
H. Bertram.
E. J. Wright.
H. B. Tilley.
A. I. Hodgson.
E. J. West.
— Hounsfield.
F. J. Phillips.
E. C. Horsley.
N. W. Pirrie.
F. C. Stephens.
C. H. R. Thorn.
A. R. Peart.
R. B. Roberts.
A. E. Levin.
D. G. W. Hume.
W. C. Cooke.

The Royal Society.—Among the Papers down for reading yesterday was "The Velocity of the Ions produced in Gases by Röntgen Rays," by Prof. J. Zelung.

Erratum.—In our note on "Dry Batteries," on p. 612 of last week's issue, for "crystallised calcium carbide" read "crystallised calcium chloride."

The Late Prof. D. E. Hughes.—At the last meeting of the Société International des Electriciens, it was announced that Prof. Hughes had bequeathed to the institution a sum of 50,000f. (£2,000).

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Obituary.—The death is announced of Mr. Emile Andreoli, in his 65th year, on the 23rd ult. Mr. Andreoli was chiefly known to the electrical profession in connection with the electrical production of ozone.

Electrical Engineers (R.E.) Volunteers.—The "send-off" dinner to the active service contingent of this corps will take place to-morrow (Saturday), at 7.15 for 7.30 p.m., at the Prince's Restaurant, Piccadilly. The honorary colonel, Lord Kelvin, has consented to take the chair.

Cable Interruptions:—

	Date of Interruption.
Latakia—Cyprus	June 21, 1899
Cayenne—Pinhieros	Oct. 11, 1899
Tangier—Tarifa	Jan. 3, 1900
Paramaribo—Cayenne	Feb. 16, 1900
Ceara—Maranham	Feb. 20, 1900

The Institution of Jnnior Engineers.—The *conversazione* of this Institution will be held at the Westminster Palace Hotel on Saturday, March 10. The reception will take place at 7 p.m. by the president, the Hon. C. A. Parsons, F.R.S., and Mrs. Parsons; and the chairman, Mr. Basil H. Joy, and Miss Joy.

The John Hopkinson Memorial Wing of the Cambridge Engineering Laboratory.—The thanks of the University have been ordered to the donors of certain valuable gifts to the engineering laboratory. Lork Kelvin has presented a set of apparatus for electrical measurements, Messrs. Siemens Bros. a pair of coupled dynamos, and the Forward Engineering Co. a gas engine.

Metropolitan Electric Supply Co.—Apropos of the recent interruption of supply on a portion of the Metropolitan Electric Supply Co.'s syatem, we learn that the company has granted to their consumers an allowance on their bills varying from 20 per cent. down to 5 per cent., according to the number of hours during which the supply was interrupted in each particular case.

Australia-Cape Town Cable.—A Reuter's telegram from Melbourne states that the details have been arranged of an agreement between the Governments of New South Wales, Victoria, South Australia, Tasmania, and Western Australia and the Eastern Extension, Australasia and China Telegraph Co. in connection with the projected cable between Australia and the Cape of Good Hope.

Telephonic Communication with the Shore.—The *Daily Mail* states that the submarine boat "Morse" has successfully held telephonic communication with the shore at Cherbourg. A small boat was connected by means of a wire to the "Morse," three miles distant, and conversation was successfully carried on. The experiment is regarded as of importance from the point of view of coast defence.

The Paris Exhibition.—It was stated in the German Reichstag, on the note for a million marks to enable Germany to take part in the Paris Exhibition, that the opening of the Exhibition would take place on the date originally settled, April 15, but owing to various mishaps and delays, neither the electricity section nor the building for the army and navy section would be ready until the middle of May.

The Royal Meteorological Society.—The jubilee of this Society will take place on April 3rd next, on which date special commemoration meetings and celebrations are to be held. Dr. E. Theodore Williams has been elected president of the Society, in place of Mr. G. J. Symons, F.R.S., who had been elected at the annual meeting on January 17th last, in view of the coming jubilee celebration, but has resigned owing to illness.

Partz Acid Gravity Battery.—A new form of primary battery is described in the *Western Electrician* of Chicago, for which is claimed—(1) a voltage of 1·9 to 2·0 volts; (2) a maximum current of 2·3 amperes, falling only to 1·5 amperes after being four years in use; (3) and long life with but little attention. The electrodes of this cell, known as the Partz acid gravity cell, are carbon and zinc. The jar contains a saturated solution of magnesium sulphate or of common table salt, and the gravity tube is filled with sulpho-chromic salts, which diffuse slowly through the solution. Surely these be commonplace means to such a wonderful end!

Explosion in Tramway Surface Boxes at Sheffield.—On Tuesday morning last a serious explosion occurred in a traction surface box at Spital Hill, Sheffield, which immediately extended to two other boxes in the neighbourhood, hurling the covers off. The cause of the explosion was the presence of a large quantity of gas which had escaped into the box from faulty gas mains in close proximity to it, and which was set alight by the portable light carried by the workman who opened the box. Happily, the accident was unattended by any very serious consequence, and the tram service was resumed after a few minutes' delay.

Opening of the York Electricity Supply Station.—The electricity works of the York Corporation were formally opened on Monday last by Mrs. E. R. Dodsworth, wife of the chairman of the Electric Lighting committee. The works, which were designed by Prof. A. B. W. Kennedy, are on the 2 × 230 volts three-wire system, and contain two Lancashire boilers, four bi-polar dynamos with an aggregate capacity of 198 kw. connected to Willans engines, a battery of 250 cells with a capacity of 250 ampere-hours, and a motor-driven booster. At present about 80 consumers are connected to the mains, equivalent to a lamp connection of some 7,000 8 c.p. lamps, and 20 public arc lamps. The mains are of Messrs. Callender's make, armoured and laid directly in the ground, the distributors being triple concentric.

The Metropolitan Electric Supply Co.'s New Works.—Yesterday afternoon a number of visitors were invited to Willesden to inspect the new works of the Metropolitan Electric Supply Co., which are now practically complete. Among those present were Lord Kelvin, Sir William Preece, Prof. S. P. Thompson, Mr. Ferranti, Mr. W. Gray, Mr. Elphinstone, Mr. G. W. Partridge, Mr. F. H. Jackson; and also Mr. Frank Bailey (director), Mr. Todd (engineer-in-chief), Mr. Holbrow (resident engineer at Willesden), and other officials of the company, besides a few ladies. In a speech at luncheon Mr. W. M. Cripps (chairman of the company) briefly sketched the *raison d'être* and the history of the new works, and the trouble experienced in obtaining delivery of the plant and material. The company will now be able, he asserted, to supply two million lamps. We reserve our description of the works until a future issue.

MEETINGS OF SCIENTIFIC AND ENGINEERING SOCIETIES, &c.

(TO-DAY) FRIDAY, March 2nd.

PHYSICAL SOCIETY.

4:30 p.m. Special Meeting in the Physical Laboratory, University College, Gower-street, by the kind invitation of Prof. Callendar. Agenda: (1) "The Relative Rates of Effusion of Argon, Helium, and some other Gases," by Dr. F. G. Donnan; (2) "On the Distillation of Liquid Air and the Composition of the Gaseous and Liquid Phases," by E. C. C. Baly; (3) "The Reversibility of Galvanic Cells," by T. S. Moore; (4) "On the Damping of Galvanometer Needles," by M. Solomon.

INSTITUTION OF JUNIOR ENGINEERS.

8 p.m. Meeting in the Westminster Palace Hotel. Paper to be read: "Electrolytic Zinc as a Protective Metallic Coating for Iron and Steel," by W. Paddon.

SATURDAY, March 3rd.

INSTITUTION OF JUNIOR ENGINEERS.

3 p.m. Visit to Messrs. Maudslay, Sons and Field's Belleville Boiler Works, East Greenwich.

MONDAY, March 5th.

ROYAL INSTITUTION.

5 p.m. General Monthly Meeting.

SOCIETY OF ARTS.

8 p.m. Cantor Lecture I.: "Photography of Colour," by E. Sanger Shepherd.

THURSDAY, March 8th.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary General Meeting. Paper to be read: "On the Applications of Electricity in Medical and Surgical Practice," by Dr. H. Lewis Jones.

SATURDAY, March 10th.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture II. on "Polarised Light," by the Right Hon. Lord Rayleigh, F.R.S.

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ON ELECTRIC *TOUCH* AND THE MOLECULAR CHANGES PRODUCED IN MATTER BY ELECTRIC WAVES.*

BY PROF. JAGADIS CHUNDER BOSE, M.A., D.SC.

(*Concluded from p. 658.*)

Allotropic Modification Produced by Visible Radiation.

As regards the action of radiation in producing allotropic modification, several such instances are known in the case of luminous radiation. In the familiar example of the conversion of yellow phosphorus into the red variety the effect is quite apparent. But this is not the case in the transformation of soluble sulphur into an insoluble variety by the action of light: here the transformation is not apparent, and has to be indirectly inferred from the insolubility of the solarised product in carbon bisulphide. The reason why a far larger number of instances of allotropic modification due to light are not known, is not because such effects are not more numerous, but because we are unable to detect such changes. It must be admitted that our knowledge of molecular changes and the means of their detection is at present extremely limited.

Variation of Conductivity Produced by Allotropic Changes.

There is one method of detecting these variations of molecular and atomic structure to which little attention has hitherto been given, but which appears to be of great interest and promises to yield important results. If through any cause molecular changes are produced in a solid, these must be attended with variation of physical properties, electric conductivity being one of them. Among other instances of the wide difference of conductivity between the allotropic varieties of the same substance may be mentioned that existing between graphite and diamond, between crystalline and amorphous varieties of silicon, and between the "metallic" and yellow varieties of phosphorus. But it is not at all necessary to take only such extreme cases to show the influence of molecular or atomic aggregation in influencing the conductivity. This effect is brought into painful prominence by the variation produced, in spite of all precautions, in our standards of resistance.

Experimental Proof of the Molecular Variation being attended with Variation of Conductivity.—Red mercuric iodide is converted into yellow variety by the application of heat, and the substance does not return to its original state till after a considerable lapse of time. The recovery here is very slow. A small quantity of iodide was placed in a tube provided with sliding electrodes, and a current was made to pass through the substance by suitable compression of the substance. The current was observed by means of a sensitive galvanometer. On the application of heat to the tube (which converts the red into the yellow variety) there was produced, simultaneously with the molecular transformation, an increase of conductivity, This effect is not due to a rise of temperature, for the increased conductivity was still exhibited on cooling the tube. From this experiment it is seen how the molecular changes can be inferred from observed changes in the conductivity. In the case described above the recovery from the B or second stage to the first stage is very slow; but there may be substances (and there are such substances) where under the given conditions of temperature and other surroundings the first stage is far more stable than the second: the substance will then pass back quickly from the B condition to the primitive state A, on the cessation of the exciting cause which gave rise to the B effect. The substance will in this case be "self-recovering."

Electrical Reversal in the Radiation Product.

In the hypotheses given above it was assumed that the reaction of the radiation product or B variety should be opposite to that of the substance in the normal condition or in the A state. Thus a negative substance which by the action of radiation shows an increase of resistance during conversion from the A to B state should exhibit a diminution of resistance when the B variety is acted on by electric waves. The contrary would be the case with positive substances.

The following tabulated statement indicates the phenomena exhibited by the two classes of substance :—

Sign of contact-sensitiveness.	Action of radiation on the fresh or A variety of the substance.	Further action of radiation on the radiation product or B variety.
Positive—*e.g.*, iron.	Diminution of resistance.	Increase of resistance.
Negative—*e.g.*, arsenic.	Increase of resistance.	Diminution of resistance

We have thus two distinct classes of phenomena dependent on the sign of electric touch. If K_A represents the conductivity of the fresh substance and K_B the conductivity of the radiation product, then

(1) With positive substances, as the conductivity of the radiation product is greater ($K_B > K_A$), the first action of radiation would be to produce a diminution of resistance. This diminution will continue to be exhibited till the maximum amount of B variety is produced. The further action of radiation now will be to reconvert B into A; but as $K_A < K_B$ there would now be produced a diminution of conductivity, and a galvanometer in circuit will indicate an electric reversal. The reconverted A variety may again be transformed to a greater or less extent to B, and in this way a series of reversals may take place, due to the continued action of radiation producing oscillation in molecular or atomic groupings. I shall designate this as the phenomenon of radio-molecular oscillation.

(2) With negative substances the conductivity of the radiation product is smaller ($K_B < K_A$), and the first action of radiation will therefore be an increase of resistance. The phenomena exhibited by these negative substances will precisely be opposite to those shown by the positive substances.

The above is but an approximate representation of the phenomena. To be more accurate, one has to take into account the partial changes and the effect of radiation on these changed products. Thus, at first suppose the substance to be entirely made up of A variety. The first flash of radiation converts a great portion of A into B, the substance now being a mixture of A and B. The action of the next flash would be to convert the unchanged A into B, and reconvert to a more or less extent B into A. The electric response will thus be very strong at the beginning, but will become continuously less and less. When the proportion of B has attained a maximum value, the reconversion of B into A will become relatively large, and thus give rise to reversal effect.

I spoke of the conversion "to a greater or less extent" of one variety into the other. There is also the question of the relative stability of the two varieties under the given conditions. From the above it will be seen what possibilities there are in the way of different combinations, and what wonderfully varied phenomena are thereby rendered possible. I will presently describe some of the typical cases.

In the above it has been assumed that the reaction of the B variety is opposite to that of A. As previously mentioned, in working with a silver receiver I found it, when fresh, exhibiting at first a diminution and subsequently an increase of resistance. The anomalous action may be explained by supposing the normal fresh silver Ag to be positive and the radiation product Ag′ negative. These two varieties would thus give rise to opposite reactions. To justify the assumptions made above, it became necessary to obtain by some other means a variety of silver Ag′ analogous to the hypothetical negative variety.

Two Different Varieties of Silver.—After many attempts I at last succeeded by a method of reduction, a variety of silver which gives a moderate negative reaction (increase of resistance), the fresh filings from a silver rod, as has been said before, giving a positive reaction. There are other differences of electric behaviour between these two varieties; for instance, when made into a voltaic cell the two varieties give a P.D. of about 0·12 volt. There are other interesting peculiarities about this cell, the consideration of which has to be postponed to a future occasion.

* An abstract of a Paper read before the Royal Society.

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Electric Reversal.

It now remains to be proved that the "radiation product" exhibits a change of sign as regards contact sensitiveness. It has been said that all the elements can be divided into two classes—positive and negative. The sensitiveness of certain substances belonging to each of these classes is very great; on the other hand, in the transition from one class to the other substances are met with the sensitiveness of which, either positive or negative, is only moderate. Experimental verification of the reversal appeared at first very difficult, as the reversed action was likely to be masked by the stronger normal action of the still unconverted substance. It therefore occurred to me that, if slightly sensitive substances were taken, the reversed actions were likely to be obtained with less difficulty. For this reason I took for my first experiments arsenic, which is moderately negative. It is, however, possible, though the adjustments are difficult, to exhibit the reversed action even with strongly sensitive substances, and as a type of such actions that of iron will be taken as an example.

Observations Made with Arsenic Receiver.

Experiment 1.—A receiver was made with freshly-powdered arsenic; the critical distance was found to be 25cm.—that is to say, when the radiator was moved from 1cm. to 25cm. there was always produced an increase of resistance—whereas the radiator placed beyond the critical distance produced a diminution of resistance. The critical distance 25cm. may therefore be taken as an appropriate measure of the negative character of the specimen. The receiver was now continuously subjected to radiation for ten minutes. After this it was found that it gave a diminution or positive reaction, even when the radiator was brought close to the receiver. The action of radiation has thus reversed the sign of electric touch. The experiment above described is open to several objections. It does not take into account what took place during the interval, and the final result may have been fortuitous. In order to obtain a complete history of the action during the interval, it is necessary to take a laborious series of observations at very short intervals. This was done, and the results obtained fairly confirmed the previous observations. I have since devised a method, to be presently described, where the observations are rendered continuous and almost automatic.

Radio-Molecular Oscillation.

It was said that, owing to molecular reversals due to radiation, there should be a corresponding series of electric reversals. In this investigation it is essential that the substance examined should be completely protected from all disturbances such as mechanical vibration, &c., and only subjected to the action of radiation. The experimental difficulties are very great. If we take a strongly sensitive positive substance—say iron, the effect of the first flash of radiation (diminution of resistance) is extremely great, and the subsequent reversal effects, unless carefully looked for, are liable to pass unnoticed. After the first adjustment the receiver should on no account be touched, as mechanical jars are found to break up the complex radiation product. Though by special care the mechanical jars could be reduced to a minimum, yet it appeared advisable to devise appropriate means by which the necessity of touching the receiver for subsequent adjustments is altogether avoided. The method adopted to this end varies with individual cases. In the case of arsenic, for example, the action of radiation is often to produce a very great increase of resistance—so great as to convert the substance into a non-conductor. The pressure has to be so adjusted at the beginning that the substance can never become altogether non-conducting; the receiver may thus be left to the action of radiation and the variation of conductivity thereby produced continuously studied. The receiver is thus absolutely free from all effects except those which are to be observed—viz., the effects due to the continuous action of radiation. The time of exposure is very accurately measured by counting the individual flashes of radiation due to interruption of the primary current in the Ruhmkorff coil by a tapping key. The conductivity of the substance at a given moment is inferred from the deflection of the galvanometer in circuit with the receiver. In order to expedite the changes the incident electric radiation is made very strong.

Before entering into the detail of the results obtained, I will say a few words about the principal types likely to be met with. We may have the following:—

I. Substances in which the B state is unstable under the given conditions; the B state will only persist during the action of radiation, the substance relapsing into the original condition on the cessation of radiation. Two cases are possible: (i.) when the substance is positive, (ii.) when the substance is negative.

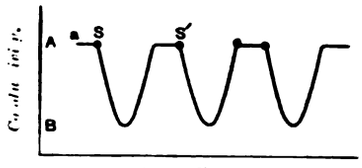

Fig. 1.—Curve for Potassium.

The latter case is exemplified by potassium. In the above curve (Fig. 1) A and B represent the two molecular states. The substance being negative, A is more conducting; *a* represents the conductivity of the fresh specimen; the thick dots S S' ... the individual flashes. It is seen that the effect of radiation is to produce a sudden diminution of conductivity, due to the transient formation of B variety with its diminished conductivity.

II. In this class the radiation product is somewhat stable: the successive conversions from A to B and from B back to A are supposed to be complete. Probably there is no substance

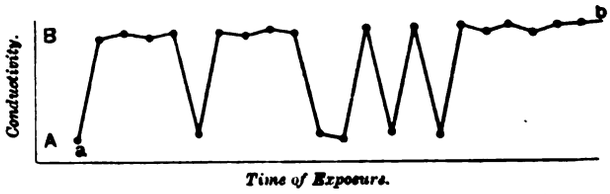

Fig. 2.—Radio-Molecular Oscillation Curve for Magnesium.

which exhibits this action in a perfect manner, but we have an approximation to this condition in the case of magnesium, which under proper adjustments shows successive complete reversals for a long time. The substance, however, after a time exhibits the effect of fatigue.

The curve given in Fig. 2 clearly exhibits the reversals. The receiver was so adjusted as to give a deflection of 5 divisions. The first flash of radiation produced an increased deflection of 90 divisions, the second flash produced a further deflection of 5 divisions, the third flash produced a *negative*

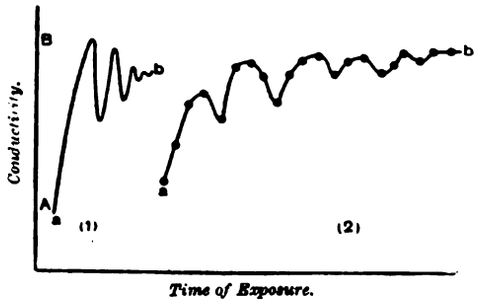

Fig. 3.—"Damped" Molecular Oscillation.

deflection of 5 divisions, the fourth flash produced +5, the fifth flash gave −90 divisions, and the sixth flash produced a deflection of +90. The reversals followed each other almost regularly till the substance became insensitive. At this inert stage the rate of formation and conversion of the two varieties balance each other.

III. Lastly we may have a class of substances where the conversion from A to B and B to A is not complete. Here we again get two subdivisions, owing to the distinction between positive and negative substances.

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Taking at first the case of a positive substance (*see* Fig. 3 (1)) the original conductivity of which is represented by *a*, the action of the first flash of radiation would be to produce a great increase of conductivity by the formation of B; the next flash converts B back to A, but not completely, and the negative deflection will therefore be less than the previous positive deflection. Owing to this "damping effect" the oscillation curve will approximate to a logarithmic decrement curve. After a series of reversals the oscillation dies away and the substance becomes almost inert. A glance at the hypothetical curve to the left shows that at the inert stage *b* *the substance as a whole ought to become more conducting than the first specimen a.* (The opposite should be the case with negative substances.)

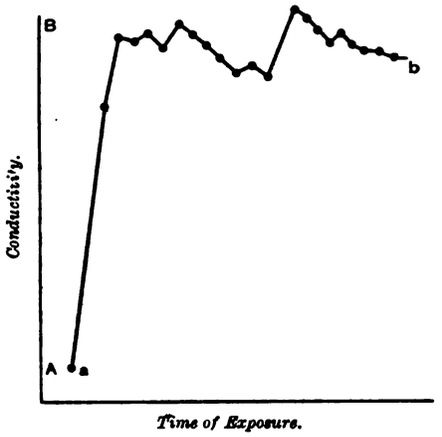


FIG. 4.—Curve for Iron.

The curve to the right (2) exhibits the actual curve obtained with a damped positive substance. The next figure (Fig. 4) gives the curve for iron. The first diminution of resistance is too great to be represented according to scale in the diagram. Observe here the same type as in the previous case; the inert stage *b* is also less conducting than *a*.

IV. I will now consider the case of a negative substance exhibiting damping: arsenic will be taken as an example when the damping is not so great as in the case of iron. Fig. 5 (1) represents the hypothetical curve: (2) represents the actual curve obtained with arsenic. It will be observed that the substance in the fatigued state is, on the whole, less

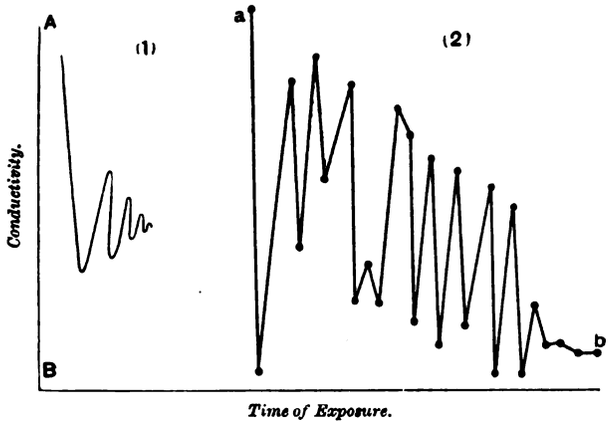


FIG. 5.—A Negative Substance (Arsenic) exhibiting Molecular Damping.

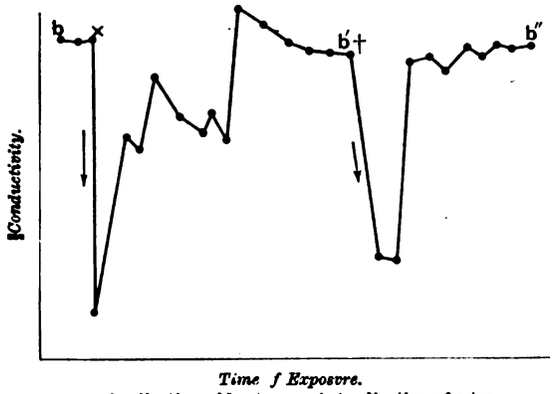
conducting than in the fresh condition. It will also be seen that the oscillations are very regular towards the end. The curves given in Figs. 4 and 5 are those obtained with specimens immediately after the receivers were set up. Had I allowed them a period of rest for the particles to get properly settled, I would have got curves even more regular. It is, however, evident that in substances exhibiting damping two opposite electric conditions are induced in fatigued specimens; the positive becomes on the whole more conducting and the negative less conducting than in the fresh specimens. At the inert stage the rate of mutual conversion from one state to the other probably becomes equal, and the apparent fatigue is thus not due to the absolute want of sensitiveness of the constituent varieties, but to the opposite reactions of A and B balancing each other.

We may now apply some further crucial tests to verify the suppositions made above.

Restoration of Sensitiveness to a Fatigued Substance.

It was said that the inertness of the substance after long exposure is due to the presence of a relatively large amount of B variety. It therefore follows that if by any means we can transform B into A, then after such a transformation there ought to be a restoration of the sensitiveness. It has also been stated that the B variety under ordinary circumstances is less stable than A. If now we apply a disturbing cause which is unilateral in its action—that is to say, if it converts B into A and not A into B—then such a disturbing cause will re-sensitise the fatigued substance.

Effect of Mechanical Disturbance.—Of the unilateral actions mechanical vibration is one, for it is known that by the action of friction a substance may pass from one modification to another in one direction only: thus, the change of monoclinic into rhombic variety of sulphur is hastened by scratching with a glass rod, but the change does not take place in the other direction. We may now apply the crucial tests. Mechanical vibration will transform B into A, and with positive fatigued substances this ought to produce an increase of resistance (as A is less conducting than B): with negative substances the same disturbance ought to produce a diminution of resistance.



× Application of heat. † Application of a tap.

FIG. 6.—Curve showing the Effect of Heat and Mechanical Vibration on a Fatigued Iron Filings Receiver.

Effect of Heat.—There are other methods by which the B variety may be transformed into A; the more subtle molecular disturbance due to heat may be expected to be even more effective in producing the transformation. Here, too, the crucial test is that by slight heating the fatigued positive substance ought to show an increase of resistance and negative substances a diminution of resistance. The two following curves (*see* Figs. 6 and 7), which are continuations of curves for iron and arsenic (Figs. 4 and 5), confirm in a remarkable manner my anticipations.

Effect of Heat and of Mechanical Disturbance on a Positive Fatigued Substance.—I shall at first deal with the curve for iron. At the end of Fig. 4 it was left in an inert stage, *b*. While in this state the receiver was heated to a slight extent. Observe the sudden fall of conductivity (increase of resistance). I should like to say here that, though the fall has been indicated here by a straight line, as representing the somewhat sudden fall of conductivity, I sometimes noticed, on careful inspection, an oscillatory movement of the galvanometer spot during this process. The significance of this I will notice on another occasion. The ultimate effect of slight heating (excess of heating produces other complications) is the restoration of original conductivity. In the experiment with the iron filings receiver the heat was applied for a very short time, and the restoration was not therefore perfect. If this process transformed B into A, we may expect the substance to regain its sensitiveness which was lost in the fatigue stage *b*. The receiver was now exposed to radiation, and it at once responded, exhibiting almost its original sensibility. Observe

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how the curve is a repetition of the previous one (compare with Fig. 4), and how the substance arrives at the second fatigued state b'. To observe the effect of mechanical disturbance, a gentle tap was given to the receiver, and at once there was an increase of resistance due to the transformation of B into A, the receiver regaining its sensibility by the transformation. The action of radiation was continued, and after a few reversals the substance once more arrived at the third fatigued state b''. The process described above could be repeated any number of times.

Effect of Heat and Mechanical Disturbance on a Negative Fatigued Substance.—Experiments similar to the above were carried out with an arsenic receiver. From the curve given below (Fig. 7) it is seen that the reaction of the negative substance is in every respect opposite to that of a positive substance. It will be noticed that the same causes—*i.e.*, tapping or heating—produce, as necessary consequences of the hypotheses previously stated, two opposite reactions in the two classes of substance. I have been able to verify this deduction by observations with nearly a dozen different substances, and have not so far come across any to contradict it. It thus appears that tapping restores the sensitiveness not by the separation of the welded particles (in which case tapping ought to have produced an increase of resistance in *both* the classes of fatigued substance), but by the conversion of the B variety into A.

The effect of electric radiation is thus to produce rearrangement of atoms and molecules in a substance: so does light produce new atomic aggregation in a photographic plate—a subject to be dealt with in detail in a future paper. Some of my audience at the Royal Institution (Jan., 1897) may re-

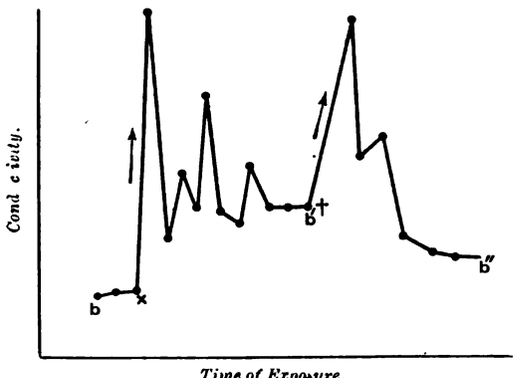

FIG. 7.—Curve showing the Effect of Heat and Mechanical Vibration on a Fatigued Arsenic Receiver.

member my attempt at explaining the action of the so-called coherers (which perhaps may be better described as "molecular receivers") by analogy with the photographic action. I had then no proofs for the assertion; besides, the explanation was not worth much, as, like the "catalytic action" in chemistry, it was an attempt to explain an action of which we know a little by something of which we know less, for the photographic action is still very obscure. It will, however, be seen that the coherer is a linear photographic plate: since we are more likely to understand the complex photographic action from the consideration of the much simpler action of electric radiation on elementary substances, when the effects are not complicated by secondary reactions, a photographic plate may be regarded as merely an assemblage of molecular receivers. I hope also to prove that nearly all the detectors of radiation are "molecular receivers" in reality. The investigation of this aspect of the subject has given me some very extraordinary and interesting results. Another interesting question, the consideration of which has for the present to be postponed, is, Why is it that the sensitiveness is so marked in discontinuous metallic particles—in other words, why is the phenomenon mainly one of skin or *twach*? Is the phenomenon wholly unknown in continuous solids?

The experiments described in the present paper show: (1) That ether waves produce molecular changes in matter; (2) that the molecular or allotropic changes are attended with changes of electric conductivity, and this explains the action of the so-called coherers; (3) that there are two classes of substances, positive and negative, which exhibit opposite variations of conductivity under the action of radiation; (4) that the production of an allotropic modification depends on the intensity and duration of incident electric radiation; (5) that the continuous action of radiation produces oscillatory changes in the molecular structure; (6) that these periodic changes are evidenced by the corresponding electric reversals; (7) that the "fatigue" is due to the presence of the "radiation product"; (8) that by means of mechanical disturbance or heat the radiation product can be transformed into the normal form, and by so doing the sensitiveness may be restored.

It is unfortunate that the behaviour of solids should have suffered unmerited obloquy from the supposed complexity of its structure and the capriciousness of its properties in comparison with the ideal properties of matter in the gaseous state. It is true that we have much show of activity in a gas, which consists in the somewhat aimless rushings to and fro of vagrant molecules and diversions in frequent encounters with others similarly disposed. But it is not true that in a solid we have the particles merely in a state of monotonous vibration. On the contrary, there is always a definite, well-directioned activity modified in perfect response to all the external stimuli, which may be mechanical, thermal, or electric. There is no caprice; the solid behaves like a perfect automaton. The curves given above show it; but they cannot give any idea of the richness and variety of the phenomena—of the transitory variations, of the curious molecular hesitation at critical times as to the choice of the structure to be adopted. It is not possible to represent by mere diagrams how at times the ether waves precipitate the transformation of one structure to another; and how, owing to the molecular inertia, the new structure is carried beyond the position of stability; and how the molecules slowly creep back, as it were, to the more stable position. The varieties of phenomena are unlimited, for we have in each substance to take account of the peculiarity of its chemical nature, the nature of its response to ether waves, the lag, and the molecular viscosity. All these combined give to each substance its peculiar characteristic curve. Some of the types have been given. It may be that in a humbler way these curves of substances in the solid state will some day be found to give information as to the chemical nature and the physical condition of the substance, similar to the information given by spectrum analysis of substances in the gaseous state. I am trying to arrange an apparatus which will, by means of the pulsating galvanometer spot of light, automatically record the history of the molecular conflict and transformation caused by various external agencies.

Before concluding I wish to say that the successes in the experiments have been comparatively few and the failures many. At every stage anomalies have been constantly met with, and these were extremely disheartening. I could not have persevered but for the encouragement I received from the Royal Society and others who have taken a kindly interest in my work. The Government of Bengal has been pleased to evince a generous interest in these investigations. My assistant, Mr. Jagadindu Ray, and my pupils, Messrs. B. C. Sen, B.A., and P. K. Sen, B.A., have rendered me active assistance.

Rail Returns in Chicago.—According to the *Western Electrician* of Chicago, Mr. E. B. Ellicott, the Chicago city electrician, after carefully studying the electrolysis problem and making a series of tests and experiments, has recommended that railway companies in Chicago be required to maintain a return circuit of such conductivity that the potential difference between any point of the return circuit and the water pipes shall not exceed one volt, and also that the variation of potential between any two points on the line, 300ft. apart, shall not exceed half a volt. It is interesting to compare this recommendation with the Board of Trade regulations. According to them, the conditions which must be fulfilled in this country are: (*a*) The P.D. between any point on the return rail and neighbouring pipes, must not exceed the E.M.F. of three cells, or one cell (Leclanché type), according as the direction of the current is from the return to the pipe or from the pipe to the return respectively; and (*b*) the P.D. between any two points of the return must never exceed 7 volts.

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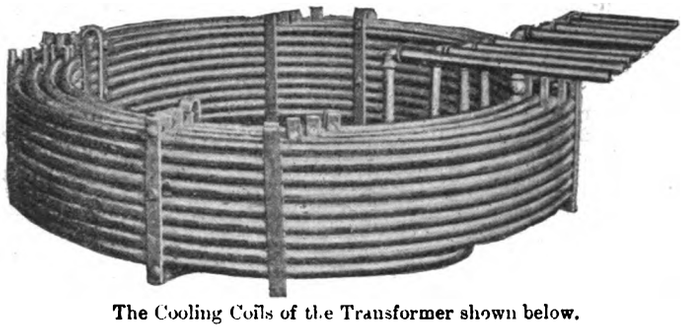
POLYPHASE DEVELOPMENTS AT NIAGARA.*†

BY J. E. WOODBRIDGE.

(*Continued from page 620*).

The 2,500 H.P. Step-up Transformers.—On account of the size of the transformers used in this installation, which are not only the largest in the world, but twice as large as any previously built, and on account of the interesting features of their construction, they will be described somewhat in detail.

The Westinghouse raising transformers, the interior of one of which is shown in Fig. 4, are of the regulation shell type, with the



The Cooling Coils of the Transformer shown below.

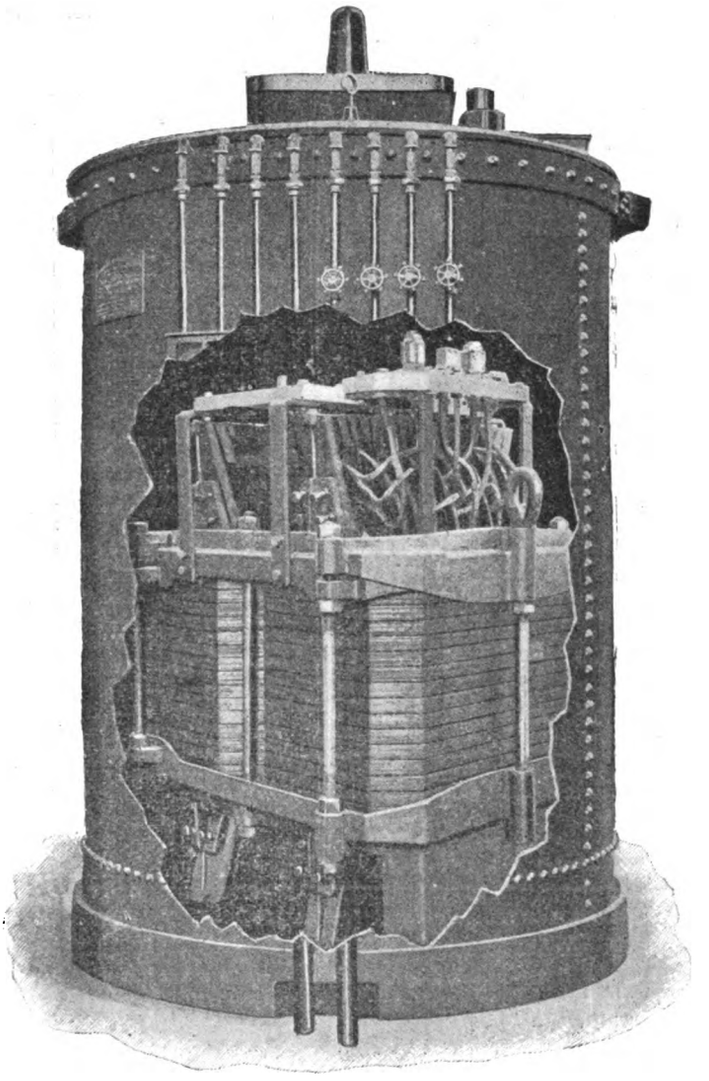


FIG. 4.—One of the 2,500 H.P. Step-up Transformers, with the case indicated as broken away to show the interior.

ends of the coils at the top and bottom of the transformer spread apart to obtain a greater exposure of cooling surface to the oil. The surface of iron exposed to the oil is also increased by spacing strips built in at regular intervals as the iron is assembled. The primary and secondary are interleaved to reduce magnetic leakage and thereby improve regulation, and a great many terminals are brought out from both primary and secondary to make it possible to obtain many different transformation ratios. The transformers are designed to take on their low-tension sides either 2,200 or 4,400 volts two-phase, and deliver on their high-tension sides either 4,400, 11,000, or 22,000 volts three-phase. They also have other connections, so that any of these voltages on the high-tension side can be raised 5 per cent.—the primary voltage remaining the same—and still other connections, so that any transformer can be used as either the main or teaser of a Scott-connected pair. As is well known, the secondary voltage of the teaser of such a pair of transformers should be about 13 per cent. less than the secondary voltage of the main. This can be obtained either by winding the secondary with a 13 per cent. smaller number of turns and a correspondingly larger cross section, or by simply cutting out and leaving idle 12 per cent. of the turns. In the case of these transformers neither of these two methods is used, but the secondary voltage is reduced by cutting in more turns on the primary or low-tension side of the teaser than are used in the primary side of the main, all high-tension copper being left in in either case. The density is lower in the teaser owing to its greater number of primary turns. Hence its secondary voltage is lower than that of the main. The 5 per cent. increase of secondary voltage for regulation purposes is obtained in a similar way—*i.e.*, by cutting out 5 per cent. of the turns of the primary side, and thereby increasing the density and the E.M.F. per turn at the same impressed voltage.

There are 600 turns in the high-tension side of each transformer connected in six separate circuits running from the terminal board within the transformer casing, the middle of each circuit being also tapped out to the terminal board. Four of these circuits have 120 turns each, while two of them have only 60 turns each. These 600 turns are connected all in series for 22,000 volts, two in parallel and 300 in series for 11,000 volts, and five in parallel and 120 in series for 4,400 volts. In all cases the middle point of each parallel path through the transformer must be brought out for connection to the teaser when the transformer is used as a main.

The low-tension side of each transformer contains altogether 272 turns connected throughout in two parallel paths. For 4,400 volt supply these two double paths are connected in series, but for 2 200 volt supply they are connected in parallel. For normal ratios of transformation all the secondary turns are used, while to obtain the 5 per cent. increase the three-turn sections are cut out. When the transformer is used as a main the eight-turn sections are cut out, while for use as a teaser these eight-turn sections are cut in, thereby reducing the E.M.F. per turn, and in consequence the secondary pressure to the proper value for the teaser side of the Scott connection. One incoming lead to the spare transformer is connected through a throw-over switch, mounted on the transformer case, so connected that when the switch is closed in one position the whole number of primary turns are cut in, while when closed in the other position the proper number are cut out to change the transformer to a main.

The regulation of these transformers is 1 per cent.—*i.e.*, the secondary pressure only falls off 1 per cent. on the application of full non-inductive load from the pressure at no load, the voltage applied remaining the same. When working at 11,000 volts secondary this drop of voltage amounts to about 110 volts. Efficiency and loss curves from measurements made by the Westinghouse Co. are shown in Fig. 5. These curves are the average of two transformers connected up just as they are in practice to change from two phases to three phases. They include, therefore, the increased copper loss in the secondary of the main and the diminished iron and increased primary copper losses of the teaser. The efficiency, therefore, is not quite as high as it would be were the transformers used with the same number of phases on the primaries as upon the secondaries. The weight of a complete transformer without oil is approximately 24,000lb, the oil adding about 5,000lb. to the weight of each transformer.

The Step-down Transformer Sub-Station.—Near the new works of the Union Carbide Co. the Niagara Power Co. has built a small brick structure, about 130ft. by 30ft. in size, for housing its 11,000 volt to 2,200 volt transformers and 2,200 volt receiving and distributing switchboard. The building is served by a hand crane, and a spur from the railroad track enters one end, so that transformers can be lifted from railroad cars direct by the crane. The building now contains seven General Electric transformers, and has foundations for four more, with a temporary wall at one end so that it can be extended. The high-tension leads enter from the conduit through a pit or subway running down one side of the room behind the transformers, and are carried up over and to the transformers in substantial stand-pipes. All connections of both high and low-tension wiring, as well as of the piping around the transformers, are made with unions, so that a transformer can be readily removed or replaced, and the spare transformer or the spare cable can be readily put in service in place of any of the regular apparatus. The incoming cables run direct to the high-tension sides of the transformers, with no intermediate switches, circuit breakers, or other

* Abstract from the *American Electrician*.

† Previous articles appeared in *The Electrician*, Vol. XLII., pp. 565, 600.

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devices. A Quimby screw pump is direct coupled to a small induction motor for use in filling or emptying any one of the transformer cases from a 23-barrel tank of oil.

These transformers differ considerably from those of the same power built by the Westinghouse Co. for stepping-up the voltage at the other end of the line. The coils in these step-down transformers lie in horizontal planes, making the plan of the transformer elliptical, the boiler-iron base being 11ft. high, 8ft. long, and 4ft. wide. The total weight of each transformer, with case, is about 50,000lb, about double that of the step-up transformers The step-down transformers are not wound for 22,000 volts on their high-tension sides, but only for 11,000. The low tension may be either 2,200 or 4,400. Each can be used as either a main or a teaser.

The cooling of the coils in the transformers is accomplished in an entirely novel way. The coils are of the flat, edgewise type, the primaries alternating with the secondaries and with one laid on top of another. Directly between these edgewise layers are inserted flat brass pipes, through which the cooling water is circulated. Other coils of pipe are used as usual to cool the oil, which in turn cools the core. The iron loss of each of these is given by the General Electric Co. as 22,600 watts, the copper loss 8,700 watts, the regulation 0·5 per cent., and the rise of temperature after eight hours' run at full load 45°C. The efficiency curve as given by the company is shown in Fig. 6.

Comparing these curves with those of the step-up transformers (Fig. 5), it will be seen that, although the total losses at full load are about the same, the iron losses of one are over twice those of the other, while the copper losses are correspondingly less. Heavy iron losses cause of course low efficiencies at low loads, but this is a matter of small moment in this service, where the transformers are fully

These transformers are scattered, in order to bring them near the furnaces, which is necessary on account of the low secondary voltage, each being located in a small transformer house built in the form of a lean-to beside the main structure of the carbide works. The transformer houses are designed to give liberal air circulation for cooling purposes. The covers of the transformers themselves, on account of the dusty location, are made absolutely dust proof in all joints. The coils in these transformers lie in vertical planes and the laminations of the core in horizontal planes, the arrangement of the spacing blocks and the plates and clamping bolts being clear from the illustration. The 110 volt secondary comes out of the top of the transformer in a large number of heavy copper straps, to which interleaved leads are bolted for carrying the current to the furnaces. The copper bars forming the leads are interleaved—*i.e.*, those of one polarity are interspersed between those of the other polarity—in order to reduce the self-induction and particularly the skin effect, which would be very serious were this amount of current (between 13 000 and 14,000 amperes) carried with all the conductors of one polarity in one group and all the conductors of the other polarity in another group.

The transformers are wound for a voltage ratio of 4,400 or 2,200 volts to 220 or 110 volts. In actual practice the windings are connected for a ratio of 2,200 to 110. The parts are guaranteed to withstand an insulation test of 10,000 volts alternating between high-tension coils and iron, and 5,000 volts between the core and the containing case. Tests under these pressures were made on each of the transformers after it had been operating continuously for 24 consecutive hours, the duration of the tests being 30 minutes on each transformer. Each transformer is further built to withstand an overload of 50 per cent. without deleterious effects of any sort for a

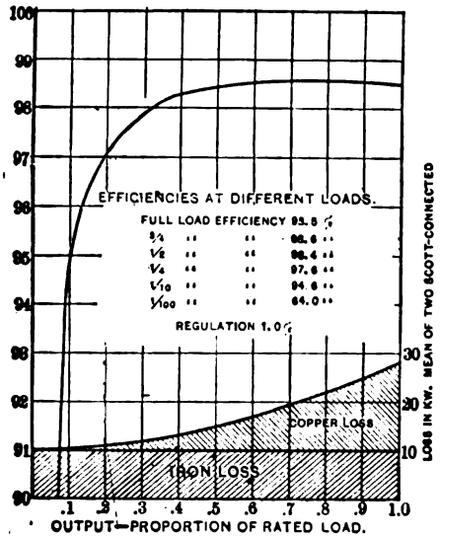

Fig. 5.—Westinghouse.

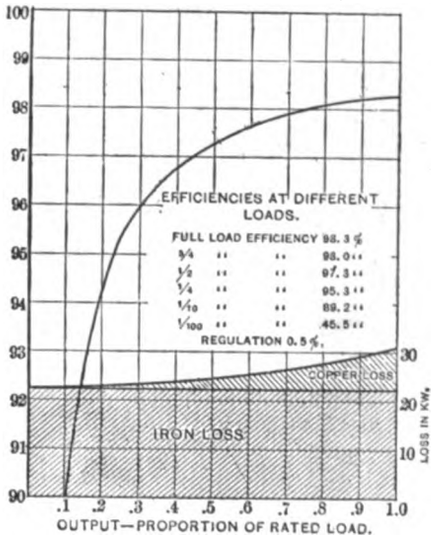

Fig. 6.—General Electric.

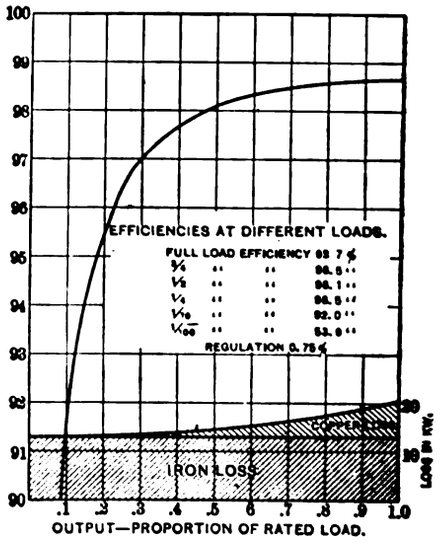

Fig. 7.—Wagner.

Efficiency and Loss Curves of the Three Makes of Transformers used on the Carbide Transmission.

loaded or out of service. The low copper loss and extremely close regulation of the General Electric transformers indicate that there is a small amount of copper in them, but their great weight shows that any saving in cost of copper is balanced by cost of iron.

The secondary circuits of these transformers lead to two similar switchboards, containing an odd assemblage of General Electric, Wagner, and Westinghouse apparatus. The central panel contains the incoming switches from four of the transformers just described. Flanking it on either side are distribution panels leading to the 2,000 H.P. transformers scattered about the carbide works for lowering the pressure to 110 volts. Each panel is fitted with a voltmeter and ammeter, two switches and a Westinghouse brush type circuit breaker.

The 2,000 H.P. 2,200 Volt to 110 Volt Transformers.—The transformers which still further lower the pressure to that required by the carbide furnaces are somewhat smaller than the step-up and step-down transformers mentioned above, being rated at 1,500 kw. or 2,000 H.P. each, while the transformers already described are rated at 1,875 kw. or 2,500 H.P. each. The 2,000 H.P. transformers were built by the Wagner Electric and Manufacturing Co. Like the others described above, they are oil-insulated and water-cooled, and are guaranteed to operate continuously at three-quarters load without the use of the water coils, dissipating all the losses by the cooling of the boiler-iron case with a rise of temperature not to exceed 40 C. They are guaranteed to run under full load with a water flow of three gallons per minute with the same rise of temperature above atmosphere.

period of 5 minutes. All transformers were subjected to a 30-day duty test prior to their acceptance by the Carbide Co., and complete electrical tests were made at the carbide plant. The loss and efficiency results obtained from these tests are plotted in Fig. 7, the curves and figures given being the mean results of seven transformers calculated from an iron loss obtained in the usual way and copper loss obtained by wattmeter measurements.

An interesting point in connection with the tests made at the Wagner factory in St. Louis and the tests at Niagara Falls is the fact that the former showed an iron loss about 1½ kw. less than the latter. This is due to the use of a smooth-body generator in the former test, which generates a sinusoidal E.M.F. wave giving a lower iron loss than the flat-topped wave of the Niagara generators.

A few of the details of construction of these transformers are of interest. A requirement of the water-cooling coils is that they should be absolutely free of any risk of leakage, since the leakage of water into the oil of the transformer would of course cause a breakdown of the insulation. The water-cooling coils of these transformers are of seamless copper tubing, sufficient to withstand a pressure of 325lb., but subjected by the Wagner Co. to a test pressure of 625lb. before shipment to the carbide plant. These cooling coils are made with welded joints inside the transformer case, and as the pressure is only a trifle above atmosphere, they can be depended upon to be absolutely free from leaks Each transformer is equipped with an oil gauge for indicating the level of the oil, and each oil gauge has enclosed within it a thermometer which indicates the temperature of the oil at the upper surface of the oil body.

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The 110 volt secondary comes out in a large number of heavy copper straps to which interleaved leads can be bolted for carrying the current to the furnaces. The power is metered at the primary terminals of these final transformers by ordinary integrating meters mounted in the transformer rooms. The primary circuits in the same location also contain water switches for cutting off the power in case of emergency. A water switch consists of a metal pail or tank filled with water, and a cast-iron rod which can be lowered into it. This arrangement is shunted by an ordinary knife switch to obtain good contact. In operation the knife switch is first opened, throwing the current through the rod and water. The rod is then raised, throwing the water into the path of the current and finally drawing an arc between the surface of the water and the lower end of the rod. If the water is of sufficiently high resistance, the power is cut off gradually as the rod is raised, so that there is but little arc when the circuit is finally broken. This arrangement is a highly effective one, as the arc finds little to feed upon with water as one electrode, and is not injurious to either terminal.

A 37,500 ampere Transformer.—Mr. E. G. Acheson, the discoverer and founder of the electrical process for making carborundum, has been at work developing an electrical process for making graphite from amorphous carbon or coke. A small plant containing one furnace has been built on the property of the Niagara Power Co., adjoining the carborundum works, an interesting feature of this plant being the transformer which lowers the voltage to that required by the furnace. Owing to the low resistance of both the raw material and the finished product, this pressure is very low, varying from 12 to 30 volts. On this account the transformer, which is rated at 450 kw., bears the distinction of delivering the largest quantity of electrical current of any single machine the world over. The transformer is designed to deliver its full rated power of 450 kw. at either 30 volts, 12 volts, or any one of a number of intermediate steps, the rated secondary current therefore being inversely proportional to the secondary pressure. At 12 volts the current required to deliver 450 kw. amounts to 37,500 amperes.

The transformer is of the usual oil-insulated and water-cooled type, cased in a boiler-iron tank about 64in. in diameter and 6ft. high. Its secondary circuit naturally consists of a single turn of very massive copper bars, and these run out through the top of the transformer to heavy leads, which run through the wall to the furnace on the other side. These leads consist of 16 copper bars, eight for each pole, the bars of the two polarities being interlaced to reduce the inductive effect: each bar is 6in. by $\frac{7}{16}$in. in cross section. By means of the interlacing the power factor, as measured on the primary, has been brought up to about 85 per cent., which is quite an achievement considering the fact that the circuit carrying this enormous current at a very low voltage must embrace a considerable area for inductive action at the furnace itself, no matter how carefully the leads thereto may be interlaced.

Another interesting feature of this plant is the means of varying the secondary pressure from 30 to 12 volts, or *vice versâ*. Naturally, the secondary circuit itself is not subject to any manipulation in the way of changes of connections, and all alterations must be carried on in the primary or 2,200 volt side. The voltage of the secondary is varied by changing the number of primary turns in circuit across the 2,200 volt line, this variation changing the E.M.F. per turn within the transformer by changing the density of the alternating magnetic field set up in the iron. This change of density naturally changes proportionally the voltage set up in the one secondary turn. Without any interruption of the circuit the variation of the number of primary turns is made by means of switches and a very simple arrangement of preventive resistances, which was made available by reason of the fact that the load is constant. The total number of steps from maximum to minimum turns in the primary is 20, 11 of these being running steps on which the transformer may be worked for any length of time, and the other nine merely intermediate change-over steps connected through resistances which are not supposed to carry the load permanently.

The switches are of a quick-break type, designed to handle the large primary current. They appear projecting from cells on the front of the switchboard. They are not fitted with handles, but simply have holes in which a hook on the end of a wooden pole may be inserted. The resistances used are of an iron-clad type, similar to street railway diverters. The whole installation was made by the Westinghouse Electric and Manufacturing Co.

The transformer works at approximately constant loss and constant efficiency over its considerable range of voltage. This is due to the fact that as the number of turns is reduced the copper loss in both the primary and secondary is reduced, but the iron loss is increased, and *vice versâ*, thus giving no considerable variation of the total loss. Since the total power continues constant, the efficiency remains nearly the same throughout the range of work of the transformer.

(To be continued.)

THE STANDARDISATION OF ELECTRICAL ENGINEERING PLANT.

The following is a continuation of our abstract of the discussion at the Institution of Electrical Engineers in connection with Mr. R. Percy Sellon's Paper on the above subject. The Paper was published in our issue of Feb. 9th, and the first portion of the discussion in our issue of Feb. 16th.

Thursday, February 8 (continued from p. 595).

Mr. MARK ROBINSON said that if he ventured to add a few words to this discussion, it was only because he had given a great many years to the work of trying to standardise on one particular branch of manufacture, and, he thought, with a good deal of success. Without going into personal questions, it was perhaps worth while saying that when 18 or 19 years ago certain works which he had in view were started for making engines for small steam launches, he well remembered that when the first order came along for a 4 H.P. engine it was decided to build half a dozen, hoping that the other five would find favour; and they did. This custom had not been departed from. He thought it perhaps well that he should offer a few words of encouragement to Mr. Sellon's object, because as Mr. Crompton had well said, there was really nothing to criticise in the Paper, and he would therefore go on to say that in the works in question the standardisation was certainly carried out not less perfectly than in any American shop, and its course had never been interfered with by anyone. He was not sure that the consulting engineer was as bad as he was painted. Sometimes he specified for somebody else's engine—which was quite wrong—but if he did not do that he left the thing very clearly open. He specified the speed of his engine sometimes, and perhaps he would have nothing to do with a high-speed engine; but in any case he made his meaning clear. He took it that this was due to increased faith in the people who made such things, and who really did know their own minds and had shown to the consulting engineer that they had knowledge and experience. He believed that if his electrical friends would attack the problem with the same determination and the same courage, matters would very soon eventuate as they wished. As a further instance of the extent to which standardisation had been carried by his firm, he mentioned that about two or three years ago a 1,200 H.P. engine had been ordered, and this was a very large advance upon anything which had been done before. In pursuance of their previous practice, a much larger sum than the price of that engine was at once spent upon standard jigs, templates, &c., in the full faith that this amount would come back again. It was really an experiment whether the size was not too big, but they believed it was not: and what was the result? Before that engine was ready to go out of the place there were 18 or 20 others on order, and the jigs and templates, which ensured that all parts should be interchangeable with all its successors, were abundantly paid for over and over again. Mr. Blackburn had referred to the matter of engine speeds, and also had stated that the engine builders might help the dynamo makers. Well, if the dynamo makers would only express a wish or work out a table of speeds, he had not the least doubt that the engine makers would keep to them directly. Referring to Mr. Raworth's statement, that even when the parts were standardised it was so easy to upset them and get off the standard, he said he did not think there was any difficulty in so organising the duties of draughtsmen and other people about a works that changes were not made, and that when they were made intentionally the makers should keep duplicates of everything ordered for the benefit of users of these parts.

Mr. ROBERT HAMMOND said the most amusing sentence that he found in this Paper was the one which read: "Assuming, then, that the buyer's engineer has come to stay, it would appear that a condition precedent to the standardisation of plant is the standardisation of the buyer's engineer." He belonged to that class of gentlemen who, according to Mr. Sellon, had to be standardised. The most important thing was to get the best plant, and next to that to get it as economically as possible. The proper spending of capital in an industry was manifestly the one great feature round which the success of the industry would turn, and nothing would help the proper spending of capital so much as the standardisation of plant. Mr. Raworth had said that in the early days they all had their ideas about periodicity, and that he and some of his friends were responsible for the 100. He thought that possibly he (Mr. Hammond) was responsible for those curious figures in the table which occasionally appeared as periodicities of 83, 84, 5, 87, 80, 81, and 82. He would like to explain that all these really came off one standard. When these plants were given to engineers in stations, they had found it convenient to run a little faster or a little slower, and so in making up their returns, instead of returning them all as a periodicity of 83 they determined upon these various periods. We had arrived at a time when consulting engineers, who are not so black as they are painted, felt that their greatest task was to see that the buyers had their capital spent ecomically. Mr. Sellon had made one admirable suggestion, and that was to back up the Institution and back up the Uniformity Committee. Of course that Uniformity Committee had perpetrated one bad act: it had said that there should be a periodicity of 50 for lighting and distribution of power on a small scale, and a periodicity of 25 with power transmission schemes; and they went on to say a periodicity of 100 when the converters were in the consumers' houses. They had all begun with converters in the people's houses—transformers on the premises—but of course they very soon found that they had to group them. He agreed with Mr. Sellon that the Uniformity Committee should be assisted by manufacturers—good standardised ones—and also by the user and the user's engineer. Then the buyer would get more economically what he wanted.

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Mr. S. Z. de FERRANTI thought the Paper was full of sound common-sense and much to the point. He was only sorry that the Paper was not read 10 or more years ago, because, according to his mind, a great deal of the evil of non-standardisation had already been perpetrated, and that evil was still here, unfortunately to stay in most cases. Let them look at the alternate-current stations in this country and they would see at once what he meant. There were innumerable periodicities, and if they multiplied these periodicities by the speeds at which it was necessary to run to serve different people's ideas, and again multiply it by the different sizes of plant that it was necessary to supply, they would find the number of different engines and alternate-current plant simply colossal. In fact, it was hard to find many machines of any one type alike, and this was the evil which was already with them. It was very difficult, once a periodicity had been fixed, to make any alteration. In one case he had arranged for 40 ∽ to be raised to 50 ∽ so as to get on to standardisation, but that was only one case in all his experience. He had some time ago, when supplying plant, begged the engineer at that station to change from 100 to 50 because it was the right thing to do and would well pay for the doing. But it had been felt that it was more than could possibly be done, seeing what a large proportion 500 H.P. was of their output. It was not done, and now that 500 H.P. plant was the only one of that time remaining in that station. All the other machines of that periodicity had disappeared, and now that large station was thinking of going in for continuous-current distribution fed by polyphase current outside the town. He felt sure that such a change would not have been necessary had the change he recommended been made, or, in other words, had a known standard existed at an earlier date. In America they had a periodicity of 120 and kept to it. A little later on it was found that this was far too high a periodicity to satisfactorily build machines for, because it was largely a question of mechanical design, and that periodicity of 120 was then halved. So that the Americans had for ordinary alternate-current lighting work a standard periodicity of 60 ∽. He had heard a very curious thing stated in an argument—viz., that it was not in all cases the best thing to do to standardise the voltage. In this argument some one had remarked why the voltage was settled at 105 instead of 100 or 110, both of which had been previously looked upon as standard voltages, and the explanation had been given that it enabled that station to use what were practically the spoilt lamps of the other two voltages. The argument was certainly a very good one, but it was an argument of selfishness; and this selfishness was largely at the bottom of all the trouble at present in the matter of standardisation. He had even been asked, when he had been trying to get a standard periodicity fixed upon, what difference did it make to the engineer, and how would he be any better off? But those who argued thus did not appreciate the reduction in cost which followed upon standardisation. With regard to the question of the consulting engineer, and what the consulting engineer should do, he noticed that Mr. Sellon stated very clearly his views on this, and he agreed very thoroughly with them. He would like to suggest respectfully to the Institution that the very function of the consulting engineer was to fully appreciate the scheme he was carrying out, and having appreciated that scheme, to clearly lay down the ends which he desired to accomplish, and to leave the manufacturers to tender the machines which they think best fit in with their standards, and which they thought best fitted the conditions which that consulting engineer desired to accomplish. Then the consulting engineer's great work came in, of sitting in judgment on behalf of the clients on the various offers made under his requirements, and telling his clients what would pay them best to buy.

On the motion of Major-General WEBBER, the discussion was then adjourned until the 22nd inst.

Thursday, February 22.

Major-Gen. C. E. WEBBER drew attention to the fact that in America standardisation of plant had been brought about by the circumstances of the demand. For the smaller kind of machinery the standardising of each individual manufacturer held the ground; and for all large units of plant, such as that used for traction purposes, the trade was settling down into an exceptional condition. In the latter case the industry had fallen into the hands of two or three great manufacturing firms, partly because of the large amount of capital at their disposal, and partly because they had bought up or inherited the tail end of master patents which had been established before the courts, and which protected them from infringement during the days when the market was beginning to expand; notably the Westinghouse and General Electric Companies. Competition disappeared, and charges were only kept in check by the public opinion within the industry. The position of these firms was quite different to, say, the numerous makers of smaller articles and specialities who employed three or four hundred workmen, and of whom there were examples in nearly every city of the United States. In the former case the heavy general charges were covered by the vastness of the job, but in the latter case these charges could be kept down to a much smaller percentage by the personal attention of the manufacturer. Thus in the case of the larger units standardisation ensured no benefit to the user. Electrical plant had to be used in combination with other engineering plant. An engineer had to be employed to instal it, and he would cast about amongst the standard stocks of the various manufacturers until he found something suited to his wants. Although his choice was affected by price, he would naturally, for his own reputation's sake, specify adequate quality. The ability of the engineer with such a variety of choice showed itself in the knowledge of and experience with the numerous standards, and not in his cleverness in framing an ideal specification which fitted into none of these standards. The matter, however, became very serious when the export trade was considered. If they took the catalogues of say half-a-dozen well-known makers in 1890, they would find that in speed, type, and price there was small resemblance; yet they were bound to believe that each type was one which the maker commonly believed would successfully compete with other makers. Incandescence lamp dynamos could be procured with reputed maximum outputs of 40 to 50 different sizes. The wants of the user of small size dynamos may have been met by this plethora of types, but it was not advantageous. The Brush Co. was at one time very nearly securing the command of the market with their arc lighting dynamos. Their 60-light series dynamo was in its way an unique machine, and if the field of public lighting of these kingdoms had not been occupied by gas, the Brush system would have gained a strong and permanent footing which would have led to a kind of standardisation of arc lighting plant. A 60-light machine costing £600 would supply 60 arcs in series and cost 1d. per hour per light. It was wrong to look to Government departments as the means by which standardisation could be brought about. Except in departments like the navy, standardisation was very little assisted. For instance, in the matter of projectors, Mr. Crompton could tell them that when he went down to Chatham, where all inventions of this kind were brought before a special committee, and where also, if anywhere, a store of such articles would be kept, he found a series of machines which had been bought for the purpose of consideration and examination by the committee whose business it was to test them for warlike purposes. If they were to bring a projector to a condition of standardisation, in two or three years it would be entirely out of date, and the large stores which might have had the effect of standardising the article for purposes of manufacture would be almost obsolete. Mr. Sellon had not laid before them a copy of any standard specification which he thought would result in securing the "ends and performances." This was most desirable, both in the interests of the market and the buyer. He wished Mr. Sellon would examine the old Admiralty specification issued in the eighties for electrical plant. The best of these specifications were extremely well drawn up, and met standardisation better than anything else at that time. He thought the user, like the Admiralty, must know best what he wanted, and would not be likely to be drawn into a strict system of standardisation which meant high prices.

Mr. W. B. ESSON was of opinion that, in order to have cheapness of production—to give customers the best value for money—it was necessary to have standardisation of a kind and to a much greater extent than at present. But the more the subject was considered the greater became the difficulties in the way of it. Although they might all know exactly what they wanted, there was very considerable diversity of opinion as to the exact manner in which the result was to be attained. The Paper dealt with two distinct kinds of standardisation, but the author had not drawn a very clear line between the two. The first was standardisation between the different firms, and the other was standardisation in the works of particular firms. As regards the first, they had in America and on the Continent apparently no greater agreement than we had in England. With regard to the other kind of standardisation—viz., standardisation inside the works—no doubt this was carried on to a much greater extent in America than here. Nevertheless, in the American machines he had examined from time to time there appeared to be a continuous difference in the pattern. The American manufacturers were fortunate in having such a large demand that they were able to sell a great number of machines of the old type before they altered their pattern. He quite agreed with Mr. Slater Lewis that if electrical engineers in this country, instead of trying to run the whole gamut of electrical apparatus, would confine themselves to one particular thing great economies would be manifested. But the fact was that no one firm in this country made enough large machines, or enough small machines, or enough of anything else to keep them going. There were now perhaps six large firms constructing alternate-current apparatus. These firms also constructed direct-current apparatus. The consequence was of course that they were constructing more expensively than if half the firms confined themselves to one class and half to the other class of apparatus. If Mr. Slater Lewis meant to strike the key-note for a combine amongst the larger firms, he was quite with him; but it was only under such conditions that would guarantee all small machines going to one firm, all the dynamos to another firm, alternators to another, arc lamps to another, &c., that this proposition could be carried out; and he (Mr. Esson) believed that this was what it would come to one day in this country. He had never known a consulting engineer who would not accept a good thing out of stock rather than invent a specification for it. To be sure, absurd things were occasionally specified for by consulting engineers; but when they were expostulated with it was generally found that this particular consultant had been bit by some contractor, and that he was obliged to be on the safe side. Neither did he think that consulting engineers generally were very unreasonable. Another thing was that consulting engineers were very useful at times. If one happened to be going on the wrong line, the consultant very often put him right by saying that so-and-so on such-and-such an occasion did the same thing, which proved disastrous, and that they had better steer clear of it. He thought there were very great difficulties in specifying the ends to be obtained without, to some extent, providing the means, because in providing the means they thereby got the very guarantee they required as to the fulfilment of the ends for a long time. Take for example such a thing as the insulation of a machine. The machine was to run at, say, 440 volts. The engineers would say that the means by which this running was to be obtained were that the insulation should be such as to stand an alternate pressure say of 1,000 volts for an hour or half an hour. In that the engineer had a guarantee that the machine would go on running for a long period without breaking down. He knew a specification in which a 440 volt machine was specified to stand 5,000 volts for an hour. He did not know that it was ever forced, but such was the specification. Of course it was out of all reason, but an explanation had been given that they thought it would be on the safe side. He took it that Mr. Sellon desired to call attention, not so much to standardisation of small isolated plants as medium-sized plants for central lighting and traction stations. But there was very great difficulty in this, because of the different lines of engines made by the engine makers. For instance, they had three-crank engines, others preferred two crank engines;

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some had triple expansion, some had compound, and so on; and the consequence was that it was really of very little use trying to standardise such a thing as steam pressure and pressure of supply and pressure of generation until there was some sort of uniformity amongst the engine makers. That they would decrease the difficulties if they made both dynamos and engines was a different matter, but in this country the dynamo makers generally had to purchase their engines, and on the other hand the engine makers had to purchase dynamos. It was a much less expensive thing to adapt a dynamo to suit an engine than an engine to suit a dynamo, because engine patterns were very much more expensive than dynamo patterns. He thought they were beginning at the wrong end and beginning badly. By fixing a hard and fast rule for the frequency they were necessitating the alteration of their patterns for every size and speed of engines. In America the driving of large alternators by belts or ropes was very much more prevalent than it was over here, and a uniform frequency in America therefore only meant a different size of pulley. In Switzerland turbines were constructed to suit the machine, and it was a matter of fact that turbines were altered with very little expense, so that the uniformity of frequency there imposed no disadvantages. But with us it was quite different, and under present conditions the fixing of the frequency at any particular value would impose no end of trouble on the manufacturer. The Uniformity Committee had endeavoured to do this very thing, but he doubted whether they realised exactly what it meant. Within the limits of say within 40 and 60 he thought one frequency was as good as another. He had even worked with a frequency as low as 22, but the circumstances were exceptional. It was significant that firms on the Continent had no hard and fast frequency, the consequence being that alterations to patterns were reduced to a minimum. The patterns, stampings, &c., of a 100 kw. machine came in for a 120 kw. machine driven faster with an increased frequency, no alteration being required to the carcase. According to the Uniformity Committee, the frequency ought not to be altered in consequence. Presumably, when it was realised what this meant, the final recommendations of the committee would be revised. The other day a consulting engineer wrote his firm asking what it would cost to rewind a 1,000 kw. transformer which his firm had supplied for a frequency of 83, as he now proposed to transmit the supply from a distance at a frequency of 50. Of course, they informed this engineer that the transformer required no alteration whatever. If a buyer's engineer realised that a transformer that worked at 40 would work equally well at 60 without any appreciable heating or difference in efficiency, they might be inclined to allow the contractors more latitude. So far as he knew, consulting engineers had never dogmatised about frequency. It was only the manufacturers who had done this, and the officials of Mr. Sellon's company worst of all. The consulting engineer, seeing the utter want of uniformity amongst manufacturers, and knowing that the mean frequency for most new stations was about 50 nowadays, specified accordingly; but he was sure the consulting engineer did not care what the frequency was, provided it was within such limits as did not interfere with the efficiency of the apparatus. Mr. Raworth had compared the differences in frequency to the differences in railway gauge; but surely there was never such a misleading analogy. The reason why uniformity of railway gauge was of such paramount importance was because of through traffic, to which they had nothing analogous yet in electrical distribution. They never had a request from Edinburgh for a supply from Newcastle. With regard to motors, it was very easy to modify the stator winding for a different frequency, and the matter was scarcely worth considering. Let them be very careful to standardise the right things. Fixing the frequency defeated the object in view. Rather let the manufacturer be given as large a selection of frequencies as circumstances would permit, and be allowed to suggest the one which best suited his patterns. They wanted reformation having as its basis something practical, and not something which had merely an academical value, as, he thought, frequency had.

Mr. SYDNEY EVERSHED thought that in attempting to standardise the consulting engineer Mr. Sellon, and those who agreed with him, were entering on a task much more formidable than they imagined. The buyer's engineer was one of the many instances of the temperament which was growing in Great Britain. Formerly we were quite content, and all our rulers were quite content, to let new industries struggle to their feet just as they could; but in these days no new industry could possibly start without one hundred and one suggestions and rules and regulations and Acts of Parliament, &c., being bound upon this new industry, attempting to regulate it in every possible and many impossible ways. If they took one of their own members and put him into a position of authority as consultant or anything else, he felt obliged to form a little Act of Parliament of his own; and he thought that until Mr. Sellon could show some way of altering the temperament of the average Englishman, he was afraid they would have to put up with the unstandardised consulting engineer. But they might do some good in spite of this, and, when they had begun to do good, the consulting engineer would help them. In his opinion the right word fell from Mr. Blackburn when he said that something could be done by beginning at home. It was true that what Mr. Esson had just said was rather disheartening, but something in the nature of a combination among manufacturers to settle the sizes or types of machine for different sizes of cable, &c., might go a long way towards cheapening production, because each manufacturer would know what sizes he was to make. Mr. Robinson rather capped the remarks of Mr. Blackburn, but he thought most of them had rather discounted his remarks to some extent, because he always spoke to them in a cheerful optimism; and they knew that the difficulties of standardising the Willans engine would have been greater if this had not been a very splendid machine, which commanded the market from the very moment it was placed upon it. In his own humble way he had been attempting standardisation in a certain branch of electrical manufacturing—viz., instruments—but his experience had been disheartening. Consulting engineers very rarely specified impossible dynamos, but in the matter of instruments the consulting engineer seemed to think anything possible. One eminent consulting engineer had specified for some device to be added to an instrument to show which way the current was flowing, but that this device should not contain a permanent magnet. On another occasion a consulting engineer had specified for an instrument with a scale 10in. long, which was to be capable of being read to within 2 per cent. at any part of the scale from zero to the end of it. Consulting engineers not only specified as to the accuracy of an instrument—and when the right time came he should certainly have some suggestions to make with regard to the standardisation of specifications as to accuracy—but they specified how the instrument maker should make his instrument. They never told a dynamo maker to make his dynamo so that it could be bolted to the ceiling, but they thought nothing of saying that an instrument should stand on its terminals—the worst possible manner of fixing an instrument. He had actually to supply instruments which were sitting on their terminals; he did it, but he protested against it. Edgewise instruments were specially designed to take up as little transverse space on the switchboard as possible, and yet one engineer had stated that he did not want to put them edgewise, but was going to make a hole in the switchboard and put the instrument through at the back. The cost of alterations to an instrument was a far larger proportion of the total cost of the instrument than in the case of dynamos. It might cost as much as £50 in a £6 instrument to get out sets of patterns to meet a new specification. No dynamo maker in selling a dynamo for £1,000 had to spend £2,000 for new patterns when he only got an order for a couple of machines. He was of opinion that manufacturers by meeting together and forming, not actually a combination, but a committee to settle such points as types, accuracy, &c., would do an immense amount of good; but he did think that the whole problem of standardisation was a far larger one than perhaps Mr. Sellon imagined.

Mr. L. ANDREWS said that at Hastings they had a periodicity of 100 ∿ per second, and after hearing the discussion on this Paper at the previous meeting he had gone away with the idea that he ought to recommend his committee to scrap all their existing machines and change over to 50 ∿ per second. However, on thinking the matter over, he had come to the conclusion that this was an impossible thing to do. In discussing the matter with his chairman he had pointed out that if a periodicity of 50 became the standard it would probably pay them in the long run to change, because they would be able to get their machines cheaper, and further suggested that it would cost much less to change at once than in two or three years' time. But his chairman was of the opinion that if they went to the ratepayers and asked for a large sum of money to buy new plant to replace the present, it would only have the effect of shaking the ratepayers' confidence in the electrical undertaking. He quite agreed with Mr. Sellon that engineers should state more clearly the ends or performance they required from the plant, rather than to give details of construction, but he thought at the same time that if certain constructional details were not to be insisted upon, the manufacturer should take a greater responsibility as to the ultimate behaviour of the plant. At present it appeared that some manufacturers thought they should be left to determine how the plant should be designed, and that it should be handed over to the station engineer, who would take the entire responsibility of its turning out all right. He did not think it fair to blame either the user's or buyer's engineer for the present lack of uniformity. Since its commencement 18 years ago up to the year 1890 the Hastings Co. was supplying current to its consumers on the Brush series system. They had then been told by the manufacturers that if they wished to keep pace with the times they must scrap their plant and go in for the up-to-date standard alternate parallel system and supply at 100 ∿ per second. They had done this, and now they were told they should change again.

(To be continued).

BOOKS RECEIVED.

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"Marquetry." By C. J. Lock and C. G. Leland. (London: Dawbarn and Ward.) 6d.

Annual Catalogue (1899-1900) of the Massachusetts Institute of Technology. (Boston: Rockwell and Churchill Press.)

The Practical Electrician's Pocket Book for 1900. Edited by H. T. Crewe. (London: S. Rentall and Co.) 1s.

"Kinematics of Machinery." By J. H. Barr. (New York: John Wiley and Sons.) $2.50.

"*Proceedings* of the Royal Society." No. 424. Vol. LXVI. (London: Harrison and Sons.) 2s.

"Church Decoration (Permanent)." Edited by H. Snowden Ward. (London: Dawbarn and Ward.) 6d.

"Problèmes sur l'Electricité." By Robert Weber. 3rd edition. (Paris: Libraire Polytechnique). 6fr.

Alphabetical Lists of United States Patentees, and Inventions for the Quarter ending September 30, 1899. (Washington: Government Printing Office.)

The Official Gazette of the United States Patent Office. Nos. 4, 5, 6, and 7, Vol. XC. Published by authority of Congress. (Washington: Government Printing Office.)

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The Oldest Electrical Journal (established as a weekly Journal 1861—1878

Published every Friday, Price Sixpence; Post Free, Sixpence-Halfpenny.
Editorial, Publishing and Printing Offices,

1, 2 & 3, SALISBURY COURT, FLEET ST., LONDON,

Telephone: 949 Holborn. *Telegrams:* "Electrician Newspaper London."

All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher "The Electrician," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "The Electrician" *Printing and Publishing Company, Limited, and be crossed "Coutts and Co."*

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ELECTRIC TRACTION CURRENTS AND SUBMARINE CABLE WORKING.

We print in another column an interesting and important Paper, which has been communicated to the Institution of Engineers and Shipbuilders in Scotland by Prof. Andrew Jamieson, on the subject of "The Action of Electric Tramway Currents on Submarine Telegraph Cables and other Electric Circuits." The subject matter of the Paper is not only of extreme interest and importance to submarine cable companies and their engineers, but also to the Government and indirectly to the general public. The gradual extension of electric tramways in all parts of the world renders it imperative that the disturbances they may produce in neighbouring cables and other telegraph and telephone lines should be thoroughly inquired into and remedied. In connection with the cable routes to the Cape mentioned in the first part of Prof. Jamieson's Paper, it may be interesting to note that since it was written a third cable, mentioned as having been partially laid, has now been completed by the laying of the section between Ascension and St. Vincent, thus putting the South African colonies in communication with Great Britain and Europe *viâ* St. Helena, St. Vincent, and onward by the Western Co.'s cables. We understand, however, that Prof. Jamieson is somewhat premature in saying that the new continuing cables from St. Vincent to Madeira and Great Britain are now being manufactured.

In dealing with the subject of the tramway disturbances at the Cape, to which his Paper more particularly refers, Prof. Jamieson remarks that upon his arrival there in August last no perfect remedy for the disturbances had been found by the cable company, although it had undoubtedly advanced a long way towards a practical solution of the difficulty in this particular case by laying out a 10-knot return earth cable in the neighbourhood of and approximately parallel to the main cable. An interesting side point in connection with telegraphic signalling raised by Prof. Jamieson relates to the current from the sending station returning entirely or in part by the cable sheathing. It is questionable if any appreciable part of this current returns to the sending battery by this path, having regard to the infinitely greater resistance it must offer to the passage of the current than that afforded by the earth's mass;

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and Prof. JAMIESON's own experiment of interrupting the sheathing connection at an intermediate station would seem to support this view.

The assumption that direct electromagnetic induction has little to do with the disturbances caused by the tramway currents is no doubt correct, bearing in mind the fact that both the sea and land insulated cable conductors are shielded to a great extent, in one case by the heavy double sheathing of the shore end, and in the other by the cast-iron pipe which encloses the land portion of the cable. In any case such direct induction, if it existed, would tend to cancel out some part of the disturbance due to the secondary induction effects in the core set up by the leakage currents from the tramway rails traversing the sheathing of the cable. These leakage currents are, in Prof. JAMIESON's opinion—an opinion which, we think it may be said, is shared by all who have studied the subject—responsible for the greater part of the disturbances noticed; and although these disturbances are naturally increased in magnitude when the limits of the fall of potential along the rails as set down by the Board of Trade are exceeded, yet it is important to remember that the delicacy of the receiving apparatus employed on long submarine cables is such that any *fluctuations* of current, even within the prescribed limits, are sufficient to cause serious interference to the received signals. It is natural that in these circumstances tramway companies should be willing to assist the cable companies in every way to devise a remedy; but there seems to be an inherent difficulty in settling these cases which it may be worth while noticing. The tramway companies would be inclined to look upon any outlay incurred by them for the purpose of overcoming the disturbances as final, and as absolving them from any further responsibility, whereas it can be readily understood that the nature and extent of the remedy for each particular case might be a matter of considerable difficulty to decide, and that any future extension of the tramway company's lines with consequent increase of power, to say nothing of faulty bonding, or dirty rails, might render any remedy originally applied ineffectual.

Prof. JAMIESON mentions several previous instances of similar disturbances, notably those at Madras and Coney Island. We may point out, however, that in the former case an earth cable to sea was not laid as he states, but only a parallel underground wire, which was found in this particular case to be sufficient, owing to the fact that, as he indicates, the tramway lines were not nearly so favourably—or should it not be unfavourably?—situated with respect to parallelism to the cables, and that consequently the disturbance was less. At Coney Island the difficulty, we understand, was also practically overcome without having recourse to a sea "earth cable," the disturbances being eliminated by the employment of a second underground wire between the cable house and office in connection with a differential coil arrangement of the receiving apparatus.

In the case of the Cape Town cable, Prof. JAMIESON has recommended in his Paper the adoption of two or three knots of anti inductive shore end made with twin *twisted* cores one of which should be joined to the core of the main cable at sea and the other to the outer sheathing of the same, the joint being sealed from the sea water. For facility of manufacture it would undoubtedly be best to employ twisted cores, but as a matter of interest it may be noted that Mr. H. D. WILKINSON has proved that parallel cores are equally efficacious. Judging from the experience of the cable company at Cape Town, the length of anti-inductive shore end suggested by Prof. JAMIESON would seem to be insufficient; also, apart from the difficulty of making a thoroughly satisfactory sealed joint between the second core and the sheathing, there is a serious objection to this joint being situated at sea, for the reason that there would be no means, without lifting the cable, of testing the dielectric resistance of the second core when necessary. Again it should be borne in mind that the development of a fault in it, even of such a resistance as to inappreciably affect its K.R. value, would undoubtedly admit of direct *conduction effects* from the tramway currents, and thus discount the value of the special shore end as an anti-inductive cable until such time as the fault was removed. For these reasons the cable company, we understand, has very wisely and necessarily insisted that the Cape tramway company should carry an anti-inductive shore end much farther out than the distance recommended by Prof. JAMIESON—*i.e.*, to Robben Island, some ten miles seawards from the cable hut at Cape Town, so that an earth should be secured beyond the influence of the disturbing tramway leakage currents, and the several cores would be under its immediate control for purposes of testing when required. This would probably prove entirely efficacious under present conditions As we have already pointed out, however, the question is one of the very greatest importance, affecting, as it does, telegraphic communication between distant parts of the world. The regulations laid down by the Board of Trade for governing the procedure of tramway companies were obviously not framed with a view to protecting the working of submarine cables, and recent experience has shown that these regulations may be obeyed and yet that serious damage may accrue to telegraphic communication. It seems therefore that the time has arrived for a further consideration of the matter by the proper authorities, so that such regulations may be enforced as will ensure mutual, fair, and proper protection to the great interests involved.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

New Phenomena of Electro-Deposition.—In the course of his researches on the formation of conducting chains in liquids, T. Tommasina discovered some curious properties of electro-deposits in distilled water which may shed some light on electro-deposition and electrolysis generally. When a current of less than a milliampere is sent from a pointed anode to a flat cathode, both of zinc, flat triangular and rhombic crystals are rapidly deposited upon the cathode. They are very small, but of brilliant metallic lustre, and their deposition is unaccompanied by the evolution of gas. Copper gives a black arborescent deposit, while silver gives an arborescent deposit of less intense metallic lustre than zinc. Aluminium, strange to say, gives no visible metallic deposit, but an arborescent structure of gas bubbles is formed which may possibly contain minutely subdivided aluminium. When the distance between the electrodes is increased beyond a certain point, a fine column of minute crystals or corpuscles descends from the anode upon the cathode. This is especially noticeable in vaseline oil. A remarkable property of this column is that it is flexible, and that it is deflected in a direction which does not change with a reversal of the current. It is deflected away from the rest of the circuit, owing to electrodynamic repulsion. The experiments have an important bearing upon the osmotic theory of the electrolytic cell.

[T. TOMMASINA, *Comptes Rendus*, Feb. 5, 1900.]

Generalised Cathode Rays.—G. Sagnac endeavours to bridge the gap between ionised air molecules and cathode rays by the following consideratiens: Let the gold leaf of an electroscope be charged positively, and let the electroscope be divided by a metallic net from a space traversed by X-rays and placed under the influence of another electrostatic field. Then the discharge of the gold leaf which takes place in the absence of any external field is accelerated or retarded, accordingly

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as the external and internal fields are of the same or of opposite directions. This acceleration or retardation is not due to the mere presence of the external field, since that field produces no effect unless the X-rays are traversing it. Hence it must be due to some action of the ionised molecules, which penetrate into the interior of the electroscope through the meshes of the net. If they have sufficient velocity on passing the mesh, they will skip over from an external to an internal line of force, and thus increase or decrease the internal flux which is slowly discharging the gold leaf. We have thus another case of bombardment by charged particles, which, on gradually reducing the pressure of the air and thus increasing their velocity, might be made to pass by insensible gradations into cathode rays. The fall of potential would be localised more and more in the neighbourhood of the cathode during the process.

[G. SAGNAC, *Comptes Rendus*, Feb. 5, 1900.]

Nature of Stratified Discharges.—The temptation to attribute the stratifications observed in vacuum tubes to the interference of some kind of direct and reflected waves has been very great, but the strongest attempt made to establish such an interpretation—that of Jaumann—cannot be said to have been particularly successful. H. Pellat gives some new and decisive reasons for its abandonment. Even in the strongest magnetic fields no separation is effected between the direct and reflected waves, if such there be. There is only one beam, and that is deflected in a direction which changes with the magnetic field. All the same, it is distinctly stratified, and the stratifications are closest where the field is strongest. A still more decisive experiment can be performed with a tube filled with rarefied alcohol vapour and provided with external electrodes. At each interruption of the current feeding the coil there is a charge and a discharge of the condenser formed by the external electrodes, giving rise to currents in opposite directions. In a magnetic field two separate beams appear, and a revolving mirror shows them separated or closer together, according to the direction of rotation, thus proving that they are not simultaneous. On examination, both these beams are found to be stratified. We must also remember that Toepler has proved the stratification of open-air discharges under conditions excluding the reflection of waves.

[H. PELLAT, *Comptes Rendus*, Feb. 5, 1900.]

Spectroscopic Arc Lamp.—The requisites of a good source of light for spectroscopic work are strict monochromatism, definition, and brilliance. Sodium and zirkonium flames are very serviceable, but they are not very brilliant, and the D line of sodium is double. Of interferential methods that of Michelson, which employs a rarefied gas illuminated by an electric discharge, gives remarkably fine lines, but it is limited to a small number of volatile substances, and like all interferential methods, is hampered by the finite width of the lines and the shifting of their centre of gravity by variations of temperature and pressure. The mercury arc yields lines of great intensity, but the temperature developed is too high for continuous use. C. Fabry and A. Perot therefore employ an intermittent form of arc. It plays between two electrodes of the metal to be examined, one of which is provided with a mechanism which brings it into contact with the other and separates it in rapid succession, so as to produce an apparently continuous light. The rays thus produced are exceedingly fine and brilliant. Silver more especially gives two brilliant green rays at 546·55 and 520·91 $\mu\mu$ respectively. For sodium, an alloy may be used.

[FABRY AND PEROT, *Comptes Rendus*, Feb. 12, 1900.]

Dispersion of Becquerel Rays.—Another sheaf of miscellaneous facts concerning Becquerel rays is contributed by H. Becquerel himself. It is gathered from the behaviour of "radium" rays, a kind of Becquerel rays distinguished for their penetrative power and their strong magnetic deflection. To study the absorption more closely by the photographic method, it was found necessary to get rid of the black paper enveloping the photographic plate. This was done by enclosing the radium preparation in a little leaden box open at the top, and placing the box on the plate laid horizontally. A uniform magnetic field was obtained by using pole pieces 10cm. by 14cm., giving a field of 1,742 units. Among the peculiar effects observed, it was found that a screen placed immediately above the radium was less efficacious in intercepting the rays, showing stronger deflection than when it was placed on the sensitive film. The rays all curved round and fell back upon the film. Those which had the longest trajectory had also the greatest penetrative power. This is in direct opposition to S. Curie's observation of polonium rays, which are not deflected at all and yet have a very feeble penetration. A scientific definition of the position of each ray in the "magnetic spectrum" is obtained by taking the product $H\rho$ of the field into its radius of curvature. The product is constant for each ray, and varies from 860 to 2,600 C.G.S. units.

[H. BECQUEREL, *Comptes Rendus*, Feb. 12, 1900]

Phosphorescence of Gases.—Wiedemann has shown that the temperature of a gas showing the ordinary vacuum phenomena is in general below 100deg. He concluded that the luminosity is not a phenomenon of incandescence, but of phosphorescence. This conclusion has since been corroborated, but the experiments are complicated by the fact that the introduction of a hot body in itself reduces the discharge potential and increases the current through the tube. J. Stark introduces white-hot carbon filaments into the tube at various points, and keeps the current constant. If the filament is in the region of positive light, it reduces or extinguishes the light. If it is stratified, the filament cuts pieces out of the bright strata. A short positive column is totally extinguished by the filament. The negative light is enfeebled, but the luminescence of the walls is unaffected, thus showing that the cathode rays are not influenced by the presence of the hot body. The heating simply deprives the gas of its power of phosphorescence under electric charge. We know that a rarefied gas is ionised by heating, and must therefore conclude that an ionised gas does not phosphoresce under the influence of the electric discharge. This, again, indicates that the phosphorescence is a molecular rather than an atomic phenomenon.

[J. STARK, *Ann. der Physik*, No. 2, 1900.]

SPECIFICATION FOR THE GLASGOW CORPORATION TELEPHONE EXCHANGES.

The following is the specification issued by the Postmaster-General as a condition to the telephone licence to be granted to the Glasgow Corporation. If licences are granted to other local authorities, it is to be expected that they will be subject to the work being carried out on the lines of this specification.

1. In this specification the term "subscribers' circuit" is applied to the wires and apparatus connecting a subscriber's office or offices with a telephone exchange; and the term "junction circuit" is applied to the wires and apparatus which connect any two separate exchanges or an exchange and a prescribed post office in the same telephone area.

2. All circuits, whether subscribers' or junction circuits, shall be metallic. Any necessary earth connections shall be made at the centre of balanced resistances of high inductance bridged across the circuit. All circuits shall be so arranged that subscribers shall be unable to overhear what passes on any other than their own circuits or those to which they are joined through.

3. The use of iron conductors in any portion of a speaking circuit shall not be permitted.

4. As a general rule wires in towns shall be laid underground, but the distribution from selected points to subscribers' offices may be either overhead or underground, as may be considered desirable.

5. Should the number of wires required in a given locality be, in the opinion of the Postmaster-General, insufficient to justify the cost of underground work, or should underground wayleaves be unobtainable, such wires may be erected overground.

6. Where wires are placed underground dry-core cables of low static capacity shall be used and the conductors shall fulfil the following conditions:—

The copper to be used shall have a conductivity of not less than 98 per cent. Matthiesson's standard, and shall be of the following minimum dimensions:—

Conductors for subscribers' circuits within half a mile of an exchange shall be not less than No. 22 S.W.G., weighing 12½lb. per mile.

Subscribers' circuits beyond the half mile limit and junction circuits less than five miles in length shall have conductors of a minimum size of No. 20 S.W.G., weighing 20·7lb. per mile.

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Junction circuits in excess of five miles long shall have conductors of No. 18 S.W.G., weighing 36·8lb. to the mile.

7. All lead-covered multiple cables shall be efficiently protected by pipes, ducts, or other means, and lead-covered cables shall not in any case be laid in the soil without such protection.

8. Wires erected overground shall comply with the following conditions :—

They shall be not less than No. 18 S.W.G., weighing 36·8lb. to the mile for subscribers' circuits and for junction circuits less than five miles in length. For junction circuits in excess of five miles long the wires shall weigh not less than 100lb. per mile.

9. A thoroughly efficient method of calling the exchange and of signalling the close of a conversation shall in all cases be provided.

10. The calling and clearing signals shall be effective in all conditions and upon the longest circuits used in an area when connected together.

11. Switch jacks on multiple sections of switchboards shall be on the branching system. Series jacks shall not be used on multiple sections without the consent of the Postmaster-General.

12. When an electric light or electric traction system co-exists in a town with the telephone system, suitable safety devices shall be provided in all circuits both at the exchange and at the subscribers' offices.

13. Lightning guards shall be provided in all circuits at the exchange and at subscribers' offices.

14. Junction circuits connecting municipal exchanges with prescribed post offices shall be provided with automatic signalling arrangements of a character approved by the Postmaster-General and suitable for working in connection with his trunk circuits.

15. Junction circuits connecting municipal exchanges and prescribed post offices shall be fitted and worked in the manner that may be from time to time prescribed by the Postmaster-General.

16. The apparatus fitted at subscribers' offices shall be efficient for trunk circuit communication, and where separate batteries are provided at each subscriber's office for speaking purposes the electromotive force shall not at any time fall below 2 volts.

17. Proposals for the modification of the foregoing specification brought about by the progress of invention will be favourably considered by the Postmaster-General.

THE ACTION OF ELECTRIC TRAMWAY CURRENTS ON SUBMARINE TELEGRAPH CABLES AND OTHER ELECTRIC CIRCUITS.*

BY PROF. ANDREW JAMIESON, F.R.S.E.

Having been asked to give a short account of my visit to Cape Town last year, I have only to mention that the subject of my remarks has to deal with one of the many causes of delay in the transmission of telegrams, in order to ensure your close attention.

Present and Future Cable Routes to the Cape.

By referring to the map, it will be seen that there are at present two telegraph routes to the Cape from this country, the one and the older route being termed the "Eastern and South African," and the other the "West African." Both routes are worked by and have their basis in the first portion of the Eastern Telegraph Co.'s system. Messages for the Cape by the Eastern lines go from London *via* Porthcurno, Lisbon, Gibraltar, Malta, Alexandria, Suez, and Aden, where they branch off down to Zanzibar, Mozambique, Delagoa Bay (Lorenço Marques), and Durban. From thence they are transmitted by the Government land lines to Cape Town, &c. The cables from Aden to Durban were laid in 1879, at the time of the Zulu war, and only one section thereof has since been duplicated —viz, that between Zanzibar and Mozambique, in 1885. I have always been particularly interested in this 1879 cable, since I had to effect the first repair upon it, just south of Mozambique, in the spring of 1880, owing to its having been broken by a submarine earthquake. The West Coast route returns to Great Britain *via* Mossamedes, Loanda, and many other places, such as Lagos, Bathurst, St. Vincent, Madeira, and Lisbon.

With the view of providing additional security to submarine telegraph communication between this country and South Africa, landing rights at Cape Town have been obtained from the Government by the Eastern Telegraph Co. for a third cable. The first section, from Cape Town to St. Helena, was completed on Nov. 26, and a further section to the Island of Ascension on Dec. 16 last year. The continuing cables to be laid to St. Vincent, Madeira, and Great Britain are now being manufactured. It is further expected that this much more direct cable will be extended from the Cape to Australia, and that the tariff will be considerably reduced.

Object of Visiting Cape Town.—At the end of last July I was requested to proceed to Cape Town for the purpose of acting as one of the advisers to the Cape Electric Tramways Co. in an action brought against it by the Eastern Telegraph Co. This action was raised owing to disturbances in the working of the submarine cables landed at Cape Town by the operations of the neighbouring electric tramways. I had an able colleague in Mr. Frank Jacob, the chief electrician and technical adviser to Messrs. Siemens Bros. and Co., of London. On the outward voyage we had the advantage of studying the many bills and Acts of the Cape Parliament relating to telegraphs and tramways, as well as Mr. A. P. Trotter's Paper which was read before the Institution of Electrical Engineers in 1897.* Upon our arrival at Cape Town we found that, although the submarine telegraph and tramway companies have willingly afforded every facility to experts for carrying out numerous and varied experiments, and although the former company had spent considerable sums of money in devising and executing plans for eliminating the vexatious electrical interferences, no perfect system had yet been adopted for thoroughly cancelling the disturbances, and consequently a considerable difficulty was still frequently experienced in deciphering the telegraphic signals.

How Submarine Cable Signal Currents are Transmitted, Received, and Returned to the Sending Station.

Looking at Fig. 1, it will be seen that the + and − electrical impulses which are set free from the sending battery by manipulating the double-current key charge (say + in the first case) the home side of the sending condensers, thereby inducing a − charge from the other side of the same and from the conductor of the cable. This naturally repels a + charge along the conductor of the cable to the receiving end, and charges the cable side of the receiving condensers +, inducing − on the opposite plates of the same, and repelling a + charge through the delicate Kelvin siphon recorder to the metal sheathing of the shore end. This current, as shown in Fig. 1, finds its way back to the sending station battery, not only along the sheathing of the cable, but also very largely, if not almost entirely, through the sea water and the earth. The splitting up of the return current in this manner is due to the shore ends making intimate electrical contact with the water and earth. Many electricians used to fancy, and even now fancy, that the return current passes back to the sending station *entirely* by the cable sheathing. I have, however, often proved that this is not the case by alternately connecting and separating the sheathing at an intermediate station,

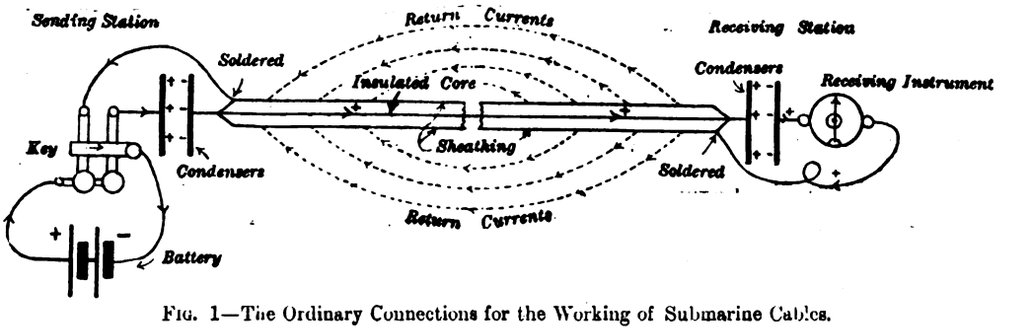

Fig. 1—The Ordinary Connections for the Working of Submarine Cables.

without affecting the strength of the signals at either of the distant ends. It is important to note that the sending and receiving currents act by induction in and from the sending and receiving condensers. These condensers serve the double purpose of cutting off the interfering effects due to "earth currents" and of sharpening or defining the receiving signals (*see* Fig. 2), thus enabling a greater speed of working to be attained than would be the case without them.

Relative Positions of the Submarine Cables and Electric Tramways Lines, &c., at Cape Town.—From Fig. 3 it will be seen that the Cape Town shore end of the main submarine cable to Mossamedes (which was laid in 1889, and is 1,383 nautical miles in length) passes round the south-eastern curve of Table Bay in order to avoid the anchorage. Further, that a part of the electric tramway lines (which are worked on the overhead trolley-wire system with the return circuit through the rails) pass from the power house towards

* Paper communicated to the Institution of Engineers and Shipbuilders in Scotland.

* See *Proceedings* of the Institution of Electrical Engineers, London, Vol. XXVI., p. 501 ; also *The Electrician*, Vol. XXXIX., pp. 81 and 137, for Mr. Trotter's Paper on "Disturbance of Submarine Cable Working by Electric Tramways."

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Wynberg on the one side, as well as to and through Cape Town on the other side, and lie almost parallel to the submarine cable. In fact, the first mile of the shore end is only at a mean distance of about half a mile from the tramway line, whilst the subterranean line from the cable telegraph office along Adderley-street to the cable house, a distance of 430 yards, lies for a certain distance thereof quite close and parallel to the tramway rails. Ever since the opening of the electric tramway service on August 6, 1896, the received signals at Cape Town from Mossamedes, or from Loanda, a further distance of 530 nautical miles, have been seriously interfered with by the working currents of the tramway system. At first the tram-

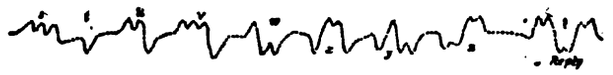

FIG. 2.—Good Siphon Recorder Signals.

way lines only extended from the suburb of Mowbray to the corner of Darling-street and Adderley-street, but now they are in full swing from the power-house to Wynberg, a distance of seven miles to the left, and through Cape Town to Sea Point, a distance of five miles to the right. These extensions, combined with the greatly increased traffic and consequently increased strength of the working currents, have naturally augmented the amount and frequency of the disturbances. The submarine telegraph company, having been unprepared for such disturbances to its receiving signals, had its cables joined up exactly as depicted in Fig. 1. At first the

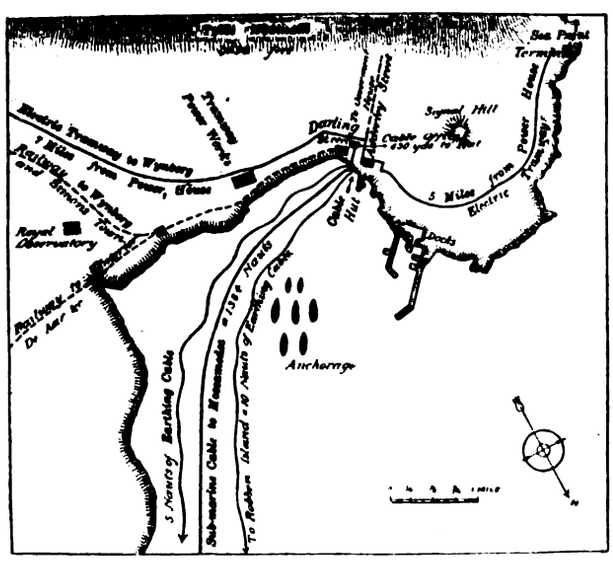

FIG. 3.—Showing Table Bay and Mountain, with Positions of the Submarine Cable to Mossamedes and the Tramway Lines.

company was evidently under the impression that the erratic kicks, vibrations, and splashes produced on the recorder slip, as seen in Fig. 4, were due to the local earth on the shore end being within the range of the stray currents from the tramway rails. Consequently, many "earths" were sought beyond this supposed sphere of action by running land lines, "such as a telephone line to the top of Signal Hill, a telegraph line ending at an earth plate in the sea near Sea Point, an earth at the Observatory 3½ miles from Cape Town, an earth at Durban Road some 12 miles from Cape Town," &c., without finding any reduction in the disturbances. In fact, the ordinary earth of the shore end gave better results than any of these

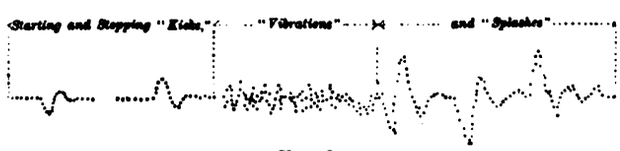

FIG. 4.

land line earths. As these various earths had failed, more definite experiments were tried at night, when it was found that the amplitude of the kicks, shown on the recorder slip, was in proportion to the distance of the experimental car from the power station (but greater when on the Cape Town side), and that the direction of the "kick" was reversed whenever the said car passed from the one to the other side of the power-house. I may here remark that the current required to pass through the coil of Lord Kelvin's siphon recorder, in order to give well-defined receiving signals, is only about from $\frac{1}{20}$th to $\frac{1}{30}$th of a milliampere; and consequently the currents delivered from the tramway power station to any one section of the tramway lines is often ten million times as great as that which creates the disturbances indicated by Fig. 4.

THE VARIOUS PROBABLE ACTIONS OF THE TRAMWAY CURRENTS ON THE SUBMARINE CABLE.

1. *Electrolysis.*—The well-known action of electrolysis on neighbouring underground conductors, such as gas and water pipes, whenever the fall of pressure along the rails exceeds a certain value, may be at once dismissed as having no effect upon the case in question. The underground cast-iron pipe containing the 430 yards of insulated conductor from the cable office to the cable hut never showed any signs of electrolysis, and no such action has been observed as taking place in the sheathing of the submarine cable.

2. *Affecting the Potential of the Earth Connection to the Receiving Instrument.*—At first sight the possible action of erratic stray currents from the tramway system more or less continuously altering the potential of the receiving instrument's earth connection is a fascinating idea to many; and this idea, as will be seen later on, is still entertained by certain cable electricians. But, from the many attempts and failures of the Eastern Telegraph Co. to obtain satisfactory results from a land or a sea "earth" connection placed in various positions and at varying distances up to 12 miles from the receiving instruments, this action may also be dismissed as having no particular bearing upon the disturbances in question.

3. *Direct Electromagnetic Induction.*—Although the well known effect of electromagnetic induction as shown by Fig. 5, and which was first proved and announced by Faraday in 1831, always takes place between a circuit wherein the current is suddenly altering in strength and any other closed parallel or approximately parallel conducting circuit, yet I doubt if the chief cause of the observed disturbances can be attributed to what may be termed *direct* electromagnetic induction. By this term I mean the effect which would be directly, or at first hand, communicated to the insulated conductor of the submarine or underground cables

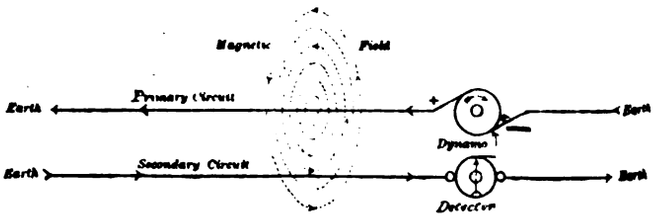

FIG. 5.—Direct Electromagnetic Induction.

from the erratic currents passing along the trolley wires in one direction and returning by the rails, or by results due to the difference between these respective currents at any time. In the first place, the underground cable is contained in a strong cast-iron pipe, and although this pipe is much nearer to the tramway rails than to the trolley wires along the seaward end of Adderley-street, yet any direct electromagnetic action due to the difference between the respective currents in them and their respective distances from the pipe would naturally result in producing inductive currents in the pipe to a greater degree than in the so far magnetically shielded insulated conductor. A secondary inductive effect would no doubt be produced upon this insulated wire by the more direct induced currents in the cast-iron pipe. These secondary currents would, however, be opposite in direction to any direct electromagnetic induction that might reach the wire. Again, the sheathing of the shore end of the submarine cable being not only double, but the outer armour being so heavy and compact (*see* Figs. 7 and 8), the insulated conductor contained therein would also be very much shielded from any *direct* electromagnetic effect. Besides which, the mean parallel distance for the first mile between the cable and the tramway is fully half a mile, and thereafter the cable diverges not only in distance but also in direction from the tramway route; therefore I do not think the chief or most prevalent cause of the interferences to the receiving signals can be attributed under these circumstances to what we have called "direct electromagnetic induction." I do not for a moment doubt that direct electromagnetic induction would take place through air or earth or sea or all combined at much greater distances, and even under less favourable conditions, with respect to parallelism and to sudden alterations in the strength of the primary currents than in the case in question, if only the cast-iron pipe surrounding the underground core and the heavy iron armour of the shore end were absent. These iron covers, however, in my opinion, not only to a great extent act as a magnetic shield, but, moreover, the electromagnetic currents produced in them so act upon the insulated conductors contained therein as to produce a current opposite in direction

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and in effect to any direct electromagnetic induction in the cable conductor. No doubt the "splashes" or more violent "kicks" of the siphon in the Kelvin recorder, which were still observable up to the time of my leaving the Cape, may be attributed to the sudden closing or to the sudden freeing of a number of the motor-circuits. For, whenever the pre-arranged limits of the automatic cut-out switches are exceeded, due to a congregation of cars (say near the corner at the meeting of Darling and Adderley-streets, or elsewhere not far from the cable) being started more or less simultaneously, then electromagnetic induction has the best chance of exhibiting its effects. One day, while standing near the switchboard in the power house, I noticed that certain of the automatic cut-out switches broke their circuits half a dozen times within a quarter of an hour at the pre-adjusted limit of 350 amperes; and of course they had also to be switched on again before the cars on that section or sections could start. Such sudden stoppage and starting a current of 350 amperes at 500 volts does undoubtedly cause *direct* electromagnetic induction in all neighbouring parallel electrical circuits, whether they are in the air, as in the case of bare or specially insulated wires, or buried in the earth, or laid in the form of a submarine armoured cable in the sea. These sudden electromagnetic disturbances are, however, distinguishable from another and more frequent source of interference which might now be considered.

4. *Disturbances due to Leakage or Stray Return Currents from the Tramway Rails.*—In Fig. 6 I have depicted graphically by dotted curved lines the "stray shunted" currents as they leave the tramway rails and find their way back to the negative poles of the dynamos in the tramway power house. When the length and the electrical resistance of the rails is taken into consideration, as well as the very heavy traffic which at times prevails in each of the two main sections to Wynberg and to Sea Point, there is no difficulty in believing that the limits of the fall of potential along the rails, as set down by the Board of Trade, are at times exceeded. The seven-mile route from the power house to Wynberg is only a single line with numerous turn-outs, whilst that to Sea Point is a double one.

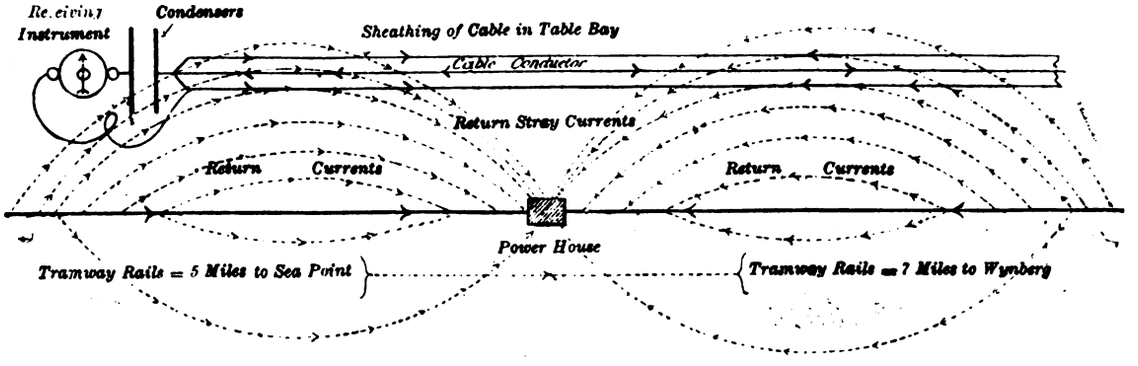

FIG. 6.—Stray Currents from Electric Tramway Rails inducing Disturbing Currents in a Parallel Submarine Cable.

The rails in each case are 81lb. to the yard, with double flexible Chicago copper bonds past the fishplates at the rail joints. Cross bonds are also introduced between each pair of rails at certain distances apart. The consequence is that when the traffic is heavy some 30 to 40 per cent. of the return current finds a way back to the power house through the earth and the sea. Since the hard rocky nature of the Table Mountain side offers a greater resistance than that of the damp low-lying shore side, the major portion of the stray currents naturally follow the latter course. These stray currents freely pass through the Observatory grounds, a mile or more distant from the tramway line to Wynberg, and Dr. David Gill, the Astronomer Royal at the Cape, informed me that ever since the electric tramway first passed the Observatory he had not been able to carry out a single delicate magnetic experiment within the grounds. These varying stray currents undoubtedly find a ready path to and along the heavy low-resistance sheathing of the submarine cable on their way back to the power house, and in doing so they produce by induction correspondingly erratic currents in the cable conductor, which of necessity interfere with the weak receiving currents during their arrival at the Cape telegraph office. No wonder, then, that such interferences mystified and defied the most skilled telegraphists to decipher the messages, so long as the tramways were working and so long as no proper anti-inductive method had been applied to cancel their baneful effects. It will be readily understood that the tramway company, having received full Government and municipal permission to adopt the overhead trolley system, with the rails for the return currents to the power house, and seeing that under such working conditions it could not possibly introduce any known and commercially satisfactory means of preventing the natural interferences, it was willing to help the cable company as far as possible to effect the desired remedy.

ANTI-INDUCTIVE EARTHING CABLES LAID BY THE EASTERN TELEGRAPH CO.

In the end of January, 1897, the Eastern Telegraph Co. laid a short cable of about five nauts, as nearly as possible over the shore end of their main cable, Fig. 3, and connected it to the earth side of the telegraph office recorder by means of a second underground cable inserted in another cast-iron pipe which lay parallel and close to the first pipe and cable. The sea end of the conductor of this short cable was earthed by soldering it to its sheathing, the soldered joint being protected from the sea water. By this it was hoped that a "sea earth" would be found, beyond the range of the tramway stray currents, to neutralise all inductive effects upon their main cable. So long as the tramway traffic remained light, and until the tramways were extended from Adderley-street to Sea Point on the one side and from Mowbray to Wynberg on the other side, the telegraph company's staff was able to receive messages by aid of this short cable. There cannot be the slightest doubt, however, that it could not be laid precisely over and parallel to the main cable from a telegraph steamer, for the main cable lay at such a depth as to be entirely out of sight. The short cable might therefore be hundreds of feet away from the original one at various places without anyone being aware of the fact. Further, since the sheathing of this short cable was not of precisely the same kind and weight as that of the main cable shore end, the induction upon its conductor, however evoked, would not be equal to the induction in the conductor of the main cable. Consequently the induced currents through them would not exactly balance each other as they arrived at the opposite terminals of the receiving instrument. In other words, the balance was not perfect. It was, however, so very much better than with any of the previously mentioned plans, that members of the staff were able to receive messages until the extension of the tramways took place. After that the cable company found it necessary to incur the still further expense of laying another cable, of 11 nauts, in a similar manner and earthing the same at Robben Island. It was also connected to the siphon recorder through an underground insulated line in the same way as had been done with the 5 naut cable (Fig. 3). With this second short cable the messages have been received ever since. But as I found, in the beginning of September, 1899 (when I inspected the receiving signals and the specimens complained of which had been entered in the cable office diary), the telegraph staff were still frequently bothered with "kicks" and "splashes." Upon joining up the 5 naut earthing cable to the recorder instead of the 11 naut one, I at once perceived that the interferences became much more pronounced; and with the earth side of the recorder connected directly to the sheathing of the main cable, as in Fig. 1, these interferences became so bad that I could scarcely read a single word.

PREVIOUS ANTI-INDUCTION EARTHING CABLES.

I could give a large number of previous instances of interruption to sea and land telegraphy and to telephony due to faulty earth connections, leakage from other sources through earth plates and between circuits, direct electromagnetic induction from lightning, and lighting and transmission of power circuits, but this is the first instance in which I have personally observed indirect or secondary induction from stray shunted tramway currents in the case of a submarine cable. The Eastern Extension Telegraph Co. had experienced similar interferences from the electric tramway lines at Madras, in the working of its submarine cables landed there; but it overcame them in a so far satisfactory manner by running a parallel underground cable as well as one out to sea for a few miles. Here, however, the tramway lines were not nearly so favourably situated with respect to parallelism to the cables, and hence the disturbing effects were not so pronounced as at the Cape. Messrs. Siemens Bros. and Co. had previously laid down a double-cored underground land line and shore end cable at Coney Island to enable the Commercial Cable Co. to bring its lines direct

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to the New York office and at the same time be free from interferences due to the neighbouring electric tramways. A cross-section of the cable laid by Messrs. Siemens is illustrated by Fig. 7, where it will be observed that the second or return core is placed between the inner or light sheathing and the outer or heavy stranded armour. Here, again, the submarine portion was not nearly so parallel to the tramway lines as at Cape Town.

Proposed Remedies for Induction and Stray Current Interferences.

Taking into consideration all the circumstances at Cape Town, I reported to the Commission before which I recently gave evidence that nothing short of a symmetrically arranged and specially made "twin *twisted* core with double armouring" would do for the shore end, and that it would not require to be more than from two to three nauts (*see* Fig. 8*). One core of this special cable would require to be jointed to the core of the main cable in the bay, the sheathings thoroughly well spliced together, and the conductor of the second core soldered to the outer sheathing of

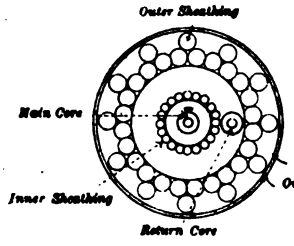

Fig. 7.—Coney Island Twin Core. Shore end.

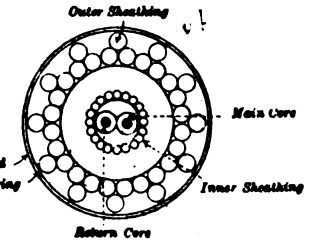

Fig. 8.—Twisted Twin Core. Anti-inductive shore end.

the main cable, and there sealed from the sea water. The ends of these two cores at the cable hut would require to be connected to corresponding ends of an armoured "double-twisted core" encased in *one* thick cast-iron pipe placed underground between the cable hut and the telegraph office, and the conductors connected to the signalling condensers and the receiving instrument (as shown in Fig. 9, in which the sending battery, switch, and keys have been omitted). Only thereby could all inductive effects, from whatever source and however caused, be equally and simultaneously evoked in the main and the short earthing conductors.†

Further, I strongly recommended the tramway company to obtain and place in circuit, with separate return feeders from different points along the rails, a sufficient number of negative boosters (or sucking dynamos), in order to reduce the return currents in the rails at these points to zero potential, and thus prevent the fall of pressure along any portion thereof ever exceeding the limits of the Board of Trade rules. This would naturally stop electrolytic action on neighbouring pipes, and greatly reduce the

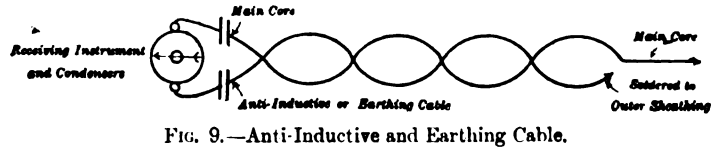

Fig. 9.—Anti-Inductive and Earthing Cable.

potential, the strength, the range of stray currents, and hence the chance of their reaching the sheathing of the submarine cable and of acting inductively upon its conductor.

Finally, I believe that land telegraph, telephone, and other electric circuits can be protected from all interfering influences of electric tramways by employing twisted forward and return insulated conductors, and that electrolysis may be prevented by employing heavy well-bonded rails with return feeders and sucking dynamos whenever the fall of pressure along any section tends to exceed 5 volts.

Water Power Plant at Laxey and the Recent Frost.—We learn that during the recent long frost the Isle of Man Tramway and Electric Power Co. experienced no actual difficulty in working their water power plant at Laxey. The only trouble, indeed, was that there was not as large a supply of water as usual, the flow being only sufficient to work one of the turbines at from three-quarters to full gate. During the severest days of the frost the steam plant was run for a short time each day to assist the turbine. The tramway is now being worked again entirely by water power.

* The author showed a specimen of this cable, which was kindly lent to him by Messrs. Siemens Bros. and Co. for the meeting.

† Since reading this Paper, the author has been informed that the recently-laid shore end of the new cable from Cape Town to St. Helena has been made and connected in the above-mentioned way.

EVERSHED MOVING COIL INSTRUMENTS.

Messrs. Evershed and Vignoles have issued a catalogue of their moving coil measuring instruments, prefaced by some interesting notes concerning this class of instrument generally and the Evershed pattern in particular. After summing up the general advantages of the moving coil type (viz., that the instrument is easily made perfectly aperiodic by winding the coil on a copper former; that a uniform magnetic field and a spring control give a scale of equal divisions over the whole range; that there are no errors due to hysteresis; and that, when used as a voltmeter for any pressure above about two volts, the moving coil instrument has practically no temperature errors), the difficulties in construction are referred to as follows:

"On the other hand, the moving parts are necessarily much heavier than those of a soft iron instrument, and hence only the most perfect pivoting will ensure freedom from friction errors, while the wear of the pivots and jewels is greater. The mechanism of a moving coil instrument is a good deal more complicated and fragile than the simple moving parts of a soft iron instrument, and there is therefore more liability to failure from rough usage. When used as an ammeter the moving coil instrument is liable to considerable temperature errors, unless the shunt has a much greater potential difference across its terminals than is usually permissible in view of the necessity for keeping the power spent small. When the ammeter is used to indicate the drop of volts over a length of the copper main which carries the current—a method sometimes advocated—the temperature errors may amount to 10 per cent. when the main is 26°C. above the air temperature. The advocates of this method of measurement naturally avoid reference to the question of temperature errors. The necessity for leading the current to and from the moving coil has led to the almost universal adoption of a spring control for this type of instrument. An imperfect spring sometimes causes a slow shifting of the index at zero, and all metal springs are liable to effects of fatigue after prolonged deflection in one direction. These effects are of course common to all instruments in which a spring control is used. The indications of a moving coil instrument are only trustworthy so long as the magnet retains its original strength. Everything, therefore, depends on the care bestowed on the manufacture of the magnet, and the method adopted for bringing it into a condition of permanence. When, as in nearly all moving coil instruments, it is necessary to take the magnetic circuit to pieces in order to insert or withdraw the movement, there is always a liability to set up new magnetic conditions, tending to cause gradual change in the value of the field in the air-gap. In addition to the liability of the magnet, when improperly made, to alter in strength, every magnetic circuit, however stable, may be disturbed if subjected to the action of too powerful an external field, and provision should always be made in the construction of the instrument for efficiently shielding the magnetic system from external influences."

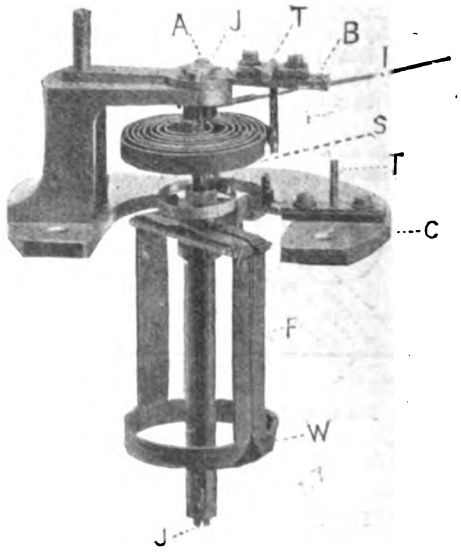

Fig. 1.—The Moving Coil System.

Mr. Evershed overcomes these difficulties in the following manner: The permanent magnet with soft iron pole pieces is fixed permanently to a brass framework. The complete magnetic circuit so formed is then magnetised and brought into a condition of permanence by a process which leaves every magnetic molecule in the circuit in a position of stable equilibrium." The Evershed moving coil has two parallel rectangular sides adapted to move in the air gaps of the magnetic circuit, the two sides being joined at one end by

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a straight cross piece through which the axle passes, and at the other end by a circular ring piece which enables the coil to be inserted without taking the magnetic circuit to pieces. Fig. 1 indicates the construction adopted. The "former" F is attached to a brass sleeve, to which the controlling spring S, the leading-in strip or strips, and the index I are also rigidly fixed. A hardened steel axle passes through the sleeve, and is fixed thereto by a set screw. The axle is ground to a needle-point at both ends, the points resting in two cups of hard sapphire, J J. By this construction the parts liable to wear—namely, the needle-point and jewels—are easily renewed or repaired without separating the essential working parts of the instrument. An internal zero adjustment is provided, seen clearly in the figure. A A are the screws by which the lever B is fixed, and if these screws be loosened any required adjustment can be made. This zero adjustment is only intended to be used, however, in case of a permanent alteration of zero, and no notice should be taken of any temporary zero error due to fatigue of the spring after prolonged deflection in one direction.

A magnetic shield, similar to that used in Evershed soft iron instruments, is fitted in the dial pattern moving coil ammeters and voltmeters, and obviates the necessity for closing in the dial by a cast iron cover-plate. In the edgewise patterns the case is necessarily complete, and serves as an efficient shield, as has been seen; the whole of the working parts are attached to a metal frame entirely independent of the case. The frame is fixed in the case by means of bushed screws, so that the case may be earthed, if necessary, without any risk of damage to the instrument. The moving coil in the voltmeters consists of many turns of fine copper wire connected in series with a high resistance wire wound in a single layer on one or more porcelain tubes. This series resistance is made of a material with a negligible temperature coefficient, and as its resistance is generally hundreds of times that of the moving coil itself, the temperature coefficient of the instrument as a whole is practically zero. The moving coil of the ammeters consists of a few turns of thick copper wire, connected in series with the two leading-in strips, and a series resistance made of the same alloy as is used

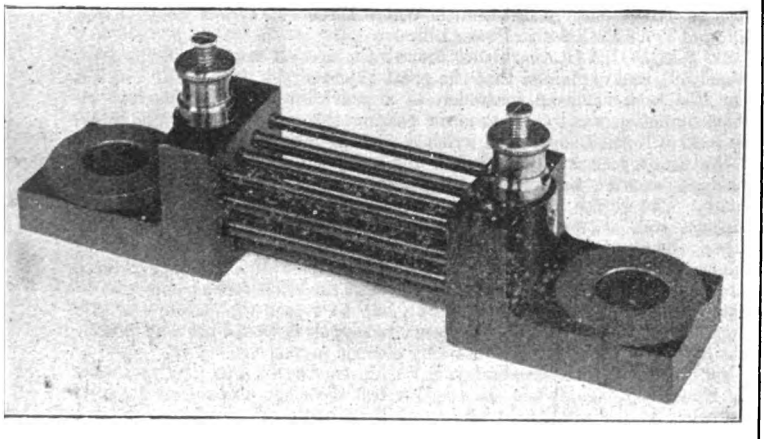


Fig. 2.—Ammeter Shunt (200-400 amperes).

for the resistances of the voltmeters. This resistance is adjusted until the potential difference on the ammeter terminals, when the latter are connected across a shunt through which the main current passes, deflects the index to the required point on the scale. The temperature variation may be reduced to any value by increasing the series resistance, but the instrument then requires a higher potential difference to work it. The makers have adopted as a value for this drop of volts "a reasonable compromise," giving a moderate temperature variation with small waste of power in the shunt.

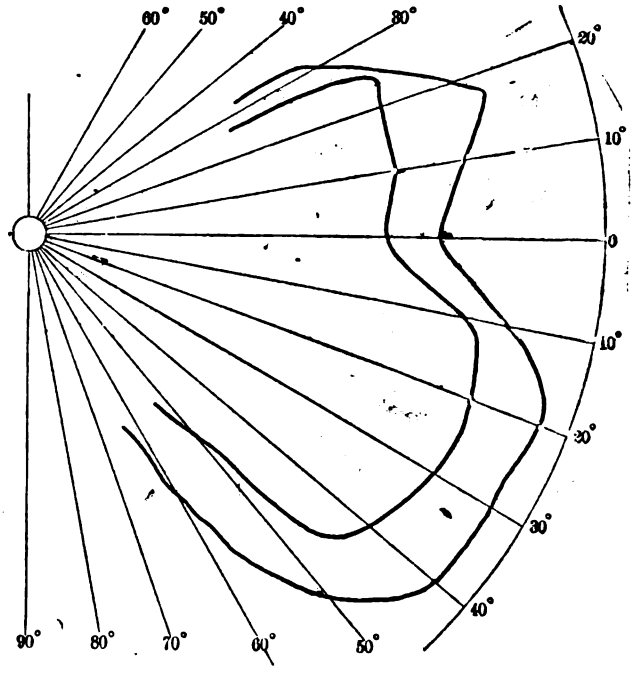
The shunt provided for use with the moving coil ammeters is shown in Fig. 2. The resistance to carry the main current is formed by a number of thick wires soldered into massive terminal castings of pure copper, a method of construction which secures ample ventilation. The wires are made of an alloy having no variation of resistance with temperature, and the resistance of the shunt is constant within the limits of observation at all values of the current. The whole resistance of the moving coil circuit in the ammeters is about half an ohm.

The Evershed moving coil edgewise instruments have been supplied to a number of electric supply works, notably to the Manchester Corporation works, where there is a set of 40 instruments of this type on the switchboard. Three sizes are made, having the radius of the scale 7in., 10in., and 15in. respectively. The width of the 7in. instrument over-all is 3½in., of the 10in. size, 4in. and of the 15in. pattern 5¼in. The arc of the scale is 60deg., which is the longest that can be used consistently with avoiding excessive parallax at the ends of the scales. The length of the scale is consequently roughly equal to the radius.

RELATIVE CANDLE-POWERS OF ALTERNATING AND DIRECT-CURRENT ENCLOSED ARC LAMPS.*

In a Paper read before the December meeting of the Chicago Electrical Association, by Mr. E. P. Warner, on "Alternating-Current Arc Lighting," the subject of the relative candle-power from direct and alternating-current enclosed arcs was discussed at some length. Accompanying the Paper was a diagram of curves plotted from photometric measurements taken of an alternating and a direct-current lamp, both of the enclosed type. The two lamps were operated under the same voltage, with the same kind of globes, and with all the other conditions alike for the two. Of these curves, which are shown in the accompanying figure, the inner one is that plotted from the measurements of the alternating-current lamp and the outer one from those of the direct-current lamp. It will be noted that while the direct-current lamp exceeds the alternating current in light capacity by an average of about 12 per cent., there is a remarkable similarity with respect to distribution. The tests were made purely with a view to determining the relative intensity, and the curves do not show actual candle-power.

Mr. Warner referred to the difficulty in making photometric measurement of arc lamps, especially of the enclosed arc. The alternating arc continually shifts from place to place, which results in enormous changes in the intensity of the light. When the arc is



Curves of Photometric Measurements.

upon one side of the carbons, the light emitted from the opposite side is comparatively weak, and for about 5deg. above and below the horizontal plane it is very strongly violet, while upon the side where the arc is located the light is quite intense and white in colour. It becomes necessary, therefore, in making the photometric tests of this arc, to secure a large number of measurements and take the mean, in order to arrive at anything like a safe average.

This peculiarity of having a violet band upon one side and a bright light upon the other seems to be more a characteristic of the alternating than of the direct-current enclosed arc lamp. It is true that the arc of the direct-current lamp shifts about very considerably, and that when it is upon one side there is a considerable shadow from the carbons upon the other side and a marked diminution of light; and the same precautions had to be taken in measurements of light intensity with this lamp as with the alternating. It was found, however, that a safe average could be obtained with a considerably smaller number of measurements than with the alternating.

Mr. Warner said that in the application of reflectors on the alternating lamps the results he had obtained are not particularly encouraging. While there is undoubtedly some advantage to be gained by their use, there are numerous difficulties in the way of using effective reflectors; and such reflectors as are found suitable for use and practical have not been found very effective. In the measurements of relative light intensity given in the diagram the alternating lamp was supplied with a metal reflector white enamelled on the under side, while the direct-current lamp had no reflector. It will be noted that, notwithstanding this fact, the light

* From the *Electrical World and Engineer*.

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intensity in the upper portion of the curve from the direct-current lamp is considerably greater than that from the alternating.

In order to correct the violet rays in the alternating lamp and make it acceptable for commercial lighting, Mr. Warner has used what is known as an alabaster globe. This globe is composed of two layers or thicknesses of glass, one of which is clear, or slightly tinted with uranium, and the other opalescent. The combination of these two acts upon the violet rays almost the same as an aqueous solution of quinine sulphate, and transforms the violet into white light. This result is not effected, however, without a material loss in the intensity of the light; but it has been found in practice to be a necessary sacrifice, as in almost all instances a proper colour of light is demanded irrespective of the power.

Recent claims relating to alternating arc lamps in series arc lighting were referred to as somewhat over-enthusiastic in the matter of light distribution and the fogging or clouding of the globe by deposits from the arc. He considers that the deposit upon the interior of the enclosing globe is somewhat greater from the alternating arc than from the direct current, and begins to form considerably sooner after the light is started. This he believes to be due to the fact that cored carbons are used in the alternating lamps, as when an alternating lamp is operated with solid carbons there seems to be no more deposit than if the current were direct. However, the advantages gained by the use of cored carbons in the alternating lamp are such as to more than offset the objection.

CORRESPONDENCE.

THREE-PHASE RAILWAYS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I am shocked to find that both you and Mr. Field have misunderstood the sketches given in Fig. 5 of my letter (see *Electrician*, Feb. 16, p. 585). I simply gave them as a comparison of the numbers of stops on an ordinary tramway as compared with the stops on say the Central London Railway. For example, whilst a street car stops say *six* times, the underground railway may stop *once*; or whilst a car stops *twenty* times, a light railway train will stop *once*, and so on. The series-parallel (continuous-current) control is a good thing for a street car which must be constantly stopped and started, but the necessity for it would not be evident on, let us say, a London-Brighton electric train, which did the journey *without a break*.

These are extreme cases, but somewhere between is the point where the difference between plain rheostatic and series-parallel-rheostatic control is so small as to lose its importance, especially as compared with other more weighty matters. Personally I believe the conditions of our underground railways are such that the advantages offered by a system worked entirely three-phase swamp any little disadvantage as to the motors being controlled rheostatically. Anyhow, if any *experiments* are to be made at all, the three-phase ought to have a trial. Mr. Field's measuring up of my sketches in twentieths of an inch and so on is amusing; he would hardly have taken the trouble had he seen the rough way in which they were made. If I had wanted to show the contour of the curve, I should have gone to much more trouble—that is, if I had started out to do such a thing at all, which is unlikely, seeing that I have so little faith in *predetermined* curves.

By showing the advantages of coasting, Mr. Field's remarks are so enthusiastic that one is given the impression that three-phase trains *cannot* be run "coasting." Of course he does not mean anything so absurd.

In conclusion, you suggest that, as we know absolutely nothing of the cost of working three-phase lines, therefore, &c. Now, wasn't this exactly what the gas people said when electric lighting was first introduced, and what the managers of horse tramways said when electric traction came forward? We have abundance of evidence that anything that is sound from an engineering and scientific point of view will give satisfactory financial results. If everyone said "First show me the financial results," we should never get any "forrader."—Yours, &c.,

E. KILBURN SCOTT.

Old Charlton, Kent, March 1.

[We once saw a diagram to show "how many beans make five." It appears that Mr. Scott's "Fig. 5" is a diagram of this sort, being merely intended to show pictorially what he means by stops at so many yards interval. Mr. Field and ourselves had supposed it was much richer in ideas, but we were evidently wrong. Mr. Scott's remarks about "the gas people" are not to the point of the discussion; the rivalry between gas and electric light is no illustration of the competitive merits of two traction systems, both of which are electrical. A railway engineer of repute dares not to ignore the question of costs in advising as to the merits of any scheme.—ED. *E.*]

FOREIGN COMPETITION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It may interest your readers to learn that the action for libel that the National Conduit and Cable Co. of New York, commenced against us last year in the matter of a letter we wrote to your paper as to the way in which the cable contract for the Dublin tramways was let, has now been finally dismissed for want of prosecution.

We inform you of this in justice to ourselves, as the taking of this action against us was published at the time. Further comment on our part is needless.—Yours, &c.,

G. H. NISBETT.

Feb. 27. The British Insulated Wire Co., Ltd.

PARLIAMENTARY INTELLIGENCE.

ELECTRICAL POWER BILLS.

The following bills were fixed for second reading yesterday in the House of Commons: Lancashire Electric Power Bill, Durham (County of) Electric Power Supply Bill, South Wales Electrical Power Distribution Bill, and Tyneside Electric Power Bill.

Mr. MACDONA (Rotherhithe) moved the second reading of the first-named bill, and explained that the great objection to the similar bill last year had been removed, inasmuch as a provision was now inserted by which no action was to be taken in passing through local districts unless the local authorities agreed in writing. In the interests of the commerce of the country it was only fitting and proper that a bill offering such privileges as were now offered should have careful consideration by the House. The North London Electrical Powers Bill, involving the same principle, was last week allowed to pass its second reading, and the same course should be now adopted. The municipal Corporations of the country had organised themselves for the purpose of strangling private enterprise. The proper procedure was to send the bill before a committee so that its details might be threshed out, but to reject the measure at this stage would be a cruel and disastrous policy, as it would prevent people who had absolute need of it obtaining electric power.

Mr. GALLOWAY (Manchester, S.W.), in moving its rejection, reminded the House that the Brush Co.'s bill a few days ago was rejected simply and solely on the point raised by this bill—viz., that it sought compulsory powers to break up streets without the consent of the local authority. The promoters of the bill proposed to lay hands on the whole of Lancashire south of the Ribble, and that whole district as represented by the local authorities was averse to the measure. Where municipal Corporations had borrowed money on the security of the rates to enter upon such undertakings with the consent and sanction of Parliament, they ought not to be subjected to the competition of private companies—(Oh! oh!). It was said that the municipalities had not done their duty, but that was disproved by the fact that the amount of municipal capital in course of expenditure on these matters was over £4,000,000. Under the conditions existing in England it was difficult to see how such a company could profess to be able to supply current better or more cheaply than the municipality, as was evidenced by the hopeless failure of private companies in London.

Sir JAS. WOODHOUSE (Huddersfield), in seconding the motion for rejection, contended that it was to the advantage of consumers to be supplied by the municipality, as was shown by the experience of Manchester, Sheffield, Birmingham, and Leeds; and he defied this company to do the work more efficiently or economically than the Manchester Corporation had done. Although they would have the control of this large district, the company need not exercise the powers, but could keep others from exercising them.

Mr. SETON KARR, in supporting the bill, contended that the question of supplying electricity in bulk was much too large a one for a municipal Corporation.

Sir WILLIAM HARCOURT, while not opposing the general principle of the bill, contended that the question had not been maturely considered. Electricity was probably *the* question of the future. These bills should not be dealt with in a haphazard way, but postponed for a year, and then a wide review of the whole question might be made and a statesmanlike electrical policy for the future adopted.

The PRESIDENT of the LOCAL GOVERNMENT BOARD (Mr. C. T. Ritchie) said that this country was very backward with regard to electrical matters, and it was urgently required that something should be done. The Act of 1882, had more than anything else delayed and hampered the

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development of electrical science, and if this bill departed from the lines there laid down it was something in its favour. The promoters had given him an assurance that they would agree to an amendment in committee making it perfectly clear that they did not ask for the power to distribute electricity, even in bulk, without the consent of the local authority. All that was asked was that the local authority should give wayleaves. It was carrying their opposition a great deal too far for municipal authorities to object with one accord against such a sensible interference with their streets safeguarded so completely as in this bill. It was distinctly in the public interest that electrical enterprise should succeed in this country, and it was so important that he desired to impress upon the House the gravity of the matter before they decided to reject the bill.

After further discussion, in the course of which the President of the Board of Trade undertook that if the bill was passed it should be considered by a very strong committee, the motion to reject the bill was negatived without a division.

Several notices of motion for the rejection of the remaining bills had been given, but on the understanding that these bills should be referred to the same committee and dealt with on the same lines as the Lancashire bill, the notices were not proceeded with, and the bills were read a second time.

COUNTY OF LONDON AND BRUSH PROVINCIAL ELECTRIC LIGHTING CO.'S BILL.

In the House of Commons, on Monday, this bill was rejected (by 147 to 105) on the motion for second reading.

Mr. PICKERSGILL, who moved its rejection, said that the object was to amalgamate eight or more separate undertakings into one gigantic concern. In order to achieve that end the promoters asked for powers to establish half-a-dozen central generating stations and to link up the various portions of their area of supply. This involved laying new mains and breaking up streets within the area of supply, and also gave to the company powers to break up streets in six districts (Islington, Shoreditch, Battersea, Lambeth, Bermondsey, and Whitechapel) in which at present they had no *locus standi*. The company were to be authorised to break up streets without giving any compensation to the public, and should not receive such powers without the sanction of the community expressed through the local authority. The company by the bill were breaking faith with those local authorities who had consented to the orders under which the company had established their eight separate undertakings. The power of purchase which the local authorities possessed would be rendered illusory if by this bill the House consented to each separate undertaking becoming part of a gigantic undertaking stretching over almost every part of London.

Sir A. ROLLIT seconded the rejection of the bill, and said that it was an attempt to override by private legislation the general law of the land, especially the provisions of the Electric Lighting Acts, which required the consent of local authorities for carrying out such undertakings.

Mr. KIMBER submitted that none of the reasons advanced against the bill afforded any reason why the House should depart from its usual course of sending such measures to be fully investigated by a committee. The powers asked for by the bill for breaking up roads and streets of intervening districts struck one at first sight as being strong, but Parliament had entrusted companies with the carrying on of industries like electric lighting, and it was bound to give them every facility for carrying out their undertakings in the most economical and approved manner. If the bill were sent to committee evidence would be taken in regard to the objections advanced against it.

Mr. J. BURNS and Mr. H. H. MARKS having supported the rejection,

Sir J. FERGUSSON urged that the House should not, on *ex parte* evidence, reject a bill at this stage, when they had provided machinery for thoroughly investigating the facts and judging whether there were any reasons why the bill should not proceed.

Mr. BOULNOIS said the proposal to pass through an intervening area was not a novel one. Last session two electric lighting companies obtained Acts which gave them power to pass through districts, although they were not actually authorised to supply light or energy in those districts. This bill would only facilitate the distribution of electric current, and it would in no way interfere with the rights or powers of any local body. What, he asked, would be the position of London with regard to the electric light if it had been left to the municipalities?

POSITION OF SUBMARINE CABLES.

In the House of Commons, on Monday, Sir CHARLES DILKE asked the First Lord of the Admiralty whether he was aware that foreign Governments prohibit the publication of the routes followed by their submarine cables, as, for example, in one of the agreements (specification as to manufacture of cable) between the Société Générale des Télégraphes Sousmarins and the French Government in reference to the cable between New Caledonia and Queensland; whether British-owned submarine cables are shown on the Admiralty charts, as, for instance, on those of Lisbon, Sierra Leone, and Delagoa Bay; and whether he would consider if it might not be better in future to omit to indicate British cables or to indicate them only, according to the practice of foreign Governments, on special private charts to be supplied to commanders of war-ships.

Mr. GOSCHEN said the right hon. baronet was under a misapprehension in supposing that submarine telegraph cables were not marked on foreign charts. The same principle appeared to govern the action of foreign Governments in this respect as had guided the British Admiralty—namely, that where there was a chance of interruption from ships anchoring over the cables, they were shown on the plans or charts of approaches to ports. On the plans mentioned in the right hon. gentleman's question the cables were shown. The course proposed in the concluding sentence of the question had already been taken for those stations where it was considered desirable.

LEGAL INTELLIGENCE.

The London Electrical Omnibus Co. (Ltd.) v. Neill.

This case came before Mr. Justice Ridley and a special jury, and was an action by plaintiff company to recover from defendant calls on shares. It was not denied that the calls were due, but defendant alleged that there were material misrepresentations in the prospectus, and counterclaimed against the company for rescission of contract and against the directors for damages. The alleged misrepresentation was denied.

Mr. H. F. Dickens, Q.C., and Mr. J. Eldon Bankes appeared for the London Electrical Omnibus Co. and for Major S. Flood Page, Mr. Sutton Cook, and Mr. J. B. W. Maunder, directors of the company and defendants on the counterclaim; Mr. Beddall represented Mr. Henry Fox and Mr. Boxall Mr. Radcliffe Ward; and Mr. Witt, Q.C., and Mr. Kimber appeared for the defendant, Mr. W. M. Neill. Two other defendants on the counterclaim, Col. Wilson and M. Marshall, were not represented by counsel.

Mr. WITT opened the case for defendant on the counterclaim, observing that the company was incorporated in 1896 to put on the streets omnibuses propelled by electricity, its nominal capital being £250,000, of which shares for £100,000 were offered. The plaintiff applied for and obtained 240 shares of £1 each, 10s. being paid up. In the prospectus there were two material misrepresentations which were relied upon. At the head of the document there was a picture of the omnibus, which it was said carried 25 passengers and had been designed by Mr. Ward for the company. This was followed up by a paragraph which said, "A contract has been entered into with the Crystal Palace Co. to view in the grounds carrying passengers a new type of omnibus similar to those about to run in the streets. Omnibuses are now to be seen at the Crystal Palace which will be carrying passengers shortly." This assertion was designed to obtain public confidence, but the facts were that there never was a finished motor omnibus at the Crystal Palace, or one which could carry passengers, but only the body of a 'bus, which had neither wheels nor motor parts. The invention was puffed up as "a sound, progressive, industrial, British enterprise," and it was added, "The electric omnibus designed by Mr. Ward has run upwards of 5,000 miles on the London streets through the most crowded traffic with complete success, and has proved as noiseless as a horseless carriage fitted with pneumatic tyres." So far from this being the fact, the company had never put the omnibus on the London streets; it never carried a passenger for hire; had never done any business at all, but had spent the whole of its money, except what had been handed over to Ward, for the purchase of some patents which counsel believed had lapsed in experiments and demonstrations. So that at last they had in the bank a sum of £1. 19s. 1d., and had got rid of £37,000 odd in experiments, salaries, and payments to Ward.

Mr. WM. MARSHALL, a mining engineer, said he was promoter of the company in conjunction with Mr. Radcliffe Ward, and one of its directors. Arrangements had been made by Mr. Ward with reference to the running of an omnibus at the Crystal Palace. He did not recollect seeing any contract with the Crystal Palace Co. for running omnibuses there, but there was a letter. There had been no omnibus at the Crystal Palace capable of running when the prospectus was issued, but there was the body of the 'bus, showing Mr. Ward's design. It had, however, no motive power or wheels. The directors believed and trusted Ward's statement, and expected that the 'bus would be running in the grounds. Ward's omnibus shown at the Palace without wheels was completed five months later, and carried over 26 passengers up St. Martin's-lane; they were at one time hanging round it like rats. It was a most successful trial, but the motor omnibus stuck a few days afterwards, and had to be drawn home by horses. There had been no other successful run. They had never carried passengers for hire.

What do you say of the statement in the prospectus that the omnibus has been running 5,000 miles through through the most crowded traffic in the London streets?—I say that was one of the statements made by Ward that induced me to go in for the scheme. Afterwards I considered the statement was absolutely untrue. If Ward had been able to run the omnibus 5,000 miles we should have been assured of a gigantic success. The company principally spent its money on experiments and directors' fees. The directors had received favourable reports from different people on the omnibuses.

His LORDSHIP here said a letter read from the Crystal Palace Co. did not constitute a contract.

WITNESS declared the directors were misled altogether by Ward as to the power of his omnibus, and so entered into a contract expecting to do what was impossible.

Mr. W. M. NEILL said that when applying for shares he was greatly influenced by the statements in the prospectus that the omnibus had run 5,000 miles in the thick of the London traffic, which he considered proved it to be a valuable commercial property.

This closed the defendant's case on the counterclaim.

Mr. DICKENS submitted that no claim was made out for rescission of the contract, owing to the delay in bringing the action after these matters had been known to defendant for years. Also that fraudulent misrepresentation had not been made out, the evidence showing that the directors *bonâ fide* believed in Ward's representations to them. The defendant did not take the shares as an ordinary investor, but on an underwriting contract, under which he was to get 15 per cent. commission. It was on the defendant to show that before he entered into the underwriting letter he saw the prospectus which he said misled him. The paragraph relating to the Crystal Palace was not in the prospectus at the date of the letter. It was a fact that a car on Ward's earlier design had been run for upwards of 5,000 miles in the London streets, and this design was being improved

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upon in the next omnibus. With regard to the substance of the prospectus, an independent committee of shareholders had declared it to be absolutely accurate.

Major FLOOD PAGE, a director of the company, testified generally to the *bona fides* of the directors in the statements they had made and their reliance upon the reports of Ward. The company paid £20,000 to Ward and Marshall for the patents, promotion, and plant, the rest of their money going on experiments and demonstrations.

Mr. WITT: Have you ever manufactured more than this one omnibus?—I think there were four, but am not sure; they have been so much altered,

Mr. J. B. W. MAUNDER said he was present at the meeting of directors when Mr. Marshall reported that he had made a contract with the Palace Co. He himself took 250 shares. He was still a director, and believed absolutely in its ultimate success.

Mr. RADCLIFFE WARD, inventor of the patent electric omnibus, said he was an electrical engineer, and had had 23 years' practical experience in his business. Since the beginning of 1882 he had interested himself in the matter of electric traction, and had taken out various patents. In 1888 he constructed an electric omnibus, and from that year to 1892 he ran it with success. It had been approximately estimated and stated in the prospectus of the Electrical Omnibus Co. that it had run 5,000 miles, but he thought that 10,000 would be nearer the mark. That omnibus was in existence in 1896, at the time the company's prospectus was issued. Mr. Marshall made a contract with witness under which he undertook to bring out the company under certain conditions and he (witness) was one of the original directors. In May, 1896, a new 'bus was in process of construction, which it was intended to exhibit at the Crystal Palace. There were several manufacturers concerned in the making of the various parts, but the principal part was made at Shrewsbury. On May 18, 1896, the whole of the essential part of the car was quite complete. The passenger part was there, but they were waiting for the wheels and for attachments, but in May he anticipated that it would be ready, and had the parts been delivered it could have been got ready in a few days. As to the other car—the 26 passenger car—sent down to the Palace, it was fully complete; had been tested and ran successfully. The reason why it was not run was that there had been a great deal of trouble in getting it into the Palace; trouble arose in connection with the floor arrangement, and they decided in consequence to keep it as an exhibition car.

His LORDSHIP here said the court was not to be further used for advertising the company.

WITNESS (continuing) said that at the time the statements were made in the prospectus he had reasonable ground for believing they were true. The omnibus built in 1894 had been run for a few miles at Wolverhampton, and when it came to London it was put into a shed at Whitehall. It remained in that shed for 18 months, when the company was formed.

His LORDSHIP: But does it require a company to run an omnibus?

WITNESS: I had not the means, my lord.

Continuing, witness said that the car ran 5,000 miles, was licensed by the police authorities, the driver was licensed, and the car was a complete success.

Mr. A. SCHANSCHIEFF, electrical engineer, said that in 1896 he arranged with Mr. Marshall for an exhibition of the cars at the Crystal Palace, and to run the omnibuses at 1s. per head. Another 'bus remained to exhibit. The wheels had not arrived, and so he put it on trestles and covered it up, so that people might go in and think that they were running.

His LORDSHIP, addressing Mr. Witt, said he thought there were *laches* proved in the case which disentitled Mr. Neill from claiming rescission. He thought that gentleman must have known the circumstances before 1897. The questions the jury had to decide were whether there had been misstatements of fact, and had the directors reasonable ground for believing they were true?

The jury found that defendant was not influenced by any misleading statement in the prospectus, and that the statements in the prospectus could not be regarded as untrue.

Judgment was accordingly entered for the plaintiff company on the claim for calls, and for the plaintiff company and the directors on the defendant's counterclaim, with costs.

Goldberg and Son v. Liverpool Corporation.

Last week, in the Lancashire Chancery Court, before Vice-Chancellor Hall, Messrs. J. Goldberg and Son (Ltd.) sought to obtain an injunction against the Liverpool Corporation to compel them to remove a tramway pole which they had erected at the entrance to plaintiffs' premises in Paradise-street.

Mr. MATTINSON, Q.C., for the plaintiffs, said they wanted an order requiring the Corporation to remove the pole. Plaintiffs were lessees under the Corporation of premises used entirely for business purposes. The footpath in Paradise-street was 12ft. wide. In 1898 the Corporation were empowered by Parliament to construct electric tramways along Paradise-street, and to erect such works as might be necessary or expedient for the efficient construction of the tramways. They decided to erect overspan wires, fixing rosettes to the buildings in Paradise-street, with the consent of the owners. Plaintiffs objected to having a rosette fixed to their building, and the Corporation erected the pole in question at the entrance to the premises, causing plaintiffs serious inconvenience. There was no necessity whatever for the Corporation to have fixed the pole in its present position. Some little time afterwards they fixed a fuse-box near the pole, creating a double inconvenience. He contended that these things had been put so close to the entrance of plaintiffs' property not because it was essential, but because the Tramways committee were determined to bring pressure to bear to compel plaintiffs to consent to the rosette being fixed on their building. The pole was 25ft. high, and was only 3ft. 2in. from the doorstep of plaintiffs' premises. The Corporation contended that the distance was 4ft. 10in., but they had measured to the door and not to the doorstep. Plaintiffs objected to the position of the pole, as it interfered with the delivery of goods, interfered with the means of ingress and egress, and caused a congregation of loungers. Between the fuse-box and the doorstep there was left only 2ft. 6in. space. The correspondence which had passed between the parties showed that the pole had been put in its present position because plaintiffs would not allow a rosette to be fixed on their building.

The VICE-CHANCELLOR remarked that a photograph put in showed that plaintiffs were fenced in all round with posts. He thought the onus was upon defendants to justify their action in placing the pole where they had.

Mr. MABERLEY (for the Corporation) said the pole could not have been fixed where the lamp-post was, on account of the gas and electric mains running under the footpath.

Mr. J. A. BRODIE, city engineer, said that it was impossible to fix the pole and fuse either in Paradise-street where the lamp-post was, or at a point a few feet up College-lane. The only suitable point was 30 feet along College-lane, which was an inconvenient distance. The position of the pole in question had been settled before plaintiffs had declined to allow the rosette to be fixed. It was not possible to put the pole in a better position without interfering with the whole of the overhead wires in Paradise-street.

Mr. ARTHUR BROMLEY HOLMES, city electrical engineer, stated that the pole and fuse-box had been fixed in the most convenient position, also to cause as little inconvenience as possible to plaintiffs. Putting fuse-boxes for tramway purposes underground was not according to modern practice. It had been tried in Liverpool, but experience had led them to alter them and put them above ground.

Mr. FRANK FORBES HIGGINSON, engineer to the contractors for the overhead equipment of the tramways, said that owing to the presence of gas, electric, and water mains, as well as cross sewers, it was found impracticable to adopt side poles in Paradise-street. The pole in front of plaintiffs' shop was fixed just where the electric lighting mains admitted. He agreed with Mr. Holmes in discarding underground section boxes for tramway traction.

The VICE-CHANCELLOR said there was evidently no malice shown in the erections complained of.

Mr. D. JACOBS, managing director of Goldberg and Son, gave evidence for plaintiffs, and said that until the trial of this action he was under the impression that the Corporation had acted in a hostile manner towards him; but since hearing the evidence he exonerated the Corporation. They simply placed it in its present position because he declined to allow a rosette to be fixed to the building.

Mr. WALTER LEAKE, electrical engineer, said that, having regard to all the tramway conditions in Paradise-street, it was neither necessary nor expedient for the Corporation to have placed the pole and fuse-box in their present position. In his opinion there was no real necessity for the fuse-box to be fixed close to the pole. He had had no experience in the construction of electric tramways similar to those in Liverpool. He was of opinion that a less obstructive form of fuse-box might be devised.

After further evidence had been submitted, the VICE CHANCELLOR intimated that the plans of the gas mains, &c., were not sufficiently explicit, and suggested that an inspection should be made of the mains in the presence of a surveyor representing each of the parties.

This suggestion having been carried out,

Mr. J. A. BRODIE gave it as his opinion that the site suggested by plaintiffs for the pole and fuse-box in College-lane adjoining the Paradise-street position were inexpedient and unfavourable from an engineering point of view.

Mr. F. F. HIGGINSON said that all the poles and fuse-boxes which were divided were now being brought together in the same way as the pole and fuse-box were put together in the case now in dispute.

Mr. EDWARD MANVILLE (Kincaid, Waller and Manville) said there would be no difficulty in removing the pole and fuse-box either farther down College-lane or into Paradise-street. If removed 6ft. back in College-lane, the strain on the span wire might be increased, but not to any appreciable extent. It would not affect the rosette on the opposite side of the road. He saw no difficulty in removing the pole and still keeping out of the way of the gas main.

Mr. MATTINSON said it had been very clearly established that the pole and fuse-box being placed together immediately opposite the entrance to plaintiffs' premises constituted, *prima facie*, a nuisance, in respect of which plaintiffs had sustained real damage. As to the precise amount of this damage he was not primarily concerned, but what the plaintiffs were concerned about was to have the box and pole removed to a site less harmful to them. It was for defendants to show that there was some statutory or other justification for the injury they had inflicted and continued to inflict upon plaintiffs. The Corporation, by a reasonable exercise of their powers, could have prevented the particular injury of which his clients complained. In not exercising reasonable care he contended that defendants had been guilty of negligence.

The VICE-CHANCELLOR pointed out that it might not have been "necessary" to place the pole and box in that particular position, but was it "expedient"? And did "expedient" mean from a public point of view, from the undertaker's point of view, or from the frontagers' point of view, or all of them?

Mr. MABERLEY said the whole question of the powers of the Corporation was raised in this case, and every pole and box might be made the subject of an action for an order in the nature of an injunction to remove. Mr. Mattinson had held that the footway was excluded from the powers of the Corporation in the laying of tramways, but that argument was untenable.

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The VICE-CHANCELLOR was of opinion that the term "street" meant the whole street.

Mr. MABERLEY: Where the Legislature gives discretion to the Corporation, it is for them to say which site should be adopted.

The VICE-CHANCELLOR: But the exercise of the statutory powers must not be "perverse, arbitrary, or vexatious." The Court is not asked to review the judgment of the Corporation based on the advice of its electrical experts, and if I give judgment against you it will not be in the shape of saying where you are to put this pole and box. I shall not advise the Corporation on electrical engineering. The question is, Has sufficient ground been shown to induce the Court to interfere? From my first view of the premises it looked an awkward obstruction to the plaintiffs' front door.

At the conclusion of the arguments, the VICE-CHANCELLOR said he would give his judgment on Monday next.

Hawkes v. Leyton Urban District Council.

This case was heard by Mr. Justice Buckley in the Chancery Division this week, judgment being given on Wednesday. [It was an action by plaintiff, Elijah Hawkes, for an injunction to restrain defendants, their servants and agents, from carrying on their electric supply works at Leytonstone so as to cause a nuisance by noise and vibration to the plaintiff] as owner and occupier of premises in the Cathall-road, where the works are situated. There was an alternative claim for damages. The facts sufficiently appear from the judgme t.

Mr. JUSTICE BUCKLEY said plaintiff was the owner of the house in which he resided, and [the action was brought to restrain the defendants, the Urban District Council of Leyton, from carrying on certain electric supply works so as to cause a nuisance by noise or vibration to the plaintiff]. The evidence satisfied his lordship that there did result in the operation of the defendants' work such an amount of noise and vibration as amounted in law to a nuisance. Defendants admitted that at the date of the issue of the writ down to July last the works were so carried on that there was a nusiance created, but they insisted that the alterations which had been made had the result of remedying this altogether. Plaintiff, however, gave evidence that the nuisance had gone on down to the present time, and various other witnesses spoke as to the existence of noise and vibration caused by the defendants' works. When defendants' counsel got up to open their case his lordship suggested that he wanted to hear evidence that the noise and vibration did not occur. Counsel, however, indicated that he was going to call scientific evidence to prove that the circumstances were such that it could not occur. Mr. Dugeld Clark was called, who went down to the *locus in quo* on Feb. 24. That gentleman said he applied various tests, and took with him instruments to detect horizontal and vertical vibrations. The witness said he was satisfied that there were no horizontal or vertical vibrations. He also said that he applied other tests by putting his ear to the floor and so on, and the result was that he did not hear any noise. Mr. Clark said that he had applied no tests at all as to the existence of aerial vibrations. The result of his evidence therefore was that the defendants' plant could be so run that a person could not detect horizontal or vertical vibration. That was the result of his evidence. Mr. Clark left the place about 9.30 p.m., and about 3 a.m. there was again extensive noise and vibration. The defendants had not mentioned that at all and had called no one to show what was the state of things at that time, and had done nothing to show his lordship that plaintiff's story as to that was not credible. His lordship said that he had come to the conclusion that the gas engines in the defendants' works required very careful watching to prevent them becoming a nuisance. Steam engines were very much better than gas engines, but defendants said that to replace the gas engines by steam engines would be very expensive. It appeared that the demand for the electric light in the neighbourhood was large. The extension of and additions to the defendants' works had been made because a larger supply of electricity was required than the undertaking could furnish. The defendants were now working close to their full capacity. They were not going to stop their gas engines, but had ordered more steam engines. The state of things therefore was that the defendants would continue to use the gas engines, which would be supplemented by steam engines, for which additional buildings were being erected. The plaintiff having proved that a nuisance was caused by noise and vibration, were not the defendants in the circumstances threatening to continue such a state of things? His lordship thought they were. It was part of the defendants' case that their works could be carried on so as not to create a nuisance. When Mr. Dugald Clark went down care was taken that the plant was run carefully, and as long as Mr. Clark was there there was nothing wrong at all. Soon after he went away, however, there were explosions. It appeared to him that he was bound to grant an injunction in the terms of the writ to restrain the defendants from so carrying on the works as to cause a nuisance to the plaintiff by noise or vibration. He accordingly granted a perpetual injunction in those terms, and ordered defendants to pay the costs of the action. The operation of the injunction was suspended till April 9, to enable defendants to consider what could be done to remedy the nuisance, they undertaking in the meantime to stop the "back firing" in the exhaust pipes and explosions as far as possible.

National Electric Wiring Co. v. Lambert.

This was a remitted action from the High Court, heard by Judge Lumley Smith, Q.C., and a jury, in the Westminster County Court. Plaintiffs sued defendant, of 33, Lower-road, Rotherhithe, to recover £19 in respect of wiring and electrical fittings supplied. Plaintiffs' representative said that early last year his firm received an order for the wiring of defendant's premises and the alteration of certain fittings. The defendant signed a joint agreement between plaintiffs and the supply company, and under that agreement plaintiffs were to be paid for their work by the payment of a rental, which was to be included in the charges for current. Apart from the agreement, however, the plaintiffs did a good deal of work in the alteration of gas fittings so as to make them suitable for the electric light, and it was principally in respect of that item that the present action was brought. Defendant said he was induced to sign the contract in consequence of the misrepresentation of plaintiffs' traveller, who led him to believe that electric light was cheaper than gas. The jury were unable to agree; but in the end it was agreed to take the verdict of the majority, which resulted in judgment for plaintiffs for £10, with costs.

Doe Portable Electric Light and Power Syndicate (Ltd.) v. Clarke.

Mr. Justice Phillimore, on Wednesday and yesterday, heard an action in which plaintiffs sought to recover £150 on a guarantee or agreement to pay money when called upon. An indenture setting forth the formation of the syndicate, and the fact that they had acquired certain English patents and contracted to buy certain colonial patents for £20,000, was read. A number of persons, of whom defendant was one, agreed to guarantee to the syndicate the repayment of that sum within 14 days after receiving a request. The share of defendant was £250. If a certain amount of capital was subscribed or profit made, the guarantors were to be repaid. Their liability absolutely ceased at the expiration of six months. The indenture was dated Dec. 7, and notice was given on May 10, 1899, well within the six months. No notice was taken of the application, and after other applications had been made the writ was issued, though this only took place after the expiration of the six months.

The defence was that the agreement had come to an end by effluxion of time; that this was a covenant to lend money, and that an action for debt did not lie.

In the result judgment was given for plaintiffs, his lordship saying that the fact of six months running out before the issue of the writ was no reason why the plaintiffs should not recover. The indenture was not a covenant to lend money, but a recognition of a debt, and an action for debt did properly lie.

Musker v. Riverside Cold Storage and Ice Co.

At Liverpool, last week, before Mr. Justice Grantham, Messrs. C. and A. Musker (Ltd.) sued defendants for the balance of contract price for supplying and erecting electric hoists, with extras, &c. The evidence was to the effect that plaintiffs contracted to construct and erect two electric lifts and two electric hoists at certain warehouses on the Albert Dock for defendants. There were two contracts (dated April 11 and May 19), and delivery of the lifts was to have been made on July 4, and Aug. 8, 1899. One of the lifts (for ice) was delivered on Aug. 5, and the other, for coal, on Aug. 15. There was therefore a delay of upwards of a month, and this was made the basis of a counter-claim. From March to July 22, however, there was a strike of pattern-makers, which caused delay. The first contract was subject to delays arising from strikes, disputes with workmen, accidents, and the second, which was for two electric hoists, was subject to the same exceptions, but did not include builders' work. The date fixed was Aug. 8, but it was Sept. 8 before they were delivered, on account of the causes named and others. Plaintiffs' claim was admitted to the extent of £257. 15s. There was also a claim of £69. 5s. 4d. for extras, of which £34. 6s. was admitted. The total amount admitted was £292. 14s. 4d. The extras disputed were £25 for repairing an armature in connection with the electric machinery, and £9 for a support for the hoists. Eventually it was agreed that judgment should be entered for plaintiffs for £227, and that the counter-claim should be struck out.

Bowen v. Duc d'Orleans.

This was an action heard in the Court of Appeal before Lords Justices A. L. Smith, Henn Collins, and Romer, being an appeal of the defendant from the judgment of Mr. Justice Wills. Mr. Kerbey Bowen is an electric launch builder at Eel Pie Island, a spot on the Thames near Twickenham, and was the owner of a portion of the island. His case was that defendant had entered into a contract to purchase his interest in Eel Pie Island for £4,500, that the contract was completed, and this was the amount sued for in the original action which was given in his favour.

After hearing the evidence, their lordships held that the contract between the parties was not binding, and allowed the appeal, but allowed defendant no costs of the appeal, being of opinion that it was a very hard case for the plaintiff.

DEATH FROM ELECTRIC SHOCK.

On Wednesday last week a fatal accident happened to Samuel Robert Harvard, an electrical engineer in the employ of the Blackheath and Greenwich District Electric Lighting Co., at their works at East Greenwich. The deceased, who was in his 21st year, had only been in the company's service a few days, and was employed on the night shift. He was an experienced and very skilful electrician. He had served 2½ years at one of the leading technical colleges, and had been with Messrs. Johnson and Phillips, at Charlton, for a further 2½ years. Mr. Harvard had for some time expressed a desire to take up central station work, and his particular knowledge of the construction of the switchboard which was the actual cause of his death led to his being appointed by the Blackheath and Greenwich Co. as assistant shift engineer. The board was in fact constructed by the deceased and his brother. Mr. Harward's shift was from 11 p.m. to 7 a.m., and just before the time for ceasing work on

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Wednesday morning last week he was observed to be leaning back against the board in a stupefied condition, and it was discovered that he had touched with his knuckles the springs of a high-tension switch which was in circuit and carrying a current of 2,750 volts. Every effort was made to restore consciousness, but without avail, and death must have been instantaneous, as deceased was seen just before the moment of the accident mounting the stairs to the switchboard platform.

An inquest was held on Friday last on the body of Samuel Robert Harvard, before Mr. Deputy Coroner E. M. Wood, at the St. Alphege Mission Room, Greenwich.

Mr. ROBERT S. HARVARD said deceased was his son, and was in his 21st year. He was an electrical engineering pupil employed at the central station of the Blackheath and District Electric Light Co., but had only been there three days. Deceased had been studying electricity for five years, and had previously been employed in two workshops. Deceased went to work at 10.30 on Tuesday night, being on the night shift for the first month. At eight o'clock a message came from the works to say that he was ill, but when witness went down with a doctor he found that he was dead. Deceased had complained that the platform on which he worked was imperfect and dangerous, and the day before his death he had asked for candles, saying that if the light failed he would be in a serious predicament.

Mr. J. A. CONSTABLE, resident engineer at the works, said deceased's duty was to regulate the voltage, and it was not his business to touch the metallic parts of the switch. The platform he worked on was lighted electrically, and was about 4ft. in width. The switches were for disconnecting the electrical machines from the main, and the handles were insulated. Witness could not conceive that deceased touched the switch intentionally. The voltage on the machine by which deceased met his death was 2,750. All the metal of the switches above the handles was exposed—he thought it was absolutely essential that it should be so exposed. It could be partially covered with thin insulating material, but it would not be possible to cover the part which one was most likely to touch. If the floor were insulated it would be an additional protection against the current passing through a man's body in the case of accidental contact. A dry wood covering or an indiarubber mat would have done this. He considered the present floor of concrete adequate. He admitted that in this case there was nothing to prevent death if a man touched the switch. The question of additional safeguards had been considered, but it was thought unnecessary to insulate the floor. Witness asked the consulting engineer if he should, and that gentleman said that he did not think it necessary in view of the arrangement of the switches, and witness agreed with him. One way in which the accident might have occurred was by the deceased slipping, putting his hand out to catch the handle, and missing it and going over it, his knuckles going against the spot where it was evident that contact had been made. The wood covering to the platform had been put down since the accident. He himself did not know of it being put down at the time, but he thought that as there had been an accident they had better put down some dry wood. It was the back of deceased's knuckles that had touched the switch.

CHRISTOPHER COE, labourer, said he saw deceased fall. He thought he had fainted, and ran up, but saw directly that he had had a shock. He only breathed once or twice.

THOMAS W. MERRY, engineer in charge of a shift at the works, said he tried artificial respiration, but from the appearance of the body he did not think there was any possibility of his recovering.

Dr. H. DAVIS said he had made an autopsy, and there was a cut on the knuckle of the right forefinger where the current entered the body. The wound was cauterised. The heart was practically empty of blood. A number of the smaller blood-vessels had given way. It was witness's opinion that deceased died instantaneously from electric shock. In his opinion the platform should have been insulated, and the electric poles projected too far. It would not have been possible to have restored the deceased by artificial respiration.

The jury found that death was due to an electric shock accidentally received, and added a rider to the effect that the floor should have been properly insulated.—The Deputy-Coroner, in drawing up the verdict, made the rider read "That the accident was due to the absence of proper precautions on the part of deceased's employers."—Mr. Batchelor (representing the company) protested, saying that this was not the finding of the jury, but the jury agreed to endorse it.

Public Lighting in St. Louis.—The experience of the residents of St. Louis must be absolutely unique in the history of the electric lighting industry. That the streets and public places of a large city should be left in utter darkness, because of a difference as regards the price to be paid for these lights, is a circumstance which has probably not had a parallel in cities of the same size. According to the *Western Electrician* of Chicago, the St. Louis Board of Delegates desired, mainly because of the low state of the city's finances, that the price heretofore paid to the local lighting company be considerably reduced. This reduction the company refused to accept, and accordingly, as soon as the existing contracts had expired, it cut off all the public lights, leaving the official buildings and public institutions to fare as best they could. So low are the city's finances that the Board explains there are not sufficient funds to pay the police next month.

TRADE NOTES AND NOTICES.

[Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.]

NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers, or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London:—

READY.

(Price 12s. 6d., by post, 13s. 3d.; Colonies, 14s.; abroad, 14s. 6d. (United States, 15s.)

"The Electrician" Electrical Trades' Directory and Handbook for 1900 (corrected to January 31st, 1900).—In addition to the well-known features of this Directory and Handbook (all of which have been carefully revised and brought quite up to date), a large addition has been made to the Handbook Division, including a Digest of the Law of the Telegraph and Telephone, for the use of municipalities and companies contemplating applying to the Postmaster-General for a Telephone Licence. This section of the book now includes the new model form of Licence issued by the Postmaster-General in January, the Telegraph Acts and Orders passed by Parliament in 1899, and other information in connection with this the latest development of electrical enterprise. The huge sheet tables of Electric Light and Power and Electric Railway and Tramway undertakings of the United Kingdom have been made complete up to the 31st January. These sheets form a most complete record of electrical engineering progress in connection with electricity supply and power and traction applications. The Directory Division has been carefully extended and corrected up to Feb. 2, and is the most reliable list of firms and persons engaged in the electrical and allied industries ever compiled. A number of additional sketches of the careers of well-known electrical experts have been added to the Biographical Division, together with many new portraits. The new volume is, we claim, the most complete and correct book of its kind ever published in any language. An analytical digest of the contents of this volume can be obtained post free.

"Localisation of Faults in Electric Light Mains."—By F. C. Raphael. Price 5s., post free. The book deals with the important subject of localising faults in electric light and power cables; and the various methods of insulation testing are here collected and discussed.

"Wireless Telegraphy: Signalling across Space without Wires by Electric Waves." A Review of the Work of Hertz and his Successors.—By Dr. O. J. Lodge, with a large number of illustrations. New and Enlarged Edition, 5s. nett. *Now ready.*

"Practical Notes for Electrical Students."—By Messrs. A. E. Kennelly and H. D. Wilkinson. Price 6s. 6d., post free. The authors give in a clear and concise manner a good summary of the general principles of electrical science.

"The Incandescent Lamp and its Manufacture."—By Gilbert S. Ram. Price 7s. 6d., post free. The principles underlying the manufacture of the incandescent lamp are carefully and fully dealt with in this volume.

"The Centenary of the Electric Current, 1799-1899."—By Dr. J. A. Fleming. Price, paper covers, 1s. net, post free 1s. 3d.; strong cloth, 2s. 6d., post free.

"Motive Power and Gearing for Electrical Machinery."—By E. Tremlett Carter, C.E., M.I.E.E. Price 12s. 6d., post free. In this comprehensive work an account is given of the scientific principles and modern practice in the use of engines for dynamo driving, not only for isolated power plants, but also for public electric lighting and power stations. The various forms of gearing in the power station and for electric motors are also dealt with; and the book contains, in addition, numerous tables giving exact data of the equipment and working of electric power stations.

"The Manufacture of Carbons for all Electrical Purposes."—by Francis Jehl. 10s. 6d., post free. This is a practical handbook, giving a complete description of the art of making carbons for electric lighting, electrodes, &c., with particulars of the various gas generators and furnaces used in carbonising. The work also contains particulars of the cost, &c. of erecting and working carbon works, and plans of a model factory.

"Electromagnetic Theory."—By Oliver Heaviside. *Vol. I.*, 12s. 6d. *Vol. II.*, 12s. 6d.

"Electric Motive Power," by Albion T. Snell, contains the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. Price 10s. 6d., post free; abroad, 11s.

"Electrical Testing for Telegraph Engineers."—By J. Eton Young, M.I.E.E. The scope of the book aims at furnishing a fuller treatment of the subject, from the standpoint of the Telegraph Engineer, than it has hitherto received, whilst it endeavours to facilitate a thorough comprehension of the theory of testing as applied to electrical lines in general. Demy 8vo, fully illustrated. 10s. 6d., post free.

"Electric Lamps and Electric Lighting," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is handsomely bound, and full of original illustrations, designs, initials, &c. *New and Cheaper Edition now Ready.* 6s., post free.

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"SUBMARINE CABLE-LAYING AND REPAIRING.—By H. D. Wilkinson M.I.E.E., &c., fully illustrated; price 12s. 6d. This work gives a detailed technical summary of modern practice in manufacturing, laying, testing, and repairing submarine telegraph cables.

"THE STEAM ENGINE INDICATOR AND INDICATOR DIAGRAMS."—Edited and enlarged by W. Worby Beaumont. Price 3s. 6d., post free. This work is a concise guide to the objects, construction, and use of the steam engine indicator and to the interpretation of indicator diagrams.

"THE ART OF ELECTROLYTIC SEPARATION OF METALS."—A second issue of Dr. Gore's book is now ready, price 10s. 6d., post free. The author treats fully both the theoretical principles of the art of electrolytic separation of metals and the practical rules and details of technical application on a commercial scale. The work is adapted to the use of the manufacturer as well as the student.

"DRUM ARMATURES AND COMMUTATORS," by Mr. F. Marten Weymouth. also ready. Price 7s. 6d., post free. Propsectus on application. This is a complete treatise on the theory and construction of drum winding, and of commutators for closed coil-armatures, together with a *résumé* of the principal points involved in their design, and an exposition of armature reactions and sparking.

"LABORATORY NOTES AND FORMS."—We have ready a set of 40 Elementary and Advanced Exercises for use with Electrical Engineering classes. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators, and Students. The object of the series is the saving of the time of the Teacher and his Assistants, and to serve as a record of the work done by the Student. Each Form is supplied either singly at 4d., or 3s. 6d. per dozen net; in sets of any three, 1s. net; or the set of Twenty (Elementary or Advanced) Exercises can be obtained, price 5s. 6d. net. The complete set of Twenty Elementary and Twenty Advanced Exercises are price 10s. 6d. net; or in handy portfolio, price 12s. net; or bound in strong cloth case, price 12s. 6d. net. Strong portfolios can be had, price 1s. each.

NOW READY.—The cheaper edition of Dr. J. A. Fleming's "Electrical Laboratory Notes and Forms." These cheaper Forms have been prepared for the use of students and teachers at the Polytechnics and other Science classes throughout the country. The demand for the original set of these Notes and Forms has led to a request for a cheaper set for use at the day and evening classes at many of the technical institutes. These new Forms, which differ only from the higher-priced set in being printed on smaller and cheaper paper, and with less space for tabulated records, are issued at half the price of the original set.

"ELECTRICAL ENGINEERING FORMULÆ," a pocket book, by Messrs. W. Geipel and H. M. Kilgour; price 7s. 6d.; by post, 7s. 9d.; abroad, 8s. *New Edition in the press.*

"THE ALTERNATE CURRENT TRANSFORMER."—By Prof. J. A. Fleming, M.A., D.Sc., F.R.S. Vol. I.—*New Edition.* Price 12s. 6d., post free, Vol. II., price 12s. 6d., post free, is also ready.

"THE MANUFACTURE OF ELECTRIC LIGHT CARBONS."—A Practical Guide to the establishment of a Carbon Manufactory. Fully illustrated price 1s 6d.; post free, 1s. 9d. In this work the author gives useful hints as to the manufacture of electric light carbons, including the preparation of material, firing, saturating, and coring, together with a description and estimate of cost of the plant required.

TENDERS INVITED.

The Visitors committee of the Lancashire County Asylum, *Rainhill*, invite tenders for the supply and erection of (1) three Lancashire boilers and superheaters and a Green economiser; (2) three 175 B.H.P. steam dynamos, with booster, switchboard, feed pumps, piping, tanks, cranes, and other accessories; (3) storage battery of 1,200 ampere-hour capacity and accessories; (4) feeder mains (solid system); and (5) wiring of buildings. Specifications, &c, can be obtained from the consulting engineer (Mr. Thomas L. Miller, M.Inst.C.E.), 7, Tower buildings, Water-street, Liverpool. Further particulars are set out in an advertisement. Tenders must be delivered at the Asylum, addressed to chairman of committee, by noon of March 22.

The *Leeds* Tramways committee invite tenders for one, two, or three steam dynamos. Specifications, &c., can be obtained at the offices of the city engineer (Mr. Thomas Hewson, M.Inst.C.E.), Municipal Buildings, Leeds, or of the consulting engineers (Messrs. Hopkinsons and Talbot), 26, Victoria-st, Westminster, S.W., and 29, Princess-street, Manchester. Further particulars are given in an advertisement, and tenders must be delivered at the town clerk's office, Town Hall, Leeds, by March 21.

The *Burton-upon-Trent* Corporation invite tenders for providing and erecting a complete electric lighting installation at their sewage pumping station at Clay Mills. Specifications, &c, may be obtained of the borough engineer and surveyor (Mr. George T. Lynham). Further particulars are given in an advertisement, and tenders must be delivered at Mr. Lynham's office by 10 a.m. of March 5.

The *Farnworth* Urban District Council invite tenders for the supply and erection of (1) Lancashire boilers, economisers, condensing plant, feed pumps, steam exhaust pipes, &c.; (2) three 120-kw. steam dynamos; (3) lighting switchboard; (4) traction switchboard; (5) accumulators; (6) underground cables; (7) travelling crane; (8) re-cooling tower. Specification, &c., can be obtained from the consulting engineers (Messrs. Lacey, Clirehugh and Sillar), 2, Queen Anne's-gate, Westminster, S.W., and 78, King-street, Manchester. An advertisement gives further particulars, and tenders must be delivered to the clerk (Mr. David Crossley), Council Offices, Farnworth, Lancs, by March 7.

The *Brighton* Corporation invite tenders for the supply and erection of a combined feeder and dynamo switchboard at the electricity station, North-road. An advertisement contains further particulars, and specifications may be obtained at the office of the town clerk (Mr. Francis J. Tillstone), Town Hall, Brighton. Tenders must be left at Mr. Tillstone's office before 10 a.m. on March 9.

The *Swansea* Corporation invite tenders for supplying and laying insulated electric mains, conduits, junction boxes, &c. Specifications may be obtained at the Guildhall, Swansea, and further particulars are set out in an advertisement. Specifications may also be inspected (but not obtained) at the offices of the consulting engineers (Messrs. Kincaid, Waller and Manville), 29, Gt. George-street, Westminster, S.W. Tenders must be sent to the town clerk (Mr. John Thomas), Guildhall, Swansea, by noon of 12th inst.

The *Barrow-in-Furness* Corporation invite tenders for the supply and erection of (*a*) water-tube boiler and steam and other pipes and sundry ironwork; (*b*) surface condenser, air and circulating pump, cooling tower, pipe connections, valves, and sundry ironwork. Specification may be obtained from the Town Hall, Barrow-in-Furness, or at the office of the consulting engineers (Messrs. Kincaid, Waller and Manville), 29, Great George-street, Westminster. An advertisement gives further particulars and tenders must be sent to the town clerk (Mr. C. F. Preston), Town Hall, Barrow-in-Furness, before March 19.

The *Dartford* District Council require tenders for the supply of generating plant for their proposed electricity supply works. Further particulars of the Council's requirements are given in an advertisement, and copies of specifications, &c., may be obtained at the offices of the clerk (Mr. J. C. Hayward), Sessions House, Dartford. The works will be carried out to the plans and specifications of the consulting engineer (Mr. W. C. C. Haytayne), 9, Queen-street-place, London, E.C., from whom further information can be obtained after 5th inst. Tenders, addressed to the clerk must be delivered at Sessions House, Dartford, by noon of 27th inst.

The Vestry of *St. Mary, Islington* (London), invite tenders for the supply of electrical stores for one year from March 25. Some particulars as to conditions of contract, &c., will be found in an advertisement, and forms of tender and further particulars can be obtained and the draft contract inspected after March 5, at the Vestry Hall, Upper-street, N. Tenders must be in not later than noon of 14th inst. Mr. W. F. Dewey, Vestry Hall, Upper-street, N., is clerk to the Vestry.

The *Great Central Railway Co.* invite tenders for the supply of stores and materials during the twelve months ending April 30, 1901, including telegraph and electric light materials, wire, signal materials, screws, asbestos packing, indiarubber, brass sheets and tubing, &c. Specifications from the secretary (Mr. Oliver S. Holt), London-road station, Manchester, and tenders to Mr. Holt by 10 a.m. of the 6th inst.

The *Edinburgh* Corporation invite tenders for an electric lighting installation at Shrubhill power station. Tenders to town clerk (Mr. Thomas Hunter, W.S.), City Chambers, Edinburgh, by March 5.

The Corporation of *Durban* (Natal) invite tenders for the supply and delivery at Durban of: 1,900 tons steel girder rails, 64 tons fish plates, the necessary fish bolts, nuts, tie bars, and electric bonds; 407 lots Australian hardwood stringers, with the necessary dog spikes. Specifications and tenders (in duplicate) to Messrs. Webster, Steel and Co., 5, East India-avenue, London, E.C., by March 8, or to town clerk, Durban, by mail delivery on or about April 2.

Tenders are invited for the hire or purchase of about 12,000ft. of new or second-hand narrow-gauge rails (16in. to 24in.), crossings, turntables, switches, and trolleys for the *Glasgow* International Exhibition, 1901. Particulars from the engineer (Mr. T. Young), 4, West Regent-street, Glasgow.

Newcastle-upon-Tyne New Tramways committee invite tenders for a 50 ton, a 25 ton, a 6 ton, and a 2 ton electric crane. Tenders to town clerk by noon, March 5.

The *Manchester* Corporation invite tenders for stores, including electrical goods, for 12 months from April 1. Tenders to town clerk by March 5.

The *Huddersfield* Corporation invite tenders for steel tramway (girder) rails, fishplates, &c. Tenders to town clerk by March 12.

The *South Shields* Corporation require tenders for high and low-tension cables and ducts. Tenders to town clerk by March 12.

The *West Bromwich* Corporation require tenders for erecting electricity station buildings, chimney shaft, ironwork, &c. Tenders to chairman Electric Lighting committee by 15th inst.

The *Blackpool* Tramways committee invite tenders for the construction of a double line of tramways in Central Drive, the Corporation providing all materials. Tenders to chairman by 12th inst.

The *Blackpool* Corporation also want tenders for extending their electricity station buildings. Tenders to borough electrical engineer by March 6.

Tenders are required for wiring the crypt of the *Leeds* Town Hall. Tenders by March 8.

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The *London* County Council Asylums committee require tenders for electric lighting sundries for their Claybury and Heath asylums. Tenders to 6, Waterloo-place, London, by March 14.

The *Rotherham* Corporation invite tenders for the erection of an electricity station building. Tenders to the architect, Old Bond-buildings, High-street, Rotherham, by March 9.

The *Wangford* (Suffolk) Guardians require tenders for supplying and fixing telephones. Tenders to the clerk, Beccles, by 10th inst.

The *Almaden* (Spain) municipal authorities invite tenders for the electric lighting of the town for ten years. Tenders to El Secretario del Ayuntamiento.

TENDERS RECEIVED AND ACCEPTED.

The following tenders have been received by the Hastings Corporation for transformers and sub-station switchgear.

Supply, delivery, and maintenance of twelve 20 kw. transformers.

Elec. Construct'n Co. (*accepted*)	£588	Gilbert Arc Lamp Co.	£695
Siemens Bros. and Co.	612	British Thomson-Houston Co.	780
British Transformer Mfg. Co.	678	Brush Co.	890
Burnand and Co.	680	S. Z. de Ferranti, Ltd.	921
John Fowler and Co.	684		

High-tension and low-tension alternate-current switchgear for eight sub-stations.

Cowans, Ltd. (*accepted*)	£1,548 16	John Fowler and Co. (for 'bus bars and fuses only)	£343
Siemens Bros. and Co.	1,759 0		
Brush Co.	1,905 0		

The Hull Tramways committee recommend for acceptance the tender of the British Thomson-Houston Co. for the supply of 35 double motor equipments and 10 car bodies (double-decked, to seat about 51 passengers), at £14,568. 15s. Messrs. Macartney, McElroy and Co. tendered at £14,575, and the British Westinghouse Electric and Mfg. Co. at £14,813. There were several still higher tenders.

The tender of Messrs. Heep and Worthington has been accepted for wiring and fitting up the Stockport Infirmary for the electric light. About a dozen tenders were received.

The Hull Corporation have accepted the tender of Messrs. R. W. Blackwell and Co. for the supply of 30 cast-iron pillars (each containing eight switch fuses, &c., at £691. 17s. 6d. Particulars of the contract were advertised in our issue of Jan. 12. Eleven tenders, varying in amount from £597. 13s. 6d. to £3,180, were received.

The Newcastle and District Electric Lighting Co. (Ltd.) have placed an order with Messrs. C. A. Parsons and Co. for two 1,000 kw. turbo-generators, each plant consisting of one steam turbine coupled to two continuous-current dynamos in tandem, each dynamo to give an output of 500 kw. and 500 volts.

The Glasgow Tramways committee recommend the acceptance of the tender of the J. G. Brill Co. (Philadelphia, U.S.A.) for the supply of 300 tram trucks at £56 each; that of the British Westinghouse Electric and Manufacturing Co. for 200 car equipments, motors, &c., at £228. 19s. each; and that of Messrs. Dick, Kerr and Co. for 100 car equipments at £120 each.

The Newcastle-on-Tyne Corporation have accepted the tender of Messrs. E. Nuttall, of Manchester, for laying 72 miles of tramway track for £105,000. In addition to this sum there is £33,000 for rails and fastenings and £5,000 for junctions and points. The Corporation have also accepted the tender of the British Westinghouse Co. for the supply of generators mentioned in our last issue.

APPOINTMENTS VACANT.

A mains superintendent and assistant-in-charge are required for the West Ham electricity department. An advertisement contains some further information, and full particulars and forms of application may be obtained at the offices of the borough electrical engineer (Mr. J. K. Bock), Abbey Mills, West Ham, London, E. Applications to town clerk (Mr. Fred E. Hilleary), Town Hall, West Ham, E., by March 8.

The British Electric Traction Co. require a district superintendent for North Lancashire, Westmorland, and Cumberland. An advertisement contains further particulars, and applications should be sent to the secretary (Mr. Geo. Stevens), Donington House, Norfolk-street, Strand, London, W.C.

The Brush Electrical Engineering Co. require an experienced works manager for their Falcon Works, Loughborough. An advertisement contains further particulars, and applications should be addressed to the secretary, 49, Queen Victoria street, London, E.C., by March 15.

The Bexhill Council require an assistant electrical engineer. An advertisement contains further particulars, and applications must be sent to the electrical engineer (Mr. Walter T. Le Feuvre), electricity works, Bexhill, by March 10.

A laboratory assistant and mechanic is required for the National Physical Laboratory. An advertisement contains further particulars. Applications should be addressed to the director (Prof. R. T. Glazebrook), Old Deer Park, Richmond.

The Bray District Council require an assistant electrical engineer. Application to the clerk (Mr. P. Macdonnell), Town Hall, Bray, by 10 a.m. of the 15th inst. See advertisement.

A switchboard attendant is required for the Chester electricity department. Applications to city electrical engineer (Mr. F. Thursfield), New Crane-street, Chester. See advertisement.

BUSINESS NOTICES.

The Hart Accumulator Co. notify us that they have received orders for the supply of storage batteries for the electricity supply schemes at Hertford, Penarth, Durham, Lewes, Weston-super-Mare, Barnet, and Gateshead-on-Tyne.

The Glasgow offices of the Telegraph Manufacturing Co. have been removed from 30, Hope-street, to 177, West George-street.

BANKRUPTCIES, LIQUIDATIONS, &c.

A scheme of arrangement has been provided under which A. E. McKechnie, of Newton-road, Bayswater, London, will pay a composition of 7s. 6d. in the £. Debtor has for some years been interested in the development of electrical patents, and attributes his insolvency to losses on advances made in connection with these patents.

In the failure of C. F. S. Pilling, electrician, Halliwell-road, Bolton, the trustee has been released.

A meeting of the creditors and shareholders of the Beaman and Deas Syndicate (Ltd.) was held in London on Tuesday. The official receiver reported that the company was formed in June, 1895, with a nominal capital of £30,000, to acquire certain patent rights relating to refuse destructor furnaces. A very small proportion of the capital was subscribed, a large number of shares being apparently distributed amongst the directors. The capital of the company was increased from time to time, but no further money was subscribed. In order to exploit the patents, contracts were accepted at unremunerative prices, and the balance-sheet for 1898 showed a deficiency of £9,634. The business was conducted throughout at a loss. Debentures were issued. A provisional contract for the sale of the company's assets for £14,450 had been entered into by the receiver appointed by the debenture-holders, which would leave nothing for distribution amongst the unsecured creditors standing in the books at £7,458.

The first meeting of creditors and contributories of the Madras Electric Tramways Co. (Ltd.), resident in the United Kingdom, will be held on 9th inst., at 33, Carey-street, London, W.C.

Matthew Henry Barber, electrical engineer, trading as Donnison, Barber and Co., 10, Corporation-street, Manchester, and 8, Mostyn-street, Llandudno, has executed a deed of arrangement. Liabilities £6,051. 0s. 5d., assets £4,664. 2s. 5d. Mr. J. Wilson, 37, Brown-street, Manchester, is trustee. The following are the principal trade creditors:—

D. Bruce Peebles and Co.	£710	J. Woodall (exors. of)	£25
General Electric Co.	484	Veritys Ltd.	25
Simon, Berry and Co.	278	A. and R. Cochran	23
Tudor Accumulator Co.	232	Drake and Gorham	20
Moores, Farrell and Co.	189	F. J. Borland	20
Heaton and Smith	175	Crompton and Co.	19
Beecroft and Wightman	174	Penistone Electrical Co.	18
Johnson and Phillips	120	J. McLellan	17
F. Rowcliffe	105	G. Casperson	15
Ward and Goldstone	94	St. Helens Cable Co.	15
H. S. Nowell	87	Inigo Jones and Co.	14
Cunliffe and Croom	77	Ross, Courtney and Co.	14
Gaskell and Grocott	74	Safety Concentric Wiring Co.	14
Simplex Steel Conduit Co.	60	I. Wild	12
F. and C. Osler	56	Automatic Standard Screw Co.	11
S. M. Van Hinden Elec. Co.	56	National Electric Wiring Co.	11
E.P.S. Co.	55	Best and Lloyd	10
Sessions and Sons	53	British Thomson-Houston Co.	10
Baxendale and Co.	42	Davis and Timmins	10
Richardson and Co.	37	Harrison and Singleton	10
J. F. Bryan	33	National Telephone Co.	10
Lander and Larsson	31	Northern Rubber Co.	10
Elliott Bros.	30		

Sale by Auction.—Particulars will be found in an advertisement of an unreserved sale by auction by Mr. J. A. Y. Matthews, on Wednesday and Thursday, March 7 and 8, of the valuable nearly new fixed plant and machinery at the North Wilts Engineering and Electrical Works, Swindon, Wilts. The plant, in addition to a large stock of engineers' tools, includes a quantity of electric lighting appliances and other machinery and apparatus, a portion of which is detailed in the advertisement. All further information and copies of the catalogue (which will be ready shortly, price 6d.) can be obtained from Messrs. Townsend, Jones and Wood, solicitors, Swindon, or at the auctioneer's offices, Park House, Swindon. The sale commences each day at 11 a.m.

Plant for Sale.—Messrs. Albright and Wilson (Ltd.), Oldbury, near Birmingham, have for sale three Babcock-Wilcox boilers and a Crompton steam dynamo. See advertisement.

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For Disposal.—An advertisement on another page announces for disposal the patent rights of "a new accumulator," for which certain advantages as to weight and solidity are claimed.

Jointing Tape, &c.—We have received from the St. Helens Cable Co a fine sample of vulcanised rubber tape intended for use in jointing cables, which is called "N. Tape." It is claimed to be cheaper and more efficient than pure rubber for making joints on internal work, and that it can never become converted into a viscous mass by exposure. The makers guarantee that the material, which is supplied ready for use, will not attack either plain or tinned copper, and that it is at the same time waterproof and indestructible The weight of $\frac{1}{16}$in. thick tape is 10lb. per square yard. We have also received lists of various types of rubber cable and of "Impregnable" paper cables. The list does not state whether these cables are impregnated as well as being impregnable. This "impregnable" paper is also employed between layers of rubber in the manufacture of a new kind of rubber floor coverings for high-pressure generating stations.

Asbestos Specialities.—A set of catalogues is issued by Cresswell's Asbestos Co. (Ltd.), describing and illustrating a variety of asbestos specialities manufactured by the company for electrical and engineering purposes.

Ward-Leonard System of Motor Control.—The Ward-Leonard Electric Co., of America, send a pamphlet relating to this system of electric motor control, extensively used in the United States for lift and other forms of electric motor plant. The same company also forward a catalogue of their rheostats and circuit-breakers, which are made in a variety of forms suitable for different purposes.

Traction Supplies.—Messrs. R. W. Blackwell and Co. forward their catalogue No. 24, for February, 1900, of engines, valves, pipes, fittings, &c, for electric traction power stations; also apparatus, tramway material, and electric supplies for the equipment of electric tramways. The volume consists of 80 large pages, well bound, and copiously illustrated with traction details and views of stations, lines, &c. One useful feature, to which we may call attention, is the subdivision of the catalogue into a number of alphabetical sections, which are readily accessible by means of a thumb index. The extensive work done by this firm in the form of electric traction in this country should render this useful catalogue acceptable to a large circle of engineers and tramway men.

German Electric Tramways.—We have received from the Allgemeine Elektricitäts Gesellschaft a handsome bound volume giving numerous illustrations and brief descriptions of the electric tramways equipped by this German firm. The letterpress is printed in German, French, and English, in parallel columns, and this, together with the numerous photo-illustrations and views, combine to produce a very handsome album of just 400 pages relating to electric traction work.

Exhibition.—An international exhibition will be held at Canea this year, under the patronage of Prince George of Greece and the Cretan Government. According to official statements, the following are likely to find a ready market in Crete: Machinery, engines, motors, fire engines, iron and steel goods, tools, photographic apparatus, &c. The exhibition will be opened on April 11, and will be closed on May 7. Applications for space, &c., should be made to the manager (Mr. Arthur Gobiet), Prague-Carolinenthal, Bohemia.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Feb. 21 to Feb. 27, with the ports of destination:—

Africa—Durban, £973 (including £763 telegraph material); East London, £40; Mogador, £44. *Argentina*—Buenos Ayres, £393 (including £200 telegraph wire). *Australasia*—Adelaide, £350; Auckland, £20; Fremantle, £820; Launceston, £60; Melbourne, £960; Sydney, £1,666; Wellington, £119. *Belgium*—Ostend, £112. *Brazil*—Rio Janeiro, £202. *British Guiana*—Demerara, £52. *Canada*—Halifax, £10. *China*—Shanghai, £377 (including £122 telegraph material); *Cochin China*—Saigon, £696. *Colombia*—Santos, £30. *France*—Paris, £89. *Germany*—Hamburg, £66. *Gibraltar*, £20. *Holland*—Amsterdam, £285. *Hong Kong*, £213. *India*—Bombay, £201; Calcutta, £230. *Japan*—Kobe, £737. *Malta*, £32. *North Atlantic*, £1,380 (telegraph cable). *Straits Settlements*—Singapore, £298. *Tonquin*—Heiphong, £172. Total £10,647, against £13,977 in the corresponding week last year (Feb. 22 to 28).

MUNICIPAL, FOREIGN, AND GENERAL NOTES.

A Missing Engineer.—*Lloyd's News* of Feb. 23 announced the mysterious disappearance of Mr. Horace J. Brydon, who for the past 18 months has been resident engineer of the Dublin United Tramways Co., representing Mr. H. F. Parshall. Mr. Brydon, it appears, was due to reach London on Feb. 11, having apparently left Dublin on the 10th. Fears are entertained that Mr. Brydon may have met with foul play, as it is remembered that during a recent strike of workmen he was compelled to obtain police protection, and he had in his possession, we understand, a good sum of money. We were informed last evening that up to 6.10 p.m. no trace had been found of Mr. Brydon. Following is the description of the missing gentleman Age 29, height 5ft. 10in., brown hair, slight dark moustache, dark brown eyes, and prominent nose; complexion fresh, but possibly pale, as he had recently had influenza. Left the Central Hotel, Dublin, at 7.20 p.m. on Saturday, Feb. 10, intending to travel by the night mail to London. Dressed in dark clothes, with black Chesterfield overcoat and black bowler hat. Information should be addressed J. M. Brydon, 31, Steele's-road, Haverstock-hill, London, N.W.

African Land Line Telegraphs.—The Uganda railway telegraph line is reported to have reached the Nile, at Ripon Falls, on the 18th inst., and was taken across the river in two spans on the 19th inst., telegraphic communication thus being established between London and the sources of the Nile.

Alfreton.—A provisional order is to be applied for and electricity supply works, estimated to cost about £12,000, are to be established by the Council, who have retained Mr. J. S. Barnes as consulting engineer.

Asylum Lighting.—Mr. A. A. Campbell Swinton has been instructed to prepare a specification for the electric lighting of the County Lunatic Asylum, Morpeth.

Barnard Castle.—The Council have decided to consult an electrical expert on the terms of purchase of the electricity works which the Northern Counties Electricity Supply Co. are seeking powers to erect. The Council wish to retain power to purchase at the end of ten years on two years' notice, the company insisting that the undertaking must be sold as a going concern if purchased at the end of that period.

Belfast.—The Electric committee propose to reduce the charge for current for lighting from 7d. to 6d. for the first hour's maximum demand, and for motor purposes from 4d. to 3d. for the first hour, and from 1½d. to 1¼d. for subsequent hours.

Bolton.—Sir F. Marindin inspected the track of the old tramway routes on Thursday. The inspector expressed the opinion that the whole of the old lines should be taken up and replaced with new rails, but he would recommend that the Corporation be given five years to carry out the work.

Bridgwater.—The Council have definitely decided to proceed with their electricity supply scheme.

Bristol.—At the Corporation meeting on Tuesday the Electrical committee recommended the appointment of Mr. K. O. Hale as architectural and engineering draughtsman in the electrical engineer's office, at a salary of £200 rising to £260 per annum. Ald. Pearson, who moved the adoption of the report, said that Mr. Hale was selected from a number of candidates, and had been engaged in many important works. Ald. Inskip moved that the appointment should not dispense with the employment of a competent architect for the works in course of construction by the committee. This amendment having been carried, Ald. Pearson tendered his resignation as chairman of the committee.

Buenos Ayres.—The *Review of the River Plate* announces that the municipality is inviting tenders for the erection and equipment of electricity works for supplying the whole of the city of Buenos Ayres with electric current for lighting and power for both public and private uses. One of the conditions permits the contractor to tender for the cost of erecting a municipal station equipped with three-phase high-pressure plant, the tenderers working the station during the period of amortisation of capital with a minimum price per kw. hour based on an output of 6,000 H.P. in units of 2,000 H.P., arrangements being made for the public lighting to be continued all night. In the event of an offer upon this basis being accepted, the municipality will provide a site for the station. The mains will be laid throughout the entire municipality and suburbs, and preference will be given to those offers which agree to the transfer of the entire undertaking to the municipality at a fixed period. Already four supply companies are at work in a portion of the area, the district being a very extensive one. Owing to the capital outlay involved in the scheme, tenderers are likely to be very few in number. So far the companies supplying current in the district have been unable to earn interest on their capital.

Country House Lighting.—The lighting of Hayes Place, Bromley, Kent, is being carried out by the Phodyne Electrical Co. to the specification of Mr. Morgan Williams. The plant consists of two 15 H.P. gas engine and dynamo belt-driven sets, with battery of 55 accumulator cells. There will be 274 lights installed.

Dock Lighting.—At the half-yearly general meeting of the Millwall Dock Co. the chairman (Mr. J. Trotter) said that hitherto all work at the docks had had to be performed during daylight, as no artificial light was available. The board learned that a considerable amount of additional tonnage could be had if facilities were given for loading day and night. The matter was investigated, and within

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three days they had one side of the inner dock lighted with the result that they had secured the increas referred to.

The Admiralty have decided to put down electricity generating plant for lighting and power purposes at Haulbowline dockyard, Cork. The work will be carried out by the electrical department of Devonport dockyard.

Electric Driving.—Messrs. Sharpe, Stewart and Co., Atlas Locomotive Works, Glasgow, are putting down generating plant for supplying electric current for lighting and power purposes. The whole of the establishment will be lighted electrically, and electricity will be employed for driving the machinery. The contract has been let to a Newcastle firm. A similar installation has recently been put down at the Hyde Park works of Messrs. Neilson, Reid and Co., and it is said that the adoption of electric driving will mean a saving of £3,000 per annum in the coal bill in the one establishment and considerably more in the other.

Electrical Progress in Italy.—During the past few weeks there has been a remarkable growth of national and foreign companies for establishing electrical undertakings in Italy. We enumerate the most important of these :—

Società per le Tramvie Elettriche di Terni.—Incorporated end of Nov., 1899, with headquarters in Rome. Capital 1,000,000 lire, entirely subscribed and three-tenths paid up. Object : the installation and operation of an electric railway from Terni to Valle del Nera, together with other electric undertakings near Terni. Duration of concession, 60 years.

Società delle Tramvie e Ferrovie Elettriche.—Incorporated Dec. 1, 1899, with headquarters in Rome. Subscribed capital 1,500,000 lire (with three-tenths paid up) ; may be increased to 15,000,000 lire. Object : to instal and operate a network of electric railways from Rome to neighbouring towns. It is reported that the first projects which this company contemplates are the substitution of electricity for steam on the Roma-Frascati railway (length about 15 miles) and the construction of an electric railway from Rome to Ostia (length about 20 miles). The latter line will afford rapid connection between Rome and the sea. The president is Count Carlo Rasponi, and the director Mr. Roberto Cavallini.

Società Anonima di Costruzioni Elettriche, Brioschi, Finzi and Co.—Incorporated Dec. 3, with headquarters in Milan. Paid-up capital 1,700,000 lire, which may be increased to 2,500,000 lire. This, a development of the existing firm of Brioschi, Finzi and Co., is engaged in the construction of electrical machinery for continuous and alternating currents.

Società Italiana di Elettricità Alioth.—Incorporated with a capital of 300,000 lire. Object : the operation of electrical undertakings in Italy. Duration of company, 20 years.

Compagnie d'Electricité Thomson-Houston de la Mediterranée.—This company has established an office in Milan, and has a capital of 500,000 lire for the exploitation of electric undertakings in Italy.

Unione Telefonica Lombarda.—Incorporated in Milan, with a capital of 350,000 lire. Object : the development of telephonic industry. The first lines and exchanges to be erected will be those connecting Milan with neighbouring towns.

Società Anonima di Electricità Umbra.—This is an offshoot of Siemens and Halske, of Berlin, and the object of the new enterprise is the operation of the important electric lighting and traction plant installed by the latter firm in Perugia. Capital 1,200,000 lire.

Société Générale des Tramways et Chemins de Fer du Centre.—Incorporated with headquarters in Naples and a capital of 1,250,000 lire. Object : the construction and operation of electric railways. A licence has already been applied for for a line between Naples and Piedmont.

The municipality of Venice are considering a project for establishing an electric launch service on the Grand Canal, and in fact trial has already been made of a launch specially constructed for this service. The launches to be ultimately adopted are to be 17 metres in length, 3 metres wide, to accommodate 60 passengers, with a speed of from 12 to 15 knots. Serious complaint is made of the damage caused to the ancient buildings which line the canal from the smoke of the steam launches and the heavy wash caused by the paddles of these boats.

A project for a long-distance electric power transmission scheme has been submitted to the prefecture of Belluno, near Venice, by Messrs. Milani and Colle, of Padua. By the utilisation of the waterfalls of Lago Santa Croce electric power will be available for use by the industrial works of Venitia. The project is being favourably entertained, and will involve a very large capital outlay. The Italian Government is, we understand, reserving the right to the last word in connection with these concessions.

Telephonic communication has been established between the islands of Murano and Lido and points on the mainland at Mestre and Treviso.

Electrical Progress in Mexico.—A company, entitled the Société Financière pour l'Industrie au Mexico, has been formed in Geneva for the purpose of financing electrical and industrial undertakings in Mexico. Amongst those interested are the Société Franco-Suisse d'Electricité.

Electric Railways in Spain.—Concessions by Royal order have been granted for the erection of an electric railway from Carthagena to Cabo de Palos, with branches to Santa Lucia, Portman, Algar, and Los Nietos. This line will be available for both merchandise and passengers. A similar concession has been granted for an electric tramway between Cadiz, San Fernando, Avanzadilla to Chiclana.

Epsom.—As the Council could not obtain a loan of £16,000 for electric lighting purposes at a cheaper rate than 3½ per cent, it has been decided to make application to the Local Government Board to authorise the issue of the amount in £50 debentures, payable in equal half-yearly instalments extending over 23 years, on the security of the rates.

Fenton.—Negotiations are proceeding between the Fenton and Stoke-on-Trent Councils in regard to the erection of joint electricity works. The Fenton Council are to submit particulars of their probable requirements and the period during which they would accept a supply of electric current from Stoke.

Friern Barnet.—The District Council have lodged a petition against the North Metropolitan Electrical Power Distribution Co.'s bill, and the Council are to discuss a motion in favour of an application for a provisional order.

Foreign Trade of the Chief Nations of the World.—Mr. C. Rozenraad has prepared the following interesting tables of the imports and exports for 1895-1899 of Great Britain, United States, Germany, France, Austria-Hungary, Belgium, Italy, and Spain :—

	Imports.				
	1895.	1896.	1897.	1898.	1899.
	£	£	£	£	£
Great Britain	416,689,658	441,809,000	451,029,000	470,518,000	485,075,514
United States	160,333,869	136,315,911	148,519,000	126,733,000	159,966,924
Germany.....	212,305,550	215,358,150	243,232,200	273,882,400	274,792,650
France.....	196,000,000	152,153,160	158,241,080	175,047,800	168,686,000
Aus.-Hungary	60,208,333	58,775,000	62,941,666	69,241,666	56,691,666
Belgium	67,216,000	65,795,560	71,781,680	77,103,680	84,314,600
Italy	43,973,637	43,710,099	44,133,287	52,345,753	56,000,000
Spain	22,890,000	24,965,212	26,139,899	19,864,191	29,266,762
	Exports.				
Great Britain	225,890,016	240,145,000	254,220,000	253,391,000	255,465,152
United States	164,972,023	201,167,449	219,941,800	250,985,000	255,097,328
Germany.. ...	171,203,800	176,256,500	189,312,050	200,087,300	207,585,350
France.....	183,560,000	136,036,800	143,918,080	140,126,680	155,965,680
Aus.-Hungary	61,816,666	64,500,000	63,850,000	67,400,000	77,366,666
Belgium	54,416,000	57,088,800	61,921,020	66,104,440	70,895,880
Italy	33,433,614	38,970,287	40,434,601	44,576,640	52,962,962
Spain	22,029,199	29,744,267	32,651,520	28,667,358	22,652,461

Gravesend.—In 1898 a provisional order was obtained for this district by Messrs. Crompton and Co. under agreement with the District Council. From various causes Messrs. Crompton have been unable to put the order into force, and the Council recently refused to sanction an application by the firm for an extension of time, deciding, on the contrary, to establish municipal works. Messrs. Crompton have protested that, while recognising that the Council are technically entitled to take this course, the cost of obtaining the order justifies them in asking the Council to reconsider the matter, and not to penalise the company by forfeiting the work and money already expended upon the order. Proposals received by the Council from the Drake and Gorham Electric Light and Power Co. to establish electricity supply works have also been rejected.

Great Grimsby.—Negotiations between the Council and the local tramways company in regard to the leasing of the local tramways have been reopened.

Guernsey.—The electricity supply works were formally started on Wednesday last.

Kingston-on-Thames.—The Lighting committee has been authorised to obtain two additional boilers for the electricity supply works, at an estimated cost of £2,700, subject to the sanction of the Local Government Board.

Lecture.—A lecture, illustrated by experiments, will be given before the Camera Club on March 8, by Mr. A. A. Campbell-Swinton, on "Steam Turbines, Land and Marine."

Light Railways.—A deputation from the Prestatyn Council waited upon the Board of Trade on Friday last, to object to the Rhyl and Prestatyn Light Railway Co. running one or two trains on Sunday. For the promoters Mr. W. Webb urged that the undertaking would be exceedingly risky unless they had a complete Sunday service. The line ran along the sea shore, and would not disturb anyone. The only effect of the objection being upheld would be that they would have to let down their passengers a quarter of a mile from the Prestatyn terminus. Sir Courtenay Boyle said he could not decide the point then, but he warned the deputation that the ratepayers of Prestatyn were going to have a meeting to represent the contrary view.

An inquiry will be held by the Light Railway Commisioners, at the Guildhall, Westminster, on 14th inst., into the application of the Middlesex County Council to construct light electric railways. The

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Council have approved of the proposed agreement with the Metropolitan Tramways and Omnibus Co. for working the lines. The Council may within six months after obtaining the order require the company to sell their interest at the cost price of the order, and in this event the Council will provide all land required for the undertaking, and construct the lines and works, but the company are to erect the generating stations, machinery, carriages, and rolling stock. If the option of purchase be exercised, the company are to do their best to procure the transfer to the Council of the lines of the North Metropolitan Tramway Co. in Middlesex; but if the sale shall not be carried into effect, the Council shall be at liberty to terminate the present agreement. The term of the lease is to be 25 years, and interest is to be paid by the company on the capital expended by the Council, equal to 4 per cent. per annum for one-third of the term, 4½ per cent. for another third, and for the remaining third 5 per cent. per annum. The company is also to pay a further rental equal to 45 per cent. of the net revenue. On the expiration of the lease the Council will acquire the undertaking at a sum to be agreed upon, or as may be settled by Board of Trade arbitration. The company must deposit £20,000 with the Council as security for the performance of the agreement, and will be empowered to work the lines projected in the Middlesex Light Railway Orders No. 2 on the same terms as those proposed under the joint order.

London County Council.—At Tuesday's meeting the Highways committee reported that the work of the erection of the generating station for the lighting of Victoria Embankment and Westminster Bridge was now in progress, and that tenders would shortly be invited for the supply and laying of the necessary mains

Col. PROBYN asked whether representation had been made to the National Telephone Co. as to the delay in reinstating the telephone lines which had been broken down by the recent storm, and whether there would be any allowance made to telephone users for the loss of service. Mr. PURCHASE asked whether the committee was considering any steps to get parliamentary powers to compel the Telephone Co. to place their wires underground and pay a wayleave to the Council. Mr. BENN said the Council had nothing to do with the reinstatement of the company's property, and he was afraid that any suggestions they made in that direction would not be respectfully received. They were anxious to see the company's wires underground, and if the Telephone Co. would agree to the same terms they readily agreed to in the case of provincial cities there would be no difficulty.

Lymington.—The contract for the equipment of electricity works for the Lymington Electric Light and Power Co. (whose Provisional order was obtained in 1898) has been placed with Edmundson's Electricity Corporation. A canvass of the town is being made.

Municipal Telephony.—A conference of municipalities took place at the Westminster Palace Hotel (London), on Wednesday, to consider the telephone question. A resolution was adopted urging municipal bodies separately to communicate with their local representatives in Parliament, with a view to obtaining their support for the Glasgow Corporation in its endeavour to obtain parliamentary protection of its streets against the Post Office, so as to prevent that body affording facilities to any private company to break up the streets for the purpose of laying wires. A sub-committee was also formed for the purpose of gathering information on the subject of telephones.

Private Bill Legislation.—The Standing Orders committee of the House of Commons have decided that the bill of the South Eastern Metropolitan Tramways Co. may proceed, provided that the whole of the proposed extensions are struck out. These extensions covered over 11 miles of new lines in Lewisham and the County of London, including a line to the Crystal Palace. The amended bill will empower the company to adapt their lines for electric traction at an estimated cost of £158,029.

The House of Lords Standing Orders committee have agreed to dispense with the Standing Orders in the case of the Airdrie and Coatbridge Tramways Bill on condition that the Coatbridge portion of the scheme is withdrawn.

"Robertson" Lamp Works.—A party of students from the Institution of Electrical Engineers visited these works last week, and were shown in detail the various operations connected with the manufacture of incandescent lamps.

Shannon Electric Power Scheme.—Some particulars of this scheme were given in a recent issue of the *Dublin Nation*. It is proposed to take water from the Shannon at a point near the entrance of the Board of Works canal at Errina, and the power house will be erected at Clonlara, where a fall of 38ft. to 40ft. can be obtained. The execution of this portion of the work will occupy, it is anticipated, two years. Electric current will be distributed from the station to Limerick. To provide compensation water to that portion of the river between the inlet and the outlet, it is proposed to utilise the great storage capacity of Lough Derg by making arrangements for lowering the lake a few feet. During eight or nine months of the year the discharge from the enormous drainage area of 4,500 square miles of the Shannon would, it is stated, suffice to generate 20,000 H.P., and the lake would require to be drawn upon for the compensation water only for a short period in each year. The execution of the work will entail an expenditure of £200,000 locally. The company's bill is now before Parliament, and is being supported by some of the neighbouring local authorities.

Sheffield.—The engagement of the engineer and general manager of the electric lighting department of the Corporation has terminated. Under the conditions upon which the undertaking of the Sheffield Electric Light and Power Co. was transferred in 1898 to the Corporation, Mr. William Johnson was given a five years engagement at £1,000 per annum. A meeting of the Electric Light committee was held on Wednesday, at which preliminary steps were taken to fill the vacancy.

Smoke Nuisance.—On Tuesday the Westminster Electric Supply Corporation were summoned for causing a nuisance through not properly consuming their own smoke at their Millbank-street station. Mr. C. Grimshaw, assistant engineer-in-chief to the company, said the usual type of furnace with water-tube boilers was employed at the works. A little extra smoke at firing-up time had been occasioned because Welsh smokeless coal was unobtainable. The London County Council had a bill before Parliament to take over the works, and pending the completion of this arrangement any change of boilers or furnaces would mean a wasteful expenditure of thousands of pounds. The magistrate, notwithstanding, inflicted a fine of £10 and £2 2s. costs.

Stoke-on-Trent.—The dispute between the Potteries Electric Traction Co. and the Corporation, as to the laying of cables under footpaths without permission from the Corporation, was recently referred to the Board of Trade, but that body has intimated to the Corporation that, as the question was of a legal character, they could not give an authoritative opinion. Counsel's opinion is to be taken.

Strike of Telephone Hands.—The strike of telephone hands, which involved about 180 men in the Leeds and Hull districts, was settled on Saturday by conceding the men's demand of 2s. per week advance in wages.

Telephone Question at Glasgow.—The minutes of the special committee on the telephone service, submitted at yesterday's meeting of the Council, contained a report by Mr. A. R. Bennett recommending that in the first instance a complete exchange for 5,250 metallic-circuit lines (5,000 subscribers within the city and suburbs, 200 in outlying places in the telephone area, together with 50 public telephone offices) should be installed. This number of completed lines exceeds by 50 that provided for in Mr. Bennett's 1897 estimate. At the same time provision should be made as regards floor space in the switch rooms, plans of the switchboards, size of distributing poles, and number of conduits in the vicinity of the switchrooms (to avoid reopening of streets) for another 5,240 lines, making a total of 10,500 lines in all. He regards available floor space and its possible future extension and accessibility of premises for conduits, a probable further expansion to 20,000 lines should be held in view. The estimated total expenditure is put at £121,000, made up as follows: 5,250 completed lines, £100,000; 5,250 partially completed lines, £21,000. The committee recommend that the Corporation should give them powers to secure premises for switch-rooms, to proceed with the organisation of a telephone department and the establishment of a municipal telephone system on the lines indicated in Mr. Bennett's report; and also to apply for the consent of the Secretary for Scotland to the Corporation borrowing £120,000 for telephone purposes in terms of the Telegraphs Act, 1899. At yesterday's meeting of the Corporation

Mr. ALEXANDER moved the approval of the minutes, and asked that the powers referred to should be granted to the committee, and also that application should be made for consent to borrow £120,000 for carrying out the scheme. He also moved that five members should be added to the committee. He drew attention to the various points of the report (as set out above), which comprehended a system which would ultimately be extended to 10,500 subscribers with a tariff of five guineas, subscribers having power to call an unlimited number of times; or an alternative toll tariff of £3. 10s. and 1d. per call. Mr. Bennett's estimate contemplated an expenditure of £95,659.

Bailie W. F. ANDERSON seconded the report, which was adopted.

Telephonic Inter-communication.—Notice has been given by the Postal Telegraph Department to postmasters that, with a view to prevent trunk calls becoming ineffective owing to the failure of the ringing current from the Post Office, the department has arranged with the National Telephone Co. that their operator shall in every case ring up the telephone subscriber once before getting his circuit to the Post Office by means of a trunk circuit. This arrangement came into force on 1st inst. This will obviate the practice now pretty general of Post Office operators, when they are unable to secure a telephone subscriber's attention by ringing, asking the National Co.'s operator to ring up the subscriber once before the call is abandoned as ineffective.

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Tipton.—The Council have decided to acquire the local tramways, and formal notice has been given to the Tramways company. The chairman of the tramways committee (Mr. Doughty) announced at the Council meeting this week that the undertaking would be purchased for £7,000, and that the necessary electrical equipment would cost about £18,000.

Wimbledon.—The Council have received sanction to a further loan of £21,545 for electric lighting extensions.

Wood Green.—Opposition to the bill of the North Metropolitan Electrical Power Distribution Co. is to be offered by the District Council, who are considering the advisability of establishing municipal electricity works. A circular has been sent out to other authorities affected by the bill, inviting co-operation in securing its rejection.

Workmen's Compensation.—In the Court of Appeal (London) judgment was given on Saturday last in an action in which the respondent was the widow of a painter (Henry Cass) in the employ of a sub-contractor under a contract to erect an electricity supply station for the Leeds Corporation. The case had already come before Judge Greenhow, at Leeds, who had awarded the widow £235. 6s. It appeared from the evidence that Cass, while painting the iron girders of the roof of the station, was standing on scaffolding belonging to the contractor for the works, a builder named Gould, when a plank broke, and Cass and another man fell and were killed. The appellant in the present action contended that he was not an "undertaker" within the meaning of the Workmen's Compensation Act, 1897, as defined by sec. 7, sub-sec. 2, of that Act. The Court allowed the appeal. Lord Justice A. L Smith, who delivered the judgment of the Court, said :—

Gould was a builder and contractor, and contracted with the building owner to construct the buildings. He then entered into a sub-contract with the appellant, whereby the latter contracted with Gould to do the painting of the building. The deceased man Cass was employed by the appellant upon the painting work. The building was a new one, and had never been painted before, and one point taken was that the painting was "construction" within the meaning of sec. 7. That point it was not necessary to determine, because the other point taken was sufficient to decide the case. It was said that the appellant was not an "undertaker" within the Act ; that Gould was the undertaker, and that if anyone was liable, it was Gould. The question, in other words, was whether a sub-contractor was an "undertaker" within the Act. It was said, on the other hand, that the respondent had the option of suing either the contractor or the sub-contractor, as they were both "undertakers." In my view this latter contention is not correct. That was not the meaning of the Act. "Undertakers" were defined in sec. 7, sub-sec 2, so far as material, as meaning persons undertaking the construction, repair, or demolition of a building. Gould was the person who had undertaken the construction of the building. The case of Mason v. A. R. Dean (Ltd), where a contractor had agreed with the building owner to construct the whole building, and had let out part by a sub-contract to a sub-contractor, was entirely different to the present case. Sec. 4 of the Act was strong to show that a sub-contractor was not an "undertaker" within the Act.

Wrexham.—The Council have accepted the offer of the Alliance Insurance Co to advance £20,000 for electric lighting purposes at 3½ per cent., the loan to be repayable in 25 years.

Marriage.—A marriage is arranged, and will shortly take place, between Mr. Henry Bligh Forde, A.M.Inst.C.E., chief cable engineer of the Norddeutsche Seekabelwerke, Nordenham, Germany, and formerly of the firm of Clark, Forde and Taylor, Great Winchester-street, E.C., and Hedwig Alice, second daughter of Baron and Baroness von Dieskau, of Rettershof, Eppstein im Taunus, Germany.

PATENT RECORD.

The following list of Applications for Patents and Specifications published has been compiled for this journal by Messrs. J. C. CHAPMAN and Co., *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs, and Trade Marks may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after the acceptance of the complete Specification. The names within parentheses are those of communicators of inventions. When complete specification accompanies application, an asterisk is affixed.*

January 24, 1900.

1,560. T. B. LAMBERT. London. Improvements in record cylinders for phonographs and method of producing the same. (Date applied for under Patents, &c., Act, 1883, Sec. 103, August 14, 1899, being date of application in the United States.)*

1,561. T. B. LAMBERT. London. Improvements in record cylinders for phonographs. (Date applied for under Patents, &c., Act, 1883, Sec. 103, November 4, 1899, being date of application in the United States.)*

1,566. M. WUILLOT. London. Improvements in or relating to accumulator plates.

1,568. C. O. BASTIAN. London. Improvements in or relating to electrolytic electricity meters.

January 25, 1900.

1,573. G. E. HEYL-DIA. Manchester. Improvements in or relating to rubber-insulated electric cables.

1,578. W. GLOINSON. Dublin. Improvements in and in connection with trolley poles of electric tramcars.

1,583. G. E. HEYL-DIA. Manchester. Improvements in or relating to the manufacture of electric cables.

1,605. W. E. AYRTON, W. F. CRAWFORD, and H. J. THOMSON. London. New or improved electrical influence machine for transforming mechanical energy into electrical energy or electrical energy into technical energy.

1,617. A. RAICHWALD. London. Improvements in or connected with carbon contacts for electrical switches and the like. (The firm of F. Krupp, Germany.)

1,618. W. KINGSLAND. London. A new or improved method of and devices for regulating or controlling electrical switches.

January 26, 1900.

1,653. D. COOK. Richmond. Method of boosting a direct current of electricity by means of an alternating current.

1,679. H. W. WEBB. London. A new and improved method of and process for insulating electrical wires.

1,680. R. C. SAYER. Bristol. Improvements in picking up electric current sent from a generating station by a railway car and returning it.*

1,692. C. ADAMS-RANDALL. London. Improvements in electric telephony.

1,694. J. T. ROBINSON and J. H. FERGUSON. London. Improvements in the treatment of carbon electrodes for electric arc lights.*

1,704. B. J. B. MILLS. London. An electric alarm. (D. Pial, jun., France.)

1,711. E. VON SZVETICS. London. Improvements in or relating to electrical condenser batteries.

January 27, 1900.

1,731. A. E. TANNER. Manchester. An improved connector for electric conductors.

1,733. J. RIDLEY and J. W. ROEBUCK. Coventry. Improvements in or relating to magneto-electric ignition devices.

January 29, 1900.

1,813. H. H. LAKE. London. Improvements in filaments for electric incandescence lamps. (R. Arno, Italy.)

1,825. B. G. LAMME. London. Improvements in dynamo electric machines. (Date applied for under Patents Act, 1883, sec. 103, June 30, 1899, being date of application in United States.)

January 30, 1900.

1,842. G. DAVIS. London. Improvements in or connected with incandescent electric lamps.

1,863. W. G. HEYS. Manchester. Improvements in coils or helics for electrical purposes. (J. Scott, R. Varley, and J. C. Anderson, United States.)*

1,864. W. G. HEYS. Manchester. Improvements in and relating to the method of winding coils or helics for electrical purposes. (J. Scott, R. Varley, and J. C. Anderson, United States.)*

1,869. H. A. COUCHMAN. London. Improvements relating to electric arc lamps.

1,886. H. E. NEWTON. London. An improved arrangement of switching appliances for use with telephones. (P. Rabbidge, New South Wales.)*

1,906. F. HAENICHEN and O. A. HAENICHEN. London. An improved electric pendulum clock.*

January 31, 1900.

1,937. R. J. URQUHART and H. GOODWIN. Liverpool. Improvements in or connected with overhead collectors for electrically-propelled railway vehicles.

1,990. J. G. JOHNSON. London. Improvements in means for producing and detecting or observing electrical waves or oscillations. (G. F. Hatton, France.)

SPECIFICATIONS PUBLISHED.

NOTE.—**All Specifications can now be obtained at the uniform price of 8d. each.**

1898.

21,633. HOOKHAM. Electricity meters.

1899.

405. ECKSTEIN, EIDSFORTH and WILKINSON (executors of the late R. P. Eidsforth). Jacks used in combination with electrical annunciators or indicators for the replacement of the shutter or signal flag.

416. BARMAN. Electrical heaters or resistances.

571. JAMES. Electric arc lamp clutch and feed mechanism.

918. DAVY. Enclosed electric arc lamps.

1,106. M. BYNG and J. EIDSFORTH and H. WILKINSON (executors of the deceased R. P. Eidsforth). Facia for electrical instruments.

1,758. EVERSHED AND VIGNOLES (LTD.) and EVERSHED. Improvements in portable hand dynamos, parts of which improvements are applicable to small-power dynamos and motors for other purposes.

1,862. BRAUN. Transmission of electric telegraph signals without connecting wires.

1,853. BRAUN. Wireless transmission of signals over surfaces.

1,865. ORLING and BRAUNERHJELM. Method of and apparatus for controlling the operating gear of rudders, signals, and the like by means of heat, light, or electrical waves. (Date applied for under International Convention, Oct. 26, 1898.)

1,960 LORRAIN (Esmond). Electric railways of the sectional conductor type.

2,131. ACOCK. Means or apparatus for reducing or extinguishing the electric arc formed on breaking electrical circuits.

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4,088. LYNES. Lampholder for incandescent electric lamps.
4,158. WYDTS and WEISSMANN. Transformers for continuous electric currents. (Date applied for under International Convention, Aug. 4, 1898.)
4,210. KINGSLAND. Electric traction on a sectional conductor system.
4,496. BOWRON. Electrical contact breakers.
4,778. WILKINSON and TITHERLEY. Electric therapeutic apparatus.
4,788. DAY. Electric arc lamps.
4,822. BROOKES (Stort). Motor suspension for electric auto-motor vehicles.
5,099. GOLLER. Storage plates for accumulators and process for the manufacture of the same.
5,322. LAMPREY. Apparatus for the production of ozone by electricity.
5,374. STANGER. Electro-theropentic baths and the like.
5,468. ZIMMERMANN (Courant). Electro-deposition of metals.
5,781. LE VERRIER. Electrolysis and electrolytical apparatus.
6,321. KINGSLAND. Surface contact studs for electric traction.
8,399. ABEL. (Soc. Anon. Continentale pour la Fabrication des Compteurs à Gaz et autres Appareils). Electricity meters.
20,002. HEYLAND. Electric motors.
20,124. HADDAN. (Soc. Anon. "Lux Nova.") Means for electrically controlling gas cocks and lighting gas burners.
20,986. HANSCOM and HOUGH. Machines for and the method of making electrodes for storage batteries.
21,219. SACHS. Electric cut-outs and electric switch devices applicable to and serving as holders therefor.
21,429. WOLFFHARDT. Incandescent electric lamps.
21,637. BREMER. Electrodes for arc lamps.
21,886. THOMSON and WARNFORD-DAVIS. Connecting plugs for electrical switchboards.
22,107. BUSH and SWAIN. Electric alarm water level indicators for steam boilers and the like. (Date applied for under International Convention, April 8, 1899.)
22,525. HALDAN (Simms). Means for placing, removing, and cleaning incandescent electric lamps.
22,679. CUTLER. Electromagnets for use in relays, sounders, and other electromagnetic apparatus.
23,100. LONG. Electric lamp supports.
23,216. JOEDICKE. Switches for permanent way and for conductors on electric railways.
23,285. THE BRITISH THOMSON-HOUSTON CO. (LTD.) (Rice). Electric arc lamps.
23,288. THE BRITISH THOMSON-HOUSTON CO. (LTD.) (Wiswell). Enclosed electric arc lamps.
23,289. BRITISH THOMSON-HOUSTON CO. (LTD.). (Potter.) Controlling devices for electric motors.
23,290. THE BRITISH THOMSON-HOUSTON CO. (LTD.) (Berg). Regulating rotary electric converters.
23,291. THE BRITISH THOMSON-HOUSTON CO. (LTD.) (Steinmetz). Systems of electrical distribution.
24,085. HALL. Terminals and connections for electric cables and like conductors.
24,228. GUNYON (Privat). Electric railways on a road contact system.
24,230. ROBERTS. Anode or other electrode for use in electrolysis, and process of making same.
24,458. RANSFORD (Compagnie Générale de Traction). Supporting electrical contact rubbers or brushes below rail or tramway vehicles.
24,723. HATCH. Process of smelting ore, and electric furnaces therefor.

MEMORANDA.—Bank rate 4 per cent. (since Jan. 25, 1900). Price of silver 27 9/16d. per oz. (Mar. 1). Consols (2¾ per cent.) 100¼—100⅜ for money, 100⅜—100½ for account; 2½ per cent. 97¾—98¼ xd (Mar. 1). Stock Exchange Settling Day: Consols, April 2; Stocks and Shares Continuation Days, Mar. 12 and 27; Ticket Days, Mar. 13 and 28; Pay Days, Mar. 14 and 29; Mining Share Carry-over Days, Mar. 10 and 26.

ALLIANCE ELECTRICAL CO. (LTD.)—The directors' report for the year ended Jan. 31 states that the accounts, after deducting directors' fees and making provision for depreciation and for bad and doubtful debts, show a net profit of £9,648. The directors propose to declare a dividend of 10 per cent. on the ordinary shares, carrying forward £864.

CHELSEA ELECTRICITY SUPPLY CO. (LTD.)—The transfer books are closed from Feb. 27 to March 8 inclusive, preparatory to the payment of dividend.

CITY OF LONDON ELECTRIC LIGHTING CO. (LTD.)—The directors of this company recommend a dividend at the rate of 8s. per share, or 4 per cent. per annum, against 6 per cent. in 1898. The transfer books and register of members are closed from the 2nd to the 15th inst. inclusive.

GESELLSCHAFT FUR ELEKTRISCHE UNTERNEHMUNGEN.—The report of this company, which is interested in numerous German and other Continental electric lighting and tramway undertakings, states that considerable progress has been made during the past year, and gives particulars of its various subsidiary companies. A dividend of 10 per cent. for 1899 is recommended. The profit for the year amounted to 4,654,784 marks, an increase of 530,000 marks over 1898.

METROPOLITAN ELECTRIC SUPPLY CO. (LTD.)—The directors recommend a further and final dividend of 5s. per share, making a total distribution per share of 5 per cent. for the past year.

WESTERN TELEGRAPH CO. (LTD.)—The directors have declared an interim dividend of 3s. per share (being at the rate of 6 per cent. per annum), free of tax, for the quarter ended Dec. 31, and payable March 23. The transfer books will be closed from 16th to 22nd inst. inclusive.

COMPANIES' MEETINGS AND REPORTS.

Telegraph Construction and Maintenance Co. (Ltd.).

The thirty sixth ordinary general meeting of this company was held at the offices, 38, Old Broad-street, E.C., on Tuesday, Sir ROBERT G. W. HERBERT, G.C.B., presiding.

The SECRETARY (Mr. E. Dickens) having read the formal notice calling the Meeting and the minutes of the preceding Meetings, and the report and accounts being accepted as read,

The CHAIRMAN said: Gentlemen, your directors have much pleasure in meeting you to-day, and in laying before you, for your acceptance, a somewhat better report and statement of accounts of the company than they have been able to present to you during the last two preceding years. The accounts show that the company has now returned to the condition in which it was, approximately, in 1896, when the net profits were £92,854, they being declared this year at £92,348. The total of the figures in the balance-sheet is larger than it has been in previous years, and it may be interesting to you that I should explain that this is in consequence of the much more extended operations of the company; we having, on the one hand, received much larger sums than in the last two previous years for the work we have done, and, on the other hand, we have had to expend much larger sums in the purchase of materials, and in wages, and in the navigation of our ships and laying of cables. The cost, as you know, of materials has very largely increased during the past few years, and there is no apparent prospect of their falling lower; and therefore it is very satisfactory to the directors to be able to recommend to you that you should carry forward this year a sum of £53,800, which is a larger sum than we have been able to advise you to carry forward since the year 1894, our "carry forward" during the years between 1894 and the present time having been somewhat less. I have explained to you on previous occasions that the board are advised, and are of opinion that, looking to the uncertainty of the business in which we are engaged—the possibility, although there are no immediate anticipations, of our being unable to pay our way in any current year, the possibility of our being saddled with large orders in any particular year—it was desirable that we should be able to carry forward in any year a considerable sum. (Hear, hear.) I think this policy has met with your approval on former occasions, and I am glad to hear that this is still the view you take of our situation. As to the report, I need not go through the figures. It mentions that after paying 15 per cent., free of tax, the carry forward is £53,800, and the usual paragraph follows, which states that the business of the company has been satisfactorily maintained, that our factories have been fully occupied, and that the company's steamships have been actively engaged. The factories are in excellent working condition. We have made improvements and are continuing to make improvements in both of them, which necessitate a considerable outlay, and we are making them very much more efficient for the execution of the best class of work. This is a matter for which we have had to make provision in the balance-sheet. The ships are in an exceedingly good condition. The "Anglia," as you have just seen from the newspapers, has completed the laying of the cable from St. Vincent to Ascension, which is the third section of the total line from St. Vincent to the Cape, and the work has been admirably done, not only by the ship, but also, it is right to say, by the very able officers who were in charge of that ship. The steaming and working qualities of the vessel have established quite a record. She laid the cable at the rate of over seven knots an hour on the average right through, including stoppages for various purposes, and I do not think a first-class cable has ever been laid with such rapidity and such perfection as this present one. And the manner in which the cable works, and its first-rate quality, are highly satisfactory. You will see that the directors propose to add a further sum of £5,000 to the pension fund established last year for the benefit of the company's staff. It is right to tell you we have not been able to get that pension system thoroughly under way yet, though, from what we have already done, we shall be able to do so before long. We found the scheme would require a somewhat larger subsidy than the £5,000 you were good enough to grant last year for that purpose. I do not think I have anything more to say with regard to the company at present. We have much work in hand, and we hope we shall be able to earn fair profits again for the year 1900. I will now move—

"That the report and accounts of the directors to Dec. 31, 1899, be adopted, and that a dividend of 24s. per share (in addition to the 12s. per share interest or interim dividend paid to June 30, 1899) be paid upon all shares of the company for the year ended Dec. 31, 1899, and that such dividends be paid free of income tax."

Sir JAMES PENDER, Bart., M.P., seconded the resolution.

Mr. CROFT said the Chairman's remarks must have been received with great satisfaction by the shareholders, and more especially with regard to what he had said as to the work done by the "Anglia." The ship, he believed, was only launched a year ago, and according to the chairman's statement had proved herself very efficient, and he hoped the cable now laid would prove of immense service to the country. He was sure the shareholders would not grudge the sum the directors had appropriated to the pension fund for their employés. It was certainly a very desirable thing that the company's staff should feel that they had really something to look forward to after long years of faithful service. There was one subject upon which he would be glad to hear something—whether any large number of the employés had been recalled to the "colours," and had gone out to South Africa. He noticed that the chairman had commented on the fact that the cost of the raw materials employed in the manufacture of cables had increased very much, and he had no doubt that the chairman, in common with the other directors, and also probably the shareholders, had seen a question which was asked in the House of Commons—addressed to Mr. Chamberlain—to the same effect. Mr. Cham-

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berlain's reply was to the effect that he was aware that these materials had very much increased in price. He presumed the company had not suffered any material loss.

The CHAIRMAN: With regard to the number of our people who have joined the force in South Africa, and what provision has been made for them, I understand that something like 40 from our various works and staff have joined, and I can assure the shareholders that the company has acted in the same liberal way in regard to this matter as all the great companies in the City of London have done, that our company will take the men back when they return, and that we shall give them such liberal treatment as the circumstances necessitate. In regard to the increase of the cost of materials, there have been very considerable increases in these prices, but we have also been able to make considerably increased prices for the cables we are turning out. Although I do not myself consider that we are making the best profit at this particular moment on the cables we are constructing, we are not doing badly, and we are getting prices which are remunerative.

The motion was then carried unanimously.

Admiral Sir ANTHONY H. HOSKINS, G.C.B., moved the re-election of Sir Robert G. W. Herbert and Sir James Pender as directors, which was carried unanimously.

Mr. John Gane and Mr. Patrick A. Glegg were re-appointed auditors of the company for the year 1900.

Mr. CROFT proposed a hearty vote of thanks to the chairman and his colleagues and also the staff of the company for the efficient way in which they had conducted the business of the company during the last twelve months. He had always held that this was one of the best managed companies in the City of London, and he hoped those present would endorse his remarks and congratulate the directors and officials on the success which had attended the company's operations.

Mr. ROBBINS seconded, and the motion was unanimously passed.

The CHAIRMAN: On behalf of my brother directors and the staff I have to thank you very much for the generous terms in which Mr. Croft has moved this resolution and for the unanimous approval you have given to his remarks. The whole of our staff has been very hard pressed during this last year in view of the great amount of construction and laying of cables which has been going forward, and, as I said at an earlier period this afternoon, they have covered themselves with credit, and everything has been done extremely well. Before I sit down I should like to congratulate you, gentlemen, on the fact that the cable laid by this company has been the bearer to-day of a piece of news which has thrilled England from end to end. It is a good cable and worthy to carry good news.

The proceedings then terminated.

W. T. Henley's Telegraph Works Co. (Ltd.).

The twenty-first ordinary general meeting was held at the Cannon-street Hotel, on Wednesday, Mr. SYDNEY GEDGE, M.P., presiding.

The SECRETARY (Mr. A. E. Salmon) read the notice convening the meeting, and the report was taken as read.

The CHAIRMAN moved the adoption of the report and balance-sheet, and, after referring in feeling terms to the death of General Hutchinson, and the election of Sir H. M. Stanley to fill the vacant seat on the board, said: You are aware from the report that I shall presently have the pleasure of moving a formal resolution declaring a dividend of 15 per cent. for the year. I think you will consider that highly satisfactory, and I shall have another word or two to say on the subject presently. The directors have, in preparing the balance-sheet, put down everything in the profit and loss account that ought to be put to the loss side, and have followed their usual practice. Everything has been most carefully taken; the liabilities are put at the outside, and the assets, so to speak, at the inside. To the reserve fund we are proposing to add the sum of £10,000 out of the profits. Nevertheless, that reserve is £20,000 less than it was at the end of last year; the reason for that I will explain presently. With respect to the reserve under cable repairing contract—that is, the Bahamas cable—I have to state that that cable has maintained its positions during the year without incurring any expense for repairs. Under the contract we have with the Government of the Bahamas they pay, as you are aware, £700 a year—£350 twice a year—to be accumulated as a repairing fund. Under the contract, when that fund has arrived at £6,000—as long as it continues at £6,000 or more—the Bahamas Government have to continue to pay the £700 a year, but only £350 is to be invested for the future, and the other £350 is paid to this company. We accordingly on Feb. 1st this year received £175, which goes to the credit of this year's income, and it will be for the directors and yourselves this time next year to determine what is to be done with it. I think you will consider that that is a very satisfactory result of that contract. Not a penny has been paid for the repair of the cable beyond a few pounds on land lines connected with it, and the £6,000 is already received. We shall therefore now begin to receive a profit from that repairing fund, there having been no repairs to pay for. The next subject is that which is bearing on all our minds—the war, and its effect upon us. In the first place, a number of our men—and many of them are good steady men—were reservists, and had to go to the front. The directors, feeling sure that they would have the sanction of the company in doing so, have treated the reservists with liberality. We are promising that when they return—and we hope that they will return safe and well—they shall come back to their posts or to similar posts in the company's service, and we are taking care of the wives and children they have left behind them. You will be glad to hear that the men themselves show their appreciation of what has been done by us, in that they are voluntarily subscribing a fund weekly for the purpose of assisting those who lose relatives in the war. That amount, I find, is £4. 15s. 6d. a week, which is collected voluntarily by a small society among the men and added to a fund for that purpose. With respect to the capital of the company, we last year received your sanction to raise £90,000 of additional capital by an issue of 4½ per cent. preference shares. We could only do that by getting rid of the £30,000 of 7 per cent. preference shares, which in the market were worth almost 200 per cent.; and we induced the preference shareholders to give up their rights of being first preference shareholders of £30,000 at 7 per cent. by accepting instead a sum of 4½ per cent. preference shares—a portion of the £150,000. They also gave up their right to vote at the annual meetings, and they gave up their first position. In order to do that we had to give them £60,000 of the new preference shares instead of the £30,000 they held. That looks something like a watering of stock, because we have £150,000 of preference capital for which we had only received £30,000 originally and £90,000 more issued—or £120,000; but it is only a watering of stock in name, for this reason—that in the years 1897 and 1898, by the issue of £50,000 of ordinary shares at a premium—part of it of £15,000 and the other part of £20,000—we received £35,000 of additional capital over and above our nominal capital. Out of that £35,000 we were able, under counsel's advice, to pay £30,000 to the holders of the 7 per cent. preference shares, which they then re-invested in our new shares; and therefore, so far from our capital really being watered, the £300,000 of nominal capital which you see in your balance-sheet is really represented by £305,000 of actual cash received. You see, therefore, that it is not a watered capital; on the contrary, there is £5,000 extra over and above the £300,000. That I think you will consider satisfactory. The whole of that preference share capital was taken up by our shareholders and their nominees without any expense for underwriting, or for advertising, or anything of that kind. The whole thing, including Government stamp, cost only a few hundred pounds, which has been charged to revenue. But it is my hope and belief that for several years our capital account is closed. We never wish to increase our capital unless we are sure that it will be interest and profit earning. Our business is a very steady, quiet business, and if any big contract comes in for which additional capital is wanted, we are always able to get it—and no doubt we always shall be able to get it—from our bankers. With regard to the dividend it is proposed to pay, some ordinary shareholders may therefore think that we ought to do more, but I will explain why we do not. In the years 1897 and 1898, when we divided more closely, we were adding, from the profits on the issue of the new capital very large sums to the reserve fund. This year it is just the reverse. We are obliged to diminish the reserve fund by £30,000. Although our business is very steady, yet accidents may happen. War may be continued; there may be a great rise in prices; various things might happen to make it difficult for us to pay the 15 per cent., and it is a good thing to have a large reserve fund to fall back upon, if necessary, to equalise our dividends and keep them steady. Although many an existing shareholder may think he would rather have 16 per cent. or 18 per cent. than 15 per cent., on the other hand, if he remains a shareholder, he will get it in the future, while if he ceases being a shareholder he will get it in the price his shares will fetch. I hope therefore that you will not only back up the directors in limiting the dividend to 15 per cent., but that you will yourselves see and express by your vote your approbation and approval of their conduct in dealing with this matter in this way. The reserve fund is now £42,500. It was only £5,000 four years ago. We have added £10,000 to it this year instead of £7,500 as last year, and we propose, with your sanction, to go on in that prudent course. I have only one thing more to say, which is to point out that the prices of materials of all kinds—especially of gutta-percha, indiarubber, and copper—have been rising very considerably, which for a time tends to diminish profits; and I may also say that wages are certainly not falling. So long, however, as we get good work we do not mind paying good wages, and I do not believe in underpaid work. We have greatly added to the warehouses, the workshops, and to the large and excellent office for the use of the staff, and I hope that many of you will go and see them. I have only to add that we have had as usual every assistance from Mr. Sutton, the managing director; Mr. Hatton, the engineer; Mr. Salmon, the secretary; and all the members of the staff, and in moving the adoption of the resolution which I have read I hope that I shall have your unanimous concurrence. If there is any shareholder who would like to ask any question, Mr. Sutton will be glad to answer it.

Mr. DRYSDALE (a shareholder) seconded the motion, and at the same time inquired whether any amount for goodwill was included in the item of freehold land, buildings, and machinery. If so, he desired to have it stated separately.

The CHAIRMAN replied that goodwill was written off long ago.

Mr. FIGGIS inquired as to the manner in which the buildings, stock, &c., were valued.

Mr. SUTTON (the managing director), in reply, stated that in regard to the value of the land, it stood at the same amount as at the inception of the company, when land at Woolwich was worth about £2,500 an acre as compared with about £5,000 now. When the old buildings were pulled down they were written off at the cost they stood at on the balance-sheet. The new buildings were taken at cost, and, in addition to depreciation written off, every year a large sum was expended for maintenance of buildings and machinery, which was charged against revenue. The maintenance this year, for instance, not shown in the accounts, was just under £6,000, and adding that to depreciation, they had written nearly 5 per cent. off the assets in land, buildings, machinery, and plant—a very large percentage. As to goodwill, he was glad that the question had been asked, because large sums for goodwill were very often concealed. He might say that in the item of £183,000 on the credit side of the balance-sheet there was a sum of £1,000 for patents, but the board thought that the company's patents were worth at least £1,000. He thought that if they went along the lines of other companies they would not be far out if £100,000 figured for goodwill in their balance-sheet, but he was happy to say they had nothing in their accounts to represent the goodwill. He had frequently heard Mr. Figgis's argument as to reserve account, but they could not put their reserves into consols and gilt-edged securities. If they had not the £42,000 of

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reserve they would have to have more capital. The valuation of the stock must be made by the company's staff, but it was carried out by them in such a way that the possibility of mistakes was reduced to a minimum, and the principle adopted in valuing was to take whichever was the lowest value, the market value or the price paid.

The CHAIRMAN afterwards stated that he had omitted to mention that another reason why they wanted floating money was in connection with the entry on the credit side of the balance-sheet of stock-in-trade, "including expenditure on orders in hand." He then proposed that the dividends set out in the report be declared.

Mr. DRYSDALE seconded the motion, which was carried unanimously.

The retiring directors—Mr. Gedge, M.P., and Mr. Frederick Newton—were afterwards unanimously re-elected, as were also the auditors, Messrs. Ball, Baker, Deed, Cornish, and Co.

Mr. LAMONT next proposed and Mr. Robbins seconded the following resolution, which was carried unanimously—

"*That a cordial vote of thanks be given to the directors and managing director, the secretary, and the staff in London and at the works, the branches at home and abroad, and also to the chief engineer and his staff at the works, for their valuable services during the past year.*"

A vote of thanks to the chairman brought the proceedings to a close.

Wireless Telegraph and Signal Co. (Ltd.).

The adjourned third ordinary general meeting of this company was held on Friday last, Major S. FLOOD PAGE (managing director), in the chair.

The SECRETARY (Mr. Henry W. Allen) read the notice calling the meeting, and the report was taken as read.

The CHAIRMAN said: The first sentence in the report says that "the year that has passed must be considered as another year of experiment and development," and if you will look at the accounts you will see that that is so. The alteration in the accounts is simply on the debtor side, where the amount of additional capital which was authorised last October is dealt with. You see that the capital of the company is £200,000, of which nearly £125,000 has been issued. If you look on the other side you will see that whereas the patents last year were entered in the accounts at £75,864. 17s. 6d., they now stand at £77,010. 16s. 6d., an additional sum of £1,145. 19s. having been expended on them. I may say, in passing, that the number of the patents last year was about 32, but this year they are as nearly as possible 100: the patents that have been taken out and that are in course of being dealt with will, I believe, prove to be of even greater value to this company than the original patent itself. You will see that we have in stock instruments, materials, plant, &c., amounting to about £4,840, that the expenditure in the two years amounts to £10,960. 13s. 7d., and that at the date on which these accounts closed we had £32,290. 13s. 1d. cash at bankers, on deposit and current accounts, and in hand. It is known to all the shareholders that I was not connected with the company during any period with which the accounts deal, but it has of course been my duty to look into these accounts; and I think I may say without the slightest fear of contradiction, that the amount spent has been well and necessarily spent, and that, as compared with a great many other companies, the amount is extremely moderate. Turning back to the report, you will see an allusion made to the fact of communication having been established for the Trinity Board between the East Goodwin lightship and the South Foreland lighthouse. On Dec. 29, 1898, connection was first made between the South Foreland and the lightship, 12 miles distant. That connection has remained from that date until the 14th of the present month, and in that time there has not been, so far as the Marconi system of communication is concerned, a single flaw, or hitch. Night and day, in fog, in storm, in thunderstorm, no difference at all has been found in the working. None of our men have been working it for many months; it has been worked by the men on board the ship. One of our assistants has always been on board in order to guarantee that everything was conducted properly, but by an arrangement made with the Trinity House, he was not permitted to send signals. Mr. Marconi has felt for a long time that every problem that required solving with respect to communicating with a lightship at a distance of 12 miles has been solved. I therefore went to the Trinity House on Dec. 20, and stated that it was our intention to remove the apparatus from the lightship. One of the most influential of the Elder Brethren of the Trinity House saw Mr. Marconi, however, and asked him not to remove it, and we stated that we would leave it until Jan. 31. *The Times* has a yearly review of scientific progress. Doubtless many of you read it year by year, and it is a wonderful record. It sums up the work of scientific progress during the year in a manner that can hardly be surpassed. It so happened that in the review of scientific progress for the year 1899 the writer referred to the fact that a French vessel that had got on to the Goodwins had been saved through wireless telegraphy, and that a sum of £52,000 had thus been saved owing to the Marconi system. The secretary of the Trinity House was instructed by the Elder Brethren to write to *The Times* to traverse that statement, and if they had rested there I do not know that there would have been any reason for us to take much notice of the matter. I can only say that the writer in *The Times* was corroborated. I read an account of the case that appeared in the Court of Admiralty, and there were two other papers that day which ascribed the saving of the vessel to wireless telegraphy. But the secretary of the Trinity House went on to say that the Elder Brethren were not aware that any single ship had been saved by means of any electric communication between the shore and any lightship since the first experiments were made. This was therefore not only with respect to Marconi's, but to all other experiments. I confess that this was to us a matter of the very greatest disappointment. We received nothing but courtesy from these gentlemen, and we did hope that there was at any rate one department of the Government that did grasp and realise the enormous advantage of communicating between all the lightships and the shore. I must confess that it seems to me incredible that any reasonable man should doubt that more lives and more cargoes are likely to be saved if there is such communication than if we go on in the old system that has been followed for so many years. The South Foreland communication was put up at our expense, but in Germany we are being paid for putting it up on a lighthouse and a lightship, as well as on the largest of the North German Lloyd steamers. Next week I hope that that steamer will pass the Isle of Wight and Poole, and will be in communication with our stations at the Needles and at Poole—another instance, I am afraid, in which we shall find the lead being taken by Germany. The report goes on to speak of what was done by the system during the naval manœuvres. You are aware that Mr. Marconi was on board during the autumn in the course of the Naval manœuvres, and very important demonstrations of his system were given. I am not going to repeat what the report states in this matter, except to say that communication was kept up in the same way day and night at a distance of 70 miles, and while vessels were going through the dark at 20 knots an hour. But the interesting portion of the paragraph is where it is stated that "the results were most satisfactory, and it is expected that the company's system of wireless telegraphy will henceforh take its place as part of the equipment of Her Majesty's ships." I believe that it is going to do so; but you will ask—on what terms? To that I must reply that we cannot tell you, and for this reason: probably everyone in the room is aware that until the passing of the Patents Act of 1883 the Crown was exempt from all payments with respect to patents: that is to say, when a patent was issued the Crown was entitled to use that patent without paying anything; but by the Patents Act of 1883 it was determined that the Crown was subject to payment the same as other people. There is, however, a clause which says that the Crown must agree with the patentee or owners of the patent as to the amount that is to be paid, and it goes on to say, or in "default of agreement" the Crown can use it "on such terms as may be settled by the Treasury after hearing all the parties interested." I am not aware whether any decision has yet been given by the Treasury in such a case. I have been to the Admiralty, where I was received with the utmost courtesy, and they have told us that they must call upon us to take steps to have the matter settled with the Treasury. They, however, refuse to come to terms with us separately for the Navy. It is a rather unfortunate thing, I think, that the Crown determined originally to leave to the Post Office the negotiations as to what was to be paid, for the Post Office, if I may say so, has been a little spoilt by what has been going on with respect to the telephone. Under the arrangements made in connection with that matter they get an enormous revenue—over £10,000 a month; they like to obtain things very cheaply, and they did not entertain at all seriously the proposals made by us to them for the purchase or use of our patents. Although, however, a gentleman said to me to-day that it is very like a man fixing his own price when we come before the Treasury, I believe that there is such a thing as justice in England; and I do not believe—even after what Lord Salisbury said a few days ago about the Treasury—that it is possible for them to commit an absolute injustice for which there is no remedy. I therefore told the Comptroller that if we could prove that large commercial shipping companies were willing to pay a certain specified price for the Marconi apparatus to be fitted on their ships, it seems impossible that the Government should maintain that the system was not worth as much on every one of Her Majesty's line of battleships as it was on the vessels of these companies. I can answer for my colleagues, and say that when we do go before the Treasury whatever may be the course of procedure, we shall do our utmost to obtain justice; and if we do not obtain what we think a fair price, we shall take what steps we think necessary to try to obtain a better price. I cannot believe that anything like confiscation can be meant.

Before entering upon a record of Mr. Marconi's work in America, I think I should perhaps say a word or two about what you all probably heard of a little time ago. There were statements in the papers to the effect that the company had sold the American patents. It is quite true that an agreement was entered into for the sale of those patents, and it seemed very much as if it was coming to pass. The very influential men on the other side of the Atlantic who were concerned in this agreement went so far as to register a company, but there was in the agreement an option, and after mature consideration they determined not to exercise that option. The negotiations were therefore broken off, but at the same time we have not parted in anything like dissension, so much so that we have promised that when we are prepared to go forward again, we shall give the gentleman who was the leader of these very influential men in New York the opportunity of taking up the business. You know how successful Mr. Marconi was with respect to the New York yacht races. We were all very excited about them, and the only information we got about them on several days was through his system. But a very much more important matter than this was the relation between the Marconi system and the United States navy, and I have seen it stated that the American navy are going to introduce another system, and are adverse to the Marconi system. I do not believe that there is any foundation for that, and I will read a letter from the United States Navy Department, which was received by Mr. W. W. Goodbody (a director) shortly after Mr. Marconi returned from the United States. The letter, which is from the Secretary of the Navy Department, and which is dated Nov. 11 last, says: "The Department desires to express its acknowledgment and thanks for the demonstration of the Marconi system of wireless telegraphy recently given by you before a naval board. The Department further desires to congratulate you upon the success attained, and upon the probable further perfection of the system. The certainty of transmitting a signal under conditions impracticable with any other known method renders the Marconi system of great value. The Department begs to express the hope that you will further perfect the system, and will be glad to learn, in the future, of any progress made in this direction."

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There is a very simple reason for Mr. Marconi not continuing the experiments with the United States Navy Department—namely, they asked things to be done the patents for which were not complete. In America there is no provisional patent, and the patents were not complete. They will be completed, however; and I have no doubt that when they are completed and ready to work, we shall be glad to accept the invitation conveyed in this letter by the Navy Department at Washington, and give them information so that they may go on.

I need not dwell very lengthily on the courtesies which were exchanged between England and France during the British Association meeting at Dover in 1899, but the interest to you is not what took place, but the result of it, which is this—that whereas the distance between the South Foreland lighthouse and the East Goodwin lightship is 12 miles, the distance between the South Foreland and Wimereux is 30 miles, and what was done demonstrated the progress of the Marconi system. But that 30 miles is really of no more interest now than the 12 miles was at the beginning, because we know that distances up to 80 miles are easily within the compass of the Marconi system. Reference is made in the report to the sailing for South Africa last November, under agreement with Her Majesty's War Office, of six assistants with apparatus. On this point I must confess that it is a matter of very great disappointment to us that the War Office were not a little earlier in coming to us and letting the assistants go out. It is painful to think how much has been lost owing to our not having had the apparatus in Kimberley or in Ladysmith. If General Buller had had the apparatus with him and there had been one in Ladysmith, I have no doubt that they would have been in constant communication, daily and nightly, with the town. They have, however, been outside all the time. Not only that, but they have had no poles; they could not get them. Eventually poles had to be taken up to the front from Cape Town. When our assistants went out the arrangement was that they were to operate at the base and in communication with the ships, but they volunteered to go to the front, feeling that that was the only place where they could be of any practical use. You have seen stories in the papers that the system was unequal to the work owing to the iron in the hills. A gentleman wrote to me who knows a good deal about it, and said that it was not the iron in the rocks that prevented the working, but the wood in the heads of those who thought that such a thing could possibly prevent its working. I can only repeat what Mr. Marconi so well said in his most admirable lecture at the Royal Institution a fortnight ago as to the immense advantage that the system would have been had the apparatus been out earlier. They had to resort to kites, and the air is so variable at one place you can fly a kite, whereas 30 miles off there might not be wind enough to do so, it is impossible to communicate. Where are they now? I have in my hands two letters—one from Pietermaritzburg, where they are doing nothing, and the other from De Aar camp, where they are erecting the poles and are perfectly ready to use the apparatus. Practically, however, it has not at present been of any great use. I am glad to say that I have received a letter from the War Office, dated on the 16th inst., in which they inform us that if our assistants are wounded or killed compensation will be given to them exactly the same as if they held the rank of lieutenant in the Army. I am sorry that on the first occasion of a war since Mr. Marconi's system was invented greater advantage has not been taken of it; but, speaking honestly and straightforwardly, I say that there has been no breakdown of any kind or description in South Africa of the Marconi system where the conditions were such as are necessary for its success.

I think the next point in the report of the directors which I may deal with is where we say we shall take the opportunity of this meeting of placing the position of the company before the shareholders. There are not many shareholders present, but I am aware that I am speaking to the whole body of shareholders, the greater part of whom, I may state, do not live in England, but in Ireland, and we have told them that they shall have a report of to-day's proceedings. I do not know how many of the shareholders of this company have faced the question as to what the business is on which we are engaged. I know that every lady and gentleman in the room is aware that the whole thing is new, but I do not know how far the question has been studied as to what it is on which we are engaged; and if you will permit me I will make a few remarks on this matter. It has been my duty since I have been connected with this company to go abroad several times. I have been to Berlin, Paris, and Brussels, and I have met with men of vast experience—some of the very leading financial men on the Continent—and it has been my duty to try and make up my mind as to what it is we are dealing with. If you will allow me to occupy a little more of your time, I hope to be able to show you what I believe to be is the vastly important enterprise on which we are engaged. I divide the probable business of the Marconi system into four great heads. One is land. What, however, it can do on land I am not going to occupy any length of time in speaking about, for this is a problem for the future; but I should not be at all surprised if the time comes when the land use of the system will be as great or even greater than the sea use. I am quite sure inasmuch as we can go very considerable distances on land now, that it is almost certain that there is a future for it, and probably a bigger future than was looked for for the telegraph when the line first went from Windsor to London. The next head is trans-ocean. A very few months ago scientific men used to laugh at the idea of the Marconi wireless system ever getting across, say, the Atlantic and they often assigned as a reason for their view the curvature of the earth. With respect to the curvature of the earth, Mr. Marconi's daily practice from Wimereux to the Haven and from Wimereux to Chelmsford, 90 miles, and his experience during the time of the naval manœuvres, when ships were far out of sight, have led to the dispersal of that bugbear. It stands to reason that if the curvature of the earth does not prevent communication in the first 100 miles, it is not going to do it in the second, or even thetenth hundred. I have it on the authority of the German professor, who knows most about wireless telegraphy, that there is not the slightest reason why it should not go across the Atlantic. And it is not only the Atlantic; there are Africa, Asia, and other places. I pass from that, however, because it is for the future and not for the present. Then the third heading of my division is the combination of land and water, like the Andamans and Hawaii. I was asked recently to go to a lecture by Colonel Temple, the Commissioner of the Andamans. He wants telegraphic communication established between Calcutta through the Andamans down to the neighbourhood of Sumatra. There is no single case in which there is more than 80 miles of water between the islands, and Colonel Temple desired the support of the Government of India in this scheme. I may say that this is regarded as a matter of great importance from a meteorological point of view. The ships cross the Bay of Bengal on their way to and from China, and they could be warned about typhoons. That is from a meterological point of view; but Colonel Temple had other reasons. There were present at the lecture representatives of many of the leading shipping companies, who listened to his suggestions most attentively. I was asked to speak, and I said, having consulted previously with Mr. Marconi, that there is no reason whatever why the expense of a cable should not be saved in such a combination of land and water, as the Marconi system of wireless telegraphy could be utilised. There are places in Canada and Brazil exactly the same. We have entered into a contract where such a use of the Marconi system is about to be introduced—that is, in Hawaii. I do not know whether anyone present has been in Honolulu: I have been there. There are five islands, which are now going to be connected by the Marconi system. They were going to have a cable, which would have been a very expensive work. Our apparatus is now being made, and our assistants would have started before had it not been for the plague in Honolulu. You thus have a practical illustration as to where the system will be certainly used. Negotiations are also going on with respect to Brazil and Canada with respect to its use there with this combination of land and water. I now come to the last of my four divisions of this business, and for the moment it is the most important—the maritime, which is ready for work. What is the maritime business? Ships at present come close in to the shore in order to signal, and the vast amount of business that is done in signalling shows that all vessels when they are coming in are very anxious to be reported. Of course, the business that is done at present is important, but I verily believe that it is insignificant compared to the business that will be done through the Marconi system. The ships crowd in at present close to shore, and especially in foggy weather, and there are two serious dangers involved: they come close in to the shore, and they crowd into a very limited space. Under the Marconi system they can telegraph 10 or 20 miles from the shore, and just as usefully in a fog. It is a curious fact, but it is rather easier to work in a fog than at any other time. There is no necessity for the vessels to come near the coast or to crowd in to such a very small space as they now do, rendering a small zone absolutely full. The apparatus is going to be put on to the South-Eastern and Chatham and Dover steamers, who are now obtaining permission from the French Government to use the Marconi system in the harbours of Boulogne and Calais. We have also reason to know, in regard to this matter, that our Post Office wanted to know what the arrangements were. I am not going to dwell on the Post Office monopoly, but I think I am quite safe in saying that that monopoly cannot extend beyond three miles out at sea, and while our ships can speak at 10 or 12 miles distance out at sea we cannot be brought under the Telegraph Act. There is also another arrangement—it is not absolutely completed—but a provisional arrangement has been made that if the ship of the North German Lloyd which is to be fitted next week is successful, they will apply the apparatus to their very large fleet. You all know what Mr. Marconi did when he came from America in the "St. Paul"; but although you all know it, it is essential to bear in mind just now that it is possible at this moment to speak at a distance of from 40 to 80 miles away from the shore. That opens up an enormous new vista for a novel kind of business—I mean sea telegraphy. I do not think there is any doubt that sea telegraphy will become as common as land telegraphy. At the present moment it is limited; but in the course of a very few years when you go to sea you will be able, I believe, to keep up communicating the whole way along the coast; and for this reason it is a matter of the greatest importance that we should have throughout the world one system as to rates, rules, and regulations for communicating between the ships and the land. If we had one class of rates in one country and another class in another, the utmost confusion would prevail; and we must therefore get into international relations in respect to charges. It is also a matter of great importance that we should get into these international relations as soon as we can, because there are rumours of the probability of the French Government calling a conference to deal internationally with this question. I hope that we shall be able to deal with this international question commercially before the Governments themselves take the initiative. This being arranged, I hope that we shall be able to succeed in showing all the Governments that we are not opposing telegraphy, but that we are going to add enormously to their business—that we shall bring to it an enormous increase of revenue. Half the ships that sail the sea are English, but they go off to the teeming populations of the East. If you will take a map, you will see that the important places we have got to deal with in thinking of all the ships that go to the East are Ushant, Finisterre, and Gibraltar. France and Spain are the countries that we must get into relation with if we are going to make this Marconi system as successful as it can be made—if we are to do the largest amount of business that might be done. I do not believe that the ships will go to the expense that will be necessary if they can only, by the use of this system, report themselves when they are getting to land. If this system is pressed into its largest possible use, it will enable every person on

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his way to India and China to communicate with the shore day by day; and, just as a newspaper was published on the "St. Paul," so they will be able probably to receive their papers daily at breakfast on board ship exactly as on the "St. Paul." In order to get influence on the Continent, the board are proposing that there shall be an international company, the chief Continental agency being in Brussels, for the reason that Belgium is a neutral State. Brussels, as you know, is a very successful financial centre. Then there will be representatives of England, France, Germany, Spain and Portugal. We have therefore placed ourselves in negotiation with gentlemen of the highest position—well-known men—known throughout Europe for their enterprise, their success, and their integrity. We are going to ask them to form with us a company for the purpose of dealing with these maritime rights. We are not going to sell any patents to them, but are only going to give to that company (we keeping all the patents to ourselves) the right to use the patents for maritime purposes. Lest any shareholder in this company thinks that we are going to part with any portion of our business which is of value to us, an arrangement has been made by which this company will receive 100,000 fully paid up shares, and according to your rateable holding of our shares, the shareholders will be able to subscribe at par for £1 shares up to a further 100,000 in number if you choose to take them. If you do not care to do so, there are a body of guarantors who are willing to guarantee that amount of capital, and they will receive no money at all, but simply have a right to call on 145,000 shares at par within a certain period. You will receive a circular with full particulars in the course of a very short time. I can quite believe—because I have been spoken to on this subject—that there are some shareholders who think that we could do this work ourselves, and probably some of them think that we could do it even better than the gentlemen on the Continent whom we are asking to act with us. I believe—and it is not only my own opinion, but is shared by many leading financial men—that in the present position of politics between England and France and England and Spain it is not unlikely that we should find it difficult to negotiate with the foreign Governments with the view of getting any rights—to utilise this great invention; and our chance of being able to get concessions from these foreign Governments is that they should be approached by men known to them. You will receive a circular, however, and no one will be asked to subscribe to this new company without these particulars being placed before him. I can only say, speaking in the presence of my colleagues who have seen the names confidentially, that I believe it would be impossible to find in Europe men more representative, more important, or men of higher position; and they will have a chance of doing our business for us and with us in a way that we could not do ourselves. I hope that we are not going to limit this business to the small amount that we ourselves can do just about these shores; whereas if we avail ourselves of our opportunity and make a great feature of this international agreement, we shall be able to do a vast amount of business, reserving to ourselves, remember, the whole of our patents, and also reserving to ourselves the whole of the United States. We should probably then be able to stand before you some day congratulating you on being connected with one of the largest and most important international companies that exist in the world. I have detained you very long, and I thank you for the very great patience with which you have listened to me. I shall now be very glad to answer, as far as I can, any question that may be asked, but in the meanwhile I beg to move

"*That the report and accounts be received and adopted.*"

Mr. JAMES F. BANNATYNE seconded the motion.

Mr. WILLIAM SMITH asked, as regarded the proposed international company, whether the directors would complete the bargain with those whom they were negotiating, or whether the shareholders would be called together to confirm the agreement before it was made legally binding.

The CHAIRMAN: There was one point I omitted to state, and perhaps you will let me say it now. The mode in which it is intended that the capital of the company should be dealt with is as follows: This company is first to receive £100,000 in fully-paid shares, and we pay nothing for them; next there is a sum of £100,000, which the shareholders of this company will be entitled to subscribe for at par; and then there is £145,000, which will be "at call" to those gentlemen who guarantee the £100,000 or any part of it which you do not take up. Therefore, supposing, as is intended, there should only be £25,000 called up at once, the position of the international company on starting would be this—that we should have £100,000 in fully paid shares, and there would be £25,000 of working capital; but there would also be the guarantee from the guarantors.

Mr. SMITH said the chairman had given the shareholders no information whatever as to any tangible results of the working of the company. The balance-sheet showed a very large and constant expenditure, but nothing had been said as yet as to any receipts. It might be that no receipts were to hand at the time the balance-sheet was drawn up, but certain contracts had been entered into since. No mention, however, was made as to what the earnings of the company were, although it had been in existence for some two or three years. The shareholders had been very patient, but he did not think that they would be able to live much longer on expectations.

The CHAIRMAN: Mr. Smith has been a director and therefore knows a great deal about the company's business. I can only say that I believe that the first paragraph of the report contains the best answer to what you have said—that "the year that has passed must be considered as another year of experiment and development." Then, with reference to the remark that the shareholders have exercised very considerable patience, I have not a word to say except this—that I do not think there is a single electric company that is paying a dividend that ever did so in the first two or three years—I was going to say the first four years. As to patent companies, I can only say that it is far more usual for a company to be our or five years before they even lay a commercial foundation in an absolutely novel business. I want the shareholders to realise that this is an absolutely new business. We all know what the position was with respect to the telephone. I can only say that another company on which I was at the very commencement, which is now paying dividends regularly, and which has paid back dividends from the first day to this—that that company was six years before it paid a dividend. Of course, there has been a good deal of talk as to what the company might be going to do, but the greater part of the time, if I have been correctly informed, has been taken up by the question of selling the patents. For my part, I think it is a comparatively easy thing to sell a patent. I may tell you that we think we have at this moment sold a patent for a distant country for a satisfactory price. I do not say that we have absolutely sold it, because when you are dealing with matters of this kind, with people thousands of miles away, it would be very unsafe to say so. In connection with no invention of this kind has a commercial business ever been established under four or five years.

The motion was then carried.

After the re-election of the retiring directors, Messrs. H. Jameson Davis and William W. Goodbody, and the re-appointment of Messrs. Cooper Bros. and Co. as auditors,

The CHAIRMAN said: In my endeavour to close my remarks quickly, I omitted to say one thing. We have got an asset that seems to me to be of the greatest possible value. I refer to the patents that are now being taken out, and are being developed. In a new business like this, in a matter that no man has experience of, and in connection with which everything has to be thrashed out *ab ovo*, it is essential that we should take time, and if we do not we shall not rear on the foundation which has been laid the successful business we hope to build up. During these two years the foundations have been laid, so do not run away with the idea that the time has been wasted. I now move—

"*That the Directors be requested to proceed with the negotiations referred to in the address of the Chairman.*"

Mr. MARCONI: I have much pleasure in seconding that resolution.

Mr. SMITH: Shall we not be called together to confirm the arrangement which you make? Is it proposed to sell to these gentlemen the exclusive right to use the patents for certain purposes?

The CHAIRMAN: All that is going to be done is to give them the exclusive right to exercise the patents for maritime purposes, but from those rights certain countries—like the United States and some others—are excluded. I am reminded that another element of profit is that we retain the sole rights for manufacturing all the Marconi apparatus, and I hope that before two or three years are over our heads we shall have developed a very large manufacturing business. I look on that as a very solid asset.

Mr. SMITH: What do you mean by maritime rights—trans-ocean—between ship and ship or ship and shore?

The CHAIRMAN: Land is excluded and trans-ocean is excluded. It is mainly from ship to shore.

Mr. SMITH held that until by the company's system communication could be carried on across distances, from this country to the Atlantic, they were not likely to get much revenue from the trans-ocean field. He thought it came to this—that what they had proved to be of value, what the public outside the shareholders had realised to be of value, and on the strength of which they were likely to take up shares in any flotation that might be made—that all this benefit was going to be handed over to the new company, in which this company were going to have 100,000 shares, or two-sevenths of the capital of the new company. Certainly the shareholders would have the right to take up another 100,000 shares, but they would have to pay for them. He thought that when the whole scheme was arranged the shareholders should be invited to attend a meeting and express their view on what was finally proposed. He thought it was too much to ask the shareholders to give the directors a blank cheque when they might find later on that they had parted with the most valuable assets they had. He should strenuously oppose the giving of such powers.

Mr. L. DAVID considered Mr. Smith took a wrong view of the matter.

The CHAIRMAN: I will now put the resolution, but will first say that it is really within the option of this company to hold four-sevenths of the capital of the new company.

The resolution was declared carried by 12 to 6.

The CHAIRMAN: I now propose—

"*That the name of the company be changed to that of Marconi's Wireless Telegraph Co. (Ltd.).*"

I am responsible for suggesting this change. Mr. Marconi's interest in this company is enormous, but he is not a supporter of this change. Although he does not object to it, he desires it to be known that the alteration comes from someone else. It would be a thousand pities that we should lose that personal interest in the name, and I therefore move this resolution with the greatest pleasure.

Mr. JOHN MOONEY seconded the motion, which was carried unanimously.

The CHAIRMAN then proposed that

"The remuneration of the directors shall be the sum of £1,000 per annum, and in addition thereto, in any year in which the dividend or dividends declared and paid on the ordinary shares of the company shall be in excess of the rate of £7 per cent. per annum, the remuneration of the directors shall, for every such year, be increased at the rate of £500 for every additional £5 per cent. paid in dividend on the ordinary shares in excess of £7 per cent. per annum, but so that in no case shall the entire remuneration of the directors for any one year exceed £3,000; and the remuneration shall be divided between the directors in such proportions as they may from time to time determine."

The resolution was carried and the proceedings terminated.

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Charing Cross and Strand Electricity Supply Corporation (Ltd.).

The annual ordinary general meeting of the shareholders of this company was held on Tuesday, at the offices of the company, 15, Maiden-lane, London, W.C., Mr. W. F. FLADGATE (chairman of the company) presiding.

The SECRETARY (Mr. E. Wilmot Seale) having read the notice calling the meeting,

The CHAIRMAN said: Gentlemen, in moving the adoption of the report and accounts I feel that we have an exceedingly satisfactory story to tell you. Last year we considerd that our position was a good one, and that the progress we had made was very satisfactory; but this year we come before you with an increased income, a more fully developed business, and with our reserves very largely augmented. I do not propose to trouble you at any length by going through either the report or the accounts. The report speaks for itself, and the accounts probably all of you have investigated, and if there are any questions which you wish to ask, or explanation that you seek upon them, I, or the accountant, who is present, will be able to supply you with all possible information. There are, however, one or two general matters in connection with the company to which I should like to call attention, and the first, and probably the most interesting, is the increase which we have made during the past year. Our sales for 1898 amounted to 3,240,000 units, and our sales for 1899 to 3,862,000 units, this being an increase of no less than 615,000 units, or 19 per cent. upon the whole sales. I cannot help thinking that this alone shows very clearly how much the reputation of this company has been sustained in the districts that we supply. The number of the lamps connected, which of course increased as the sale increased, is again remarkable. In 1898 which, as I have said, was a good year, we increased our number of lamps by 26 000, and in 1899 we have increased the number by 48,000, which, I think, is a very startling amount to be able to report. Our largest increase was where I expected it would be—in the Strand district. Then, again, the result of our increased sales has been satisfactory. In 1898 the result of our sales was £59,000, and in 1899 it has been £69,700. With regard to the expenditure on coal. For some time we were not by any means happy as to the amount of coal consumed. We thought we consumed more than we ought, and we found that one reason of our greater consumption was the fact that some of the boilers supplied to us, and which we had every reason to believe to be good ones, were not working in a way that we considered satisfactory. We hope and think that we have now put an end, to a great extent, to that difficulty; and the proof of the pudding is in the eating, or, in this case, in the consumption of coal, as you will see when I tell you that, with the large amount of extra work we have done in 1899, as compared with 1898, we have actually consumed 104 tons less of coal. The effect of this may not for the moment appear to be very large, but I will give a few figures which will show it clearly to you. The price of coal, as you know, was last year very high, considerably higher than in 1898. If the average price in 1899 had been the same as in 1898, it would have meant a sum in our pockets of no less than £3,392. Therefore, on that one item we should have largely increased our profits. Our net profit for 1899 amounts to £27,677, as against £21,377 for 1898, and that is, I think, a very satisfactory result. It has not been arrived at without making due provision for repairs. The keeping of our stations, mains, and plant in the very highest condition possible is one of the most important things which our engineer has to look to; and in the income account of the current year no less than £5,000 has been spent upon repairing plant, machinery, and mains. We have set aside for the depreciation of machinery, in addition to what we have actually spent on keeping it in order, £8,000, against £7,000 last year, the increase being consequent upon our having increased our machinery. After having done this we are able to recommend, and we trust you will agree with us, in declaring a dividend at the rate of 9 per cent. per annum; and I trust that you who followed our fortunes when we put our capital before you last year and subscribed to it, will regard it as a very satisfactory return on your subscription. This brings me to the capital account, which now stands at £350,000, with practically, I may say, no debenture debt whatever, as all that there is left of the old debentures was a sum of £25,000 odd, which was due at the end of the last financial year. We did not consider it necessary last year to deal with the outstanding debentures. We shall have to deal with them this year, and we will do so when we deal with the capital. The result of our issue of shares at the beginning of last year was this: We were able to put into our reserves a very large sum. We have put to our share premium account, after deducting expenses of issue, £99,000, and we have dealt with it in the following way: We have put £9,000 to capital reserve account, and we thought it right, having regard to the fact that our station at Lambeth is held on a leasehold tenure, to begin to write it down, although we have little doubt that we shall be able to get a renewal of it at the end of the term. Therefore we have set up a leasehold depreciation account with £5,000, which leaves £85,000 to bring forward on the share premium reserve account. Now, the result is this—our reserves altogether now amount to £137,000, or 40 per cent. of the share capital of the company. I think we may fairly say that these figures are satisfactory. There are two companies, both of which are doing good business and which are working in this neighbourhood, the St. James' and the Westminster. The St. James' proportion of reserves are 17 per cent. and the Westminster's 20 per cent. Therefore, at any rate as far as reserves are concerned, between us and the two companies mentioned, we hold a very much better position than either of them. With regard to these reserves, I have little doubt that some of you gentlemen will say, What have you done with them? We have put them into our business, and we consider, having looked at the matter from every point of view, that that is the sensible way of dealing with our reserve capital. When we were fighting with the City of London Electric Supply Co. before the Parliamentary committee last year, one of their great grievances was that under the terms of their arrangement with the City they were bound to invest their reserve fund in what are called gilt-edged securities, while we were under no such obligations. Whether or not there is any hardship in so investing the reserve fund is a matter of opinion, but the result of investing any portion of our reserves would be to bring in an income of perhaps 2½ or 3 per cent., while by using it in our own business we increase our power of earning money without paying anything whatever in the way of interest on such capital, except the loss of that small percentage. That being so, it seems to me better policy to use the reserve in our business and not to have to borrow money, which otherwise we should have to do and pay a considerable rate of interest on it. As regards our stations, we have at the present time three actually in working order—Lambeth, Maiden-lane, and Short's Garden. Lambeth station is not yet completed, at Short's Garden there is yet some work to be done, but it is doing its work well; and the present capacity of these stations is sufficient to supply 250,000 lamps. Against that our present supply is 190,000 lamps, so that we have the power to supply a further 60,000 lamps which will soon be used up in the course of the increase of our business; and I may say at once that our engineer, who has gone very carefully into the matter, tells us there is no doubt whatever that in order to compete with the demand of our districts—the Strand, St. Giles, Holborn, St. Martin's—independent of the City district—we shall have to spend large sums on further machinery, on further mains, and on further stations; but on this subject we shall shortly have to call you together. Dealing now with the general position of the company, I cannot help congratulating the shareholders upon the working of the whole of the districts. Instead of there being any falling off in any part, every department shows an increase, and during the past year 300 more customers have been obtained, making the total number 1,300, while the future seems to be most promising. With regard to the City, you will remember that when I was addressing you last year I told you we were applying for, and hoped to get, a provisional order for dealing with the City. We have got the order. As to the value of that order to us personally I have no doubt; as to the way in which we are going to work it, that has been a matter of grave consideration to the board, and for practical purposes I may say we have arrived at a conclusion, the results of which will be put before you at the special meeting. One of the greatest advantages of this order to us, to my mind, is that it gives us a very large area of supply; that that large area will make it worth our while to build, a large station in order to really be able to compete not only in the City when in working order, but in the West-End districts which we are supplying. We have made arrangements for acquiring a large plot of land, over 7½ acres, at Bow, and we are promoting a bill to obtain Parliamentary powers to run our mains from that station to the City and through the City to our existing stations, thus to be able to link up the whole of our stations and to make the one supply supplement the other. Under our provisional order for the City we are bound to give a separate installation for the City, and that will be provided for, as on the land we have acquired we have ample room to build two stations. I think I have now touched upon all the important points, and the only matter that remains for me to say a few words upon is the capital. Our present capital is all issued. Our present power to issue debentures is limited to £150,000. Without in any way committing myself to figures, I would like to tell you this: that in all probability the course that we shall adopt will be that we shall ask you to increase the whole of the share capital, both ordinary and preference, and also ask you to increase our powers to borrow upon that capital. We shall estimate what we believe, wholly irrespective of the City order, will be the necessary amount of capital required to fully complete the whole of our work in the districts of St. Giles, the Strand, Holborn, and St. Martin's. In addition to this, there is the City undertaking to be dealt with: and in all probability what we shall suggest to you to put into that undertaking is £200,000, which will be dealt with by a separate capital, or by some means which will not have the effect of jeopardising your dividends during the year or so in which that money may be more or less lying idle. I say more or less lying idle, because, as a matter of fact, at the present time we are doing work in the City. We have been received there, as far as the customers are concerned, with open arms, and if we had an installation in the City in working order now we might have a great many orders, many of which we have been obliged to refuse. That is the position of our company to-day. We have been able to earn a 9 per cent. dividend and to put by to reserve a large amount of money, and we stand before you as a successful company. Before finishing I want to pay a tribute to the officers of the company, through whose good work we have been brought into our present position. I want to say a word of approval of the services of Mr. Seale, our secretary, and of Mr. Patchell, our engineer. I can only tell the shareholders that in their respective departments they, as well as the other members of the staff, have worked zealously and carefully, and that though the board have to do a considerable amount of work, and give such time and intelligence as they possess to the affairs of the company, they could not have produced anything like the result shown by the report but for the assistance of the company's officers. I now move the adoption of the report and accounts and the payment of the dividends set out therein.

Mr. G. H. BROUGHAM GLASIER seconded the motion.

Mr. LAURIE: In the report you say, "The provisional order to supply electric energy within the City of London, referred to in the directors' report for the year 1898, was granted to this corporation by the Board of Trade, and the order confirmed by Parliament. Some mains have already been laid in the western portions of the City, and supply given from the existing stations of the corporation." Then in paragraph 10 it says, "The directors have made arrangements for acquiring 7½ acres of freehold land at Bow. The greater portion will be devoted to the purposes of the City provisional order, which provides that a separate station shall be

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erected for the purposes of supplying the City." No doubt the chairman will be able to say that the Board of Trade in their order have given us permission to use our present power until the City station is complete. If the chairman could tell us that, I think it would reassure a good many of our shareholders.

Mr. SQUIBB: Will the City business stand on its own merits, or be thrown into the general pot of this company's undertaking?

Mr. J. WATSON: I heard a report the other day that the London County Council were likely to require the site of this station at Maiden-lane. Is there any truth in that; and if so, what would the directors propose to do? May I ask you also to tell us how many lamps this company supply in the City now, because that is a very important matter. It seems to me that at the low price of 4½d. you cannot make a large profit unless you supply some millions of units.

The CHAIRMAN: As to transgressing the provisional order in supplying the City, we are doing nothing whatever of the kind. We may supply the City from our own mains to any extent that we choose. All the clause provides is that, for the protection of the City, within a certain period——two years from the date of the provisional order—we shall erect a station for the City itself. As to some of the other questions asked, I prefer not to give information to shareholders as to plans which are not complete. I have been asked what benefit I expect the City undertaking will be, and I may say that I expect it will be considerable. The Metropolitan Co. fought vigorously to get the order, and besides them there were other people, whom one cannot put down as fools, who tried after the same thing. The same comments that we have heard to-day were made when we went in for the Strand order and the Holborn and St. Giles orders, but in each case we have been justified by results.

The resolution was then carried unanimously.

Messrs. G. H. Brougham Glasier and J. M. Gatti were re-elected as directors, and the sum of 1,000 guineas was voted as directors' remuneration. The reappointment of Messrs. O. R. Johnson and Son as auditors was also approved.

A cordial vote of thanks to the chairman and directors brought the proceedings to a close.

Edison and Swan United Electric Light Co. (Ltd.).

An extraordinary general meeting of this company was held on Tuesday, Mr. J. STAATS FORBES presiding. The object of the meeting was to consider the resolution authorising the creation and issue of £300,000 5 per cent. debenture stock.

The SECRETARY (Mr. H. Charles Gover) having read the notice convening the meeting,

The CHAIRMAN introduced his remarks by referring to the very small number of shareholders attending. He said it was somewhat discouraging to those who took upon themselves the great responsibility of managing other people's business to find so few people take an interest in their own affairs. Continuing, he said: I daresay that few people who are interested in this company understand the least about the character of the business in which they have put their money. You know that when we started we were protected by patents. We could then charge anything we chose for our goods. Then followed the time when the patents expired and the business was thrown open to the world, and we had to enter into competition with others as clever as ourselves. But we retained a considerable business after the expiration of the well-known Edison and Swan lamp patent, or perhaps I may say, in the presence of Mr. Swan, the Swan and Edison lamp, because it is a very singular fact that Swan's patent has worn out the Edison lamp in this company. Our lamps are all made on the Swan patent, our customers having elected to use the Swan as against the Edison lamp. Later we bought the patent of a lampholder, making a large number of these ourselves and licensing other manufacturers under the patent, they paying us a royalty. In 1894, therefore, when the Edison and Swan lamp patents expired (we were then receiving 2s., 2s. 6d., and 2s. 9d. for our lamps, whereas we are now glad to get 1s. 1d. or 1s. 2d.) the profits on our business were £27,900. Between 1894 and 1895 the profits dropped to £19,400, or a decrease of about £8,000. Between 1895 and 1896 a further decline of £3,300 occurred. In 1897, however, our business began to expand—in fact, we pushed it. We were face to face with competition, but the electrical business was rapidly expanding under what was called "the wholesome breath of competition," and our profits rose to £20,000 in 1897, and in 1898 to £26,700. At the end of 1898 our lampholder patents expired, which had been bringing us in during the two or three preceding years about £8,000 a year, so that in 1898 we emerged into the open market without any protection whatever. Notwithstanding this, our profits for the year ended June 30, 1899, rose to £32,200. This justifies us in looking forward to the future. The character of our business has greatly changed since 1894, and from being mere makers of lamps we have become makers of fittings, electroliers, generating machines—in fact, of everything that is used by electric light and power contractors. We do no installation work, but confine ourselves to the manufacture and sale of the immense variety of articles involved in electric installation work. This expansion means of course the locking up of money. In our balance-sheet for the last complete year (to June 30, 1899) particulars are given of how this money is locked up. Firms engaged in installation work (and there are hundreds of these) are frequently short of capital. Some of the firms are very wealthy, but they are governed by what is called "the custom of the trade," and this custom is that the unfortunate manufacturer or dealer who is to supply their wants has to wait a long time for his money. The tradition is three months' credit; and after this it frequently requires another two months to extract your account from your customer, who threatens, if you press him too hardly, that he will go elsewhere for his goods. We have, therefore, in a measure to finance a great number of people. In our balance-sheet to June 30 you will see sundry debtors and debit balances to the amount of £90,000. This is a big sum to lock up, and is a considerable percentage of our whole income. Another matter which leads to the locking up of capital is our large number of depôts where we have showrooms and storerooms to enable buyers to select the goods they require, and this means the locking up of a vast amount of money. Our last balance-sheet shows that in this way we have £168,000 locked up in things which take their chance of being sold, and as this business goes on increasing from year to year—remember that we doubled our profits in three years—if we are to go on we must have more money. One other disadvantage of the lock up of our money is that when we cannot get our money we cannot pay the people from whom we buy. In making large contracts for platinum, copper, and other raw materials used in the business, we find that when we have the money at hand we can obtain these goods on more moderate terms in the form of discounts for cash down or within a short period. The locking up of our floating capital in financing other people leads to our getting into debt, and already we owe our bankers about £40,000, and bankers are not philanthropists and do not lend money without interest. That, gentlemen, is the state of our affairs, and in the opinion of your directors means that we must have some money at our command. I am satisfied that if we had more money we should have done even a larger business than we have and a much more profitable business. As soon as we have the means we have a very large future before us. Your directors have come to the conclusion that the most economical and possibly the only way of dealing with the position is to raise debentures. We have thought out whether it was possible to raise share capital. For some reason which I cannot conceive—and I am a pretty large holder myself of shares in the company—these shares are always at a discount, a state of affairs absolutely unjustified by anything whatever in the state of the business. We pay 6 per cent., have done so for two years, and shall go on doing so, I have no doubt. Share registers are instructive documents, and it is not uncommon to find that your shares are bought for £2 and sold for £2. 5s. or £2. 10s. by the original purchaser to some other person, and this is constantly going on. I cannot tell why this is so, but I think the shareholders ought to know it and protect themselves by declining to sell at these low prices. This is at any rate an objection to our issuing shares. Another disadvantage is that we have a sleeping partner in this concern. The B shares, as you know, represent the interests, I think, of Mr. Edison and his friends, who sold their patents to the original Edison Co. in virtue of a certain number of shares which stands in the balance-sheet at £117,000; and a condition of the bond is that if there is an issue of capital over and above the capital of the company at any time, Mr. Edison's friends and himself can claim to have one share of the sum given to them for every three issued. So you will see that it is improvident to raise money in such a way as to incur this liability. After the ordinary shares get 7 per cent. the B shares referred to take a proportion of the surplus profits. Therefore everything points to raising money on terms which at all events will give you something like 20s. in the £ and relieve you of an incubus which would be created by the contract between the B and A shareholders. We therefore recommend raising the money by issuing debentures. We consider the amount should be £300,000, but with this provision that only £100,000 will be wanted in the coming year to put us on our legs, pay our debts, and make us independent of bankers' advances. The remainder of the £300,000 is not to be issued for the next two or three years, and then only to meet the expansion of our business. I now move—

"That the directors be authorised to create and issue debenture stock providing for the payment of principal sums not exceeding £300,000 and carrying interest at the rate of not exceeding 5 per cent. per annum, such stock to be secured in such manner (subject to the existing debenture stock already issued by the company to the amount of £350,000) and to be issued to such persons and on such terms as the directors shall think fit."

The EARL OF LICHFIELD seconded the resolution.

Col. STROUD: One of the conditions of the issue is that the first £100,000 shall be so far secured that no second £100,000 can be issued until a certain period has expired, but the resolution does not say this. You might, in fact, as the period is not fixed, receive power from the resolution to place upon the market £300,000 all at once.

The CHAIRMAN: We have specifically determined that we will not raise more than £100,000 during the present year.

Col. STROUD: I understand that from your remarks, but it is not so stated in the resolution.

The CHAIRMAN explained the expressions which would be used in the prospectus in connection with the first application for £100,000, and the explanation was accepted by Col. Stroud.

Mr. DEEDS asked whether any provision was to be made as to the incurring of bad debts and other casualties.

The CHAIRMAN: We have rather anticipated this point, as in the balance-sheet there is £73,000 carried to reserve out of profits. This is under specific powers in the articles of associaton, and is to secure you, amongst other things, against bad debts, which I may say have not at any time amounted to a ½ per cent.

The resolution was then put and carried with two dissentients [representing, we believe, the "B" shareholders].

Col. STROUD: I would like to ask a question as to the position of the Altrincham electric supply which figures in our books at £40,000.

The CHAIRMAN: We absorbed the Manchester Edison and Swan Co., and, among other things, that company had commenced installation work under electric lighting provisional orders, among other places, at Altrincham, where the Manchester Co. had spent a great deal of money. We have taken over this asset, and I am able to say that the £40,000, according to assurances I have had from the manager of the works, will this year be covered with interest. He thinks the works will make £2,000 profit this year. We think that the Altrincham electric supply is a solid business.

Some further questions having been answered by the chairman, the proceedings terminated.

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Chelsea Electricity Supply Co. (Ltd.).

The directors' report for the year ended Dec. 31 states that in October, 1899, an issue of £50,000 debenture stock was made at 107 per cent. This issue was fully paid up in January, and a Stock Exchange quotation has been granted. The balance of premium received, after deducting expenses of issue and certain incidental expenses, has been carried to reserve. In consequence of the exceptionally high price of coal, the directors think it prudent to place a special amount of £1,096. 8s. 5d. to reserve, as provision for the largely increased outlay under this head of expenditure, for the current year. The total of reserve now stands at £48,604. 13s. 8d. The sum of £3,000 has been added to renewals and depreciation fund out of net revenue. After deducting these amounts, and after payment of debenture interest (£4,668. 15s.), there remains a balance of £12,000, which the directors recommend shall be applied as under:—

Interim dividend of 6 per cent. per annum on preference shares for half-year to June 30	£900
Interim dividend of 5 per cent. per annum on ordinary shares for half-year to June 30	4,250
Dividend of 6 per cent. per annum on preference shares for half-year to Dec. 31	900
Dividend of 7 per cent. per annum on ordinary shares for half-year to Dec. 31 (making 6 per cent. for year)	5,950
	£12,000

The number of lamps connected on Dec. 31 was 128,667, an addition of 16,280 during the year, The directors have adopted the maximum demand system of charge for customers on the 200 volt supply. They believe that this change is appreciated by consumers, and that it will benefit the company. The hire purchase system for wiring and fittings has also been introduced. Mr. Emile Garcke, owing to pressure of other engagements, has retired from the board.

Hove Electric Lighting Co. (Ltd.).

The directors' report for the year to Dec. 31 shows that the quantity of electric current sold to consumers during the year amounted to 444,499 units, compared with 350,354 units in 1898; while gross revenue amounted to £12,070. 5s. 8d., against £9,480 7s. 1d., an increase of £2,589. 18s. 7d. The gross expenditure was £4,973 2s. 1d., against £4,390. 8s. 11d. in 1898, an increase of £582. 13s. 2d., the net result being a profit of £7,097. 3s. 7d., compared with £5,089. 18s. 2d., an increase of £2,007. 5s. 5d. The directors attribute the successful working of the undertaking to the reduction made in the price of current in 1898. A further reduction has been made, under certain conditions, from Jan. 1 this year, which it is hoped will further add to the profits, and the directors propose that further reductions be made as the board see their way to meeting the increasing demand.

The lamps and motors connected to the company's system on Dec. 31 were equivalent to 44,824 8 c.p. lamps, and the number of houses connected 671, compared with 36,967 lamps and 513 houses at the end of 1898.

To net revenue (£7,097. 3s. 7d.) £376. 0s. 7d. brought forward is added, making £7,473. 4s. 2d. After deducting debenture interest, the interim dividend at the rate of 6 per cent. per annum paid in October last, and providing for income tax, there remains £5,030. 14s. 3d. to the credit of net revenue. The directors propose to write £262. 5s. off preliminary expenses account, to place £2,000 to reserve, to declare a dividend, payable April 14, at the rate of 9 per cent. per annum for the half-year on the share capital, making with the interim 7½ per cent. for the year, and to carry £614. 17s. 10d. forward. The sum at credit of reserve will now amount to £12,287. 17s., and with £155. 14s. 3d. added to depreciation and maintenance reserve, this account is increased to £1,261. 7s. 4d.

During the past year 2,000 additional shares have been issued at £7. 10s. each, the premium being added to reserve. The expenditure on capital account during the year amounted to £16,210. 2s. 7d. The generating station has been enlarged to the fullest extent which the Corporation of Hove will allow on the present site. Two additional steam dynamos of 350 H.P. and 250 H.P. respectively, and an additional boiler, have been placed in the station; £4,686 has been expended on new mains and in strengthening the existing feeders and mains, and £1,255 on additional meters and demand indicators. The total expenditure to the close of the year amounted to £93,660. 14s. 9d. Another 250 H.P. steam dynamo is on order for delivery in the early autumn. This will completely fill up the space for machinery at the present station, and it is hoped will meet the requirements for next winter. The company must add largely to its generating power before the directors can reduce the charges to a point which it is anticipated will yield the very best results, and the steady growth of the company's business fully justifies the erection of a second generating station, as the following figures for the period 1896–1899 will prove:—

Year.	Houses.	8 c.p. lamps.	Units sold.	Gross revenue.	Net revenue.
1896	314	21,756	200,562	£6,518	£3,114
1897	397	27,777	268,243	7,269	3,602
1898	513	36,967	350,254	9,480	5,089
1899	671	44,824	444,499	12,070	7,097

The directors have consequently been seeking a site for a second station, and have found one in an exceptionally good position, upon which they propose building as soon as the agreements, &c., are completed and the necessary plans and estimates have been prepared. The erection of this station and its equipment with generating plant, together with the connection of the station with the existing mains, will involve considerable capital expenditure, but the directors have every confidence that the outlay will prove as remunerative as that already incurred.

NEW COMPANIES, STATUTORY RETURNS, &c.

ALLEN, ALDERSON AND CO. (LTD.)—This company was registered on Feb. 16, with a capital of £100,000 in £1 shares (50,000 preference), to acquire the business carried on at Alexandria, Egypt, as Allen, Alderson and Co., and to carry on the business of general merchants, electrical and mechanical engineers, &c. The first directors are G. B. Alderson, F. Allen, G. A. Alderson, and H. F. Dickson.

AUTOMATIC CINOGRAPH CO. (LTD.)—This company was registered on Feb. 12, with a capital of £5,000 in £1 shares, to acquire patents and rights connected with kinetoscope films and apparatus, and to carry on the business of photographic and other apparatus makers, electrical and chemical engineers, &c.

H. W. COWLEY AND CO. (LTD.)—This company was registered on Feb. 15 with a capital of £6.000 in £1 shares, to carry on the business of mechanical, electrical, and hydraulic engineers, machinists, metal workers &c. The first directors are C. H. Cowley, H. W. Cowley, R. W. Kenyon, and T. Shurmer

DIALENE RUBBER CO. (LTD.)—This company was registered on Feb. 20, with a capital of £12,000 in £1 shares, to acquire from Mr. Geo. E. Heyl-Dia certain secret processes for the manufacture of Dialene rubber from old and used rubber by means of chemical treatment, and to apply the same to the insulation of telegraphic, telephonic, and electric cables, wires, and appliances. The subscribers (with one share each) are F. Reddaway, H. Walmsley, Geo. E. Heyl-Dia (electrical engineer), H. Holgkinson, L. Reddaway, W. H. Cresswell, and F. B Craven. The first directors are Geo. E. Heyl-Dia, W. H. Cresswell, H. Walmsley, and L. Reddaway.

DOUST BROTHERS (LTD.).—This company was registered on Feb. 24 with a capital of £2,000, in £1 shares, to carry on the business of electrical engineers' merchants, wire workers, cycle and motor car makers, &c.

ELECTRO-CHEMICAL CO. (1900) (LTD.)—This company was registered on Feb. 14, with a capital of £200,000 in £1 shares, to adopt an agreement with the Electro-Chemical Co. (Ltd.) (incorporated in 1894), for the acquisition of the business of the old company, and to carry on the business of chemical, carbon, and alkali manufacturers, makers of sulphuric and hydrochloric acids, &c. The subscribers are Col. T. J. Holland, R. Vogan, L. Evans, R. Taylor, W. Dedrick, R. Shaw, T. M. Dunster, and R. Smith. The first directors are Col. T. J. Holland, L. Evans, M. H. Pirie, T. M. Dunster, J. H. F. Walter, and R. Vogan.

ENGLAND, ROBINSON AND CO. (LTD.)—This company was registered on Feb. 9, with a capital of £12,000 in £1 shares, to acquire the businesses carried on under the style of James England and Sons and Jame Robinson, and to carry on the business of electrical and mechanical engineers, &c.

HONEYWOOD, AUSTIN AND CO. (LTD.)—This company was registered on Feb. 22, with a capital of £5.500 in £1 shares, to carry on the business of engineers, electricians, motor car and vehicle manufacturers, &c.

IDEN'S PATENTS (LTD.).—This company was registered on Feb. 24 with a capital of £10.000, in £1 shares, to carry on the business of engineers, electricians, smiths, motor car builders, wire drawers, &c.

NATIONAL GAS ENGINE CO. (1900) (LTD.).—This company was registered on Feb. 24 with a capital of £200,000. in £1 shares (£100,000 5½ per cent. cumulative preference), to acquire the business carried on under the style of the National Gas Engine Co. (Ltd.), and to carry on the business of gas and oil engine manufacturers, mechanical and electrical engineers, gas and electrical plant makers, &c.

AUTOMATIC TELEPHONE CO. (LTD.)—The annual return to Feb. 8 has been filed. The capital is £100,000 in 5s. shares, 314,326 of which have been taken up. 3s. has been called up on each of 26,410 and 5s. on each of 17,620. £7,740. 7s. has been received (exclusive of £156. 13s. 4d. paid in advance of calls), leaving £626. 3s. in arrears. £67,574 is considered as paid on 270,296 shares.

DIRECT UNITED STATES CABLE CO. (LTD.)—The annual return to Feb. 16 has been filed. The capital is £1,300,000 in £20 shares, 60,710 of which have been taken up.

PERU TELEPHONE CO. (LTD.)—The annual return to Jan. 14 gives the capital as £100,000 in £5 shares, 7 of which have been taken up. No calls have made.

RENEWABLE ELECTRIC LAMP CO. (LTD.)—The annual return to Dec. 6, 1899, gives the capital as £150,000 in £1 shares (50,000 preference), of which 30,000 preference and 100,000 ordinary have been taken up. 5s. has been called up on each of 30,000 preference and 7s. 6d. on each of 1,074 ordinary.

SOUTHERN ELECTRICAL INSTALLATION AND WIRING CO. (LTD.)—The annual return to Dec. 9 has been filed. The capital is £10,000 in £1 shares (2,500 preference). 1,853 preference and 3,493 ordinary have been taken up, 15s. per share has been called up on 422 preference and 2,824 ordinary and £2,399 12s. 6d. has been paid, leaving £34 17s. 6d. in arrears. 1,431 preference and 669 ordinary are considered as fully paid.

WEYMOUTH ELECTRIC LIGHT AND POWER CO. (LTD.).—The annual return to Jan. 10 gives the capital as £10,000 in 2,000, £5 shares, seven of which have been taken up. No calls.

DUBLIN AND LUCAN STEAM TRAMWAY CO.—At the half-yearly meeting of this company the chairman (Mr. Wm. Mooney) said that the work of electrically equipping the line was practically finished. They had had several satisfactory trial trips, and had received notification that the Board of Trade inspection would take place on Tuesday, this week. The line would be opened as soon as possible after they received the Board's certificate.

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CITY NOTES.

MOTOR MANUFACTURING CO. (LTD.)—A meeting of this company was held on Monday, at which a good deal of information was given about the business of the company, but no reference was made to electric vehicles, by the chairman (Mr. J. H. Gretton), gas being the element with which the company is chiefly concerned. The chairman complained that the company had met with a great deal of opposition, and that the motor industry was viewed with considerable prejudice. He appears to have failed to attribute this prejudice to its real source—the use of gas and oil as motive power.

MUNICIPAL LOAN.—The Tynemouth Corporation invite offers for a loan of £39,850 for electric lighting purposes, &c. Tenders to borough accountant by 13th inst.

NORTHAMPTON ELECTRIC LIGHT AND POWER CO. (LTD.)—The annual meeting was held last week. The chairman (Mr. F. H. Thornton, J.P.) said that the report (given in our last issue) was by far the most satisfactory report presented since the formation of the company. In spite of a reduction of something like 20 per cent. in the price of current and an increase of about 15 per cent. in the price of coal, the company were able to keep up the dividend, though a small one, to the same level as in 1898. They began the year with the equivalent of 13,061 8 c.p. lamps, and ended the year with 19,763, an increase of 6,702. Their best thanks were due to their officers and employés. The increase in the number of lamps was not altogether due to the reduction in the price of current, but was partly due to the reduced cost of installation, which had been cheapened so much that an installation formerly costing 20s. to 25s. could now be done for about 10s. During the year the company had connected up a great many private houses on the "free" wiring system, and it was from private houses that they had the best returns. There were now 14 motors in use, an equivalent of about 50 H.P. During the year the company proposed to raise the pressure of the current, the result of which would be that a better light would be obtained for less money. The increase in the length of their mains (2¼ miles) had resulted in an increase for January, 1900, of something like 60 per cent. in units sold compared with 1899, a very happy omen for the future success of the company. The report was adopted.

SANTANDER (SPAIN).—A new company has recently been established here with the title of La Sociedad Electrica de Biscaya, with a capital of $400,000 to establish extensive electric light and power plant works. The entire works are to be driven by water power erected 28 miles from Santander on the river Biscaya. Contracts for plant will shortly be placed.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	1900	£	£		£	£
*Birmingham Tramways.	Feb. 24	4,074	+ 251	8	31,097	+ 1,067
Blackpool Corporation...	„ 22	133	− 17	47	21,725	+ 4,394
Blackpool and Fleetwood	„ 24	143	− 64	8	1,112	− 155
Bradford Corporation	„ 18	314	+ 26	80	26,633	...
	„ 25	372	+ 90			
Brisbane Trams	Jan. 10	1,712	+ 506	15	32,473	+ 9,883
*Bristol Trams & Carriage	Feb. 23	2,648	+ 58	8	20,562	+ 722
*Buenos Ayres & Belgrano	Jan. 28	2,217	+ 709	4	9,487	+ 2,826
City & South London Ry.	Feb. 25	1,115	+ 13	8	9,014	+ 54
Dover Corporation	„ 24	141	− 1	47	9,368	+ 1,027
Dublin United	„ 23	2,931	+ 250	8	22,130	+ 1736
Dublin Southern Dist....	„ 23	613	− 42	8	4,490	
*Glasgow Corporation ...	„ 24	8,270	+ 330	...	...	...
*Liverpool Corporation...	„ 17	6,208	+ 269	7	45,216	+ 4,822
Liverpool Overhead Rly.	„ 25	1,360	+ 80	8	11,500	+ 1,167
*Sheffield Tramways	„ 25	1,905	+ 743	8	14,288	+ 4,293
*South Staffs. Trams.....	...	...	...	...	...	...

* Partly electrical.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	NAME.	Previous Week's Price, Feb. 21.	Price Wednesday, Feb. 28.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Feb. 28. Highest	Lowest
			TELEGRAPHS.			£ s. d.			
£110,800	100	4%	*African Direct Telegraph 4% Mort. Deb. (red.)	99 103	99 103	3 17 8	January and July.....	...	...
26,000	10	...	Amazon Telegraph.....	3 4	3 4	...	June and December ...	...	...
£125,000	100	5%	Do. 5 per Cent. Debentures	85 90	85 90	5 11 1	... ...	...	...
£375,520	Stock	28/6	Anglo-American	63 66	63 66	5 11 5	Feb., May, Aug., Nov.	63½	...
£3,062,240	Stock	30/0	Do. Preferred	114 115	114½ 115½	5 3 11	„ „	115	114½
£3,062,240	Stock	27/0	Do. Deferred	14½ 15	14½ 15½	3 17 0	... ...	14½	14½
$10,000,000	$100	$2½	Commercial Cable Capital Stock	165 175	165 175	4 12 1	Jan., Apr., July, Oct.	...	...
£1,563,078	Stock	4%	* Do. 4 per Cent. Debenture Stock	103 105	103 105	3 16 8	„ „	104½	...
16,000	10	8/0	Cuba Submarine Ordinary	9 10	9 10	3 0 0	February and August	...	...
6,000	10	10/0	Do. Preference 10 per Cent.	19 20	19 20	5 0 0	„ „	...	...
12,981	5	2/0	Direct Spanish Ordinary.....	4 5	4 5	4 0 0	April and October.....	...	...
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference	9 10	9 10	5 0 0	„ „	...	...
£30,000	50	4½%	Do. 4½ per Cent. Debentures	101⅞ 105⅞	101⅞ 105⅞	4 5 9	January and July.....	...	...
60,710	20	3/0	Direct United States Cable	11½ 12	11½ 12	5 16 8	Jan., Apr., July, Oct.	11½	...
£120,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red.)	99 102	99 102	4 8 3	June and December ...	...	...
£4,000,000	Stock	5%	Eastern Ordinary	155 160	155 160	4 7 6	Jan., Apr., July, Oct.	158½	156
£1,795,000	Stock	3½%	Do. 3½ per Cent. Preference Stock	98 101	98 101	3 9 3	„ „	100½	98½
£1,432,268	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.)	116 121	116 121	3 6 8	May and November ...	119	116
250,000	10	2/6	Eastern Extension	15½ 16	15½ 16	4 7 6	Jan., Apr., July, Oct.	16	15½
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	115 120	115 120	3 6 8	February and August	116	...
£6,700	100	5%	* Do. 5% (Austin. Gov. Sub.) Deb.,1900 (reg.) ...	100 103	100 103	4 17 1	January and July.....	...	...
£26,600	100	5%	Do. (Bearer)	100 103	100 103	4 17 1	„ „	...	...
£300,000	100	4%	*Eastern and S. African 4% Mort. Deb., 1909.....	100 103	100 103	3 18 5	February and August	...	...
£200,000	25	4%	Do. 4 per Cent. Mauritius Sub. Debs.(red.) ...	101⅞ 104⅞	101⅞ 104⅞	3 16 10	May and November ...	...	...
180,227	10	1/9	Globe Telegraph and Trust	11½ 11⅝	11½ 11⅝	4 9 4	Jan., Apr., July, Oct.	11⅝	11⅝
180,042	10	3/0	Do. 6 per Cent. Preference	15⅝ 16	15⅝ 16	3 15 0	„ „	15⅝	...
150,000	10	5/0	Great Northern of Copenhagen	31 33	31 33	3 15 9	January and July.....	32½	...
£86,200	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb.(red.) ...	99 102	99 102	4 8 3	... ...	...	...
17,000	25	12/6	Indo-European.....	49 53	49 53	4 14 4	May and November ...	...	...
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904 ...	106 109	107 110	5 9 5	March and September	...	...
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.)	101 104	101 104	3 16 11	June and December ...	...	...
11,839	8	4/0	Reuter's	7 8	7 8	5 0 0	April and October.....	8½	8
3,381	£100 Cert.	6%	Submarine Cables Trust	124 129	124 129	4 14 6	„ „	125	...
15,609	10	...	West African Telegraph	2½ 3½	2½ 3½	4 9 3	December and July ...	...	...
£300,000	100	5%	* Do. 5 per Cent. Debentures (red.)	98 101	98 101	4 18 9	March and September	...	...
20,008	2½	...	West Coast of America.....	½ 1	½ 1	...	... ...	...	...
£150,000	100	4%	* Do. 4 per Cent. Debentures	100 103	100 103	3 17 8	January and July.....	...	...
88,321	10	6d.	West India and Panama	¾ 1⅛	¾ 1⅛	...	May and November ...	1 1/16	1 1/16
34,563	10	6/0	Do. 6 per Cent. 1st Preference	9½ 9¾	9½ 9¾	6 3 1	„ „	...	...
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	7 8	7 8	7 10 0	„ „	...	...
£80,000	100	5%	* Do. 5 per Cent. Debentures	104 107	104 107	4 13 6	January and July.....	107	...
£289,731	Stock	4%	Western & Brazilian 4 per Cent. Debenture Stock ...	100 104	100 104	3 16 11	June and December ...	...	...
207,980	10	3/0	Western Telegraph (late Brazilian Submarine)	14½ 15½	14½ 15½	4 11 10	Mar., June, Oct., Dec.	15⅛	15
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1900)	106 109	106 109	4 11 9	June and December ...	...	...
£158,100	100	6%	*Western Union 6 per Cent. Sterling Bonds (red.) ...	98 103	98 103	5 16 6	March and September	...	...
			TELEPHONES.						
44,000	£5	3/0	Chili Telephone (fully paid)	2 3	2 3	6 13 4	August	...	...
224,850	10s.	0/1½	Consolidated Telephone Const. & Manufacturing ...	¼ ⅜	¼ ⅜	4 15 3	July	...	...
72,690	1	2½%	Monte Video Telephone Ordinary	⅞ 1	⅞ 1	5 0 0	November	...	...
86,493	1	1/0	Do. 5 per Cent. Preference	⅞ 1	⅞ 1	5 0 0	„	...	...
490,000	5	3/0	National ..... xd	5½ 5⅝	5½ 5⅝	5 11 7	February and August	5 5/16	5½
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Preference xd	14 15	14 15	4 0 0	„ „	...	...
15,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference xd	14 15	14 15	4 0 0	„ „	14⅜	...
250,000	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref. ...	5⅜ 5⅝	5½ 5⅝	4 10 11	„ „	5 7/16	5⅜
2,000,000	Stock	3½%	* Do. Debenture Stock 3½ per Cent. (red.)	97 100	77 100	3 10 0	June and December ...	99	97½
171,504	1	0/4	Oriental	¾ 1	¾ 1	5 0 0	April and October.....	...	...
58,000	5	2/6	United River Plate	4¾ 5½	4¾ 5½	7 2 10	July	...	...
16,639	5	1/4	Do. 5% Cumulative Preference	4¾ 5¼	4¾ 5¼	4 15 3	June and December ...	...	...
£179,947	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	103 106	103 106	4 14 4	„ „	...	...

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Feb. 21.	Price Wednesday, Feb. 28.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Feb. 28. Highest	Lowest
			ELECTRICITY SUPPLY COMPANIES.			£ s. d.			
100,000	1	...	Bl'ckh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.)	⅛ ⅞	⅛ ⅞	...	...	...	...
6,000	10	7/9⅜	Bournemouth and Poole Elec. Supply Ord.	12 13	12 13	3 0 0	...	...	...
6,000	10	4/6	Do. 4½ per Cent. Cumulative Pref.	10 11	10 11	4 1 10	...	...	...
19,661	5	2/6	Brompton & Kensington Electricity Supply Ord.	7 8	7 8	3 15 0	...	...	...
12,000	5	3/6	Do. 7 per Cent. Preference	8½ 9½	8½ 9½	3 13 8	March and September	...	...
20,000	5	...	Calcutta Elec. Supply Ordinary (fully paid)	6½ 7½	6½ 7½	...	...	...	...
30,000	5	4/0	Charing Cross & Strand Electricity Supply Corp.	10 11	10 11	3 18 3	February and August	10⅜	...
20,000	5	...	Do. (Nos. 30,000 to 50,000)	10 11	9½ 10½	...	...	...	...
20,000	5	2/3	Do. 4½ per Cent. Preference xd	5½ 6½	5½ 6	3 15 0	,, ,,	...	...
34,000	5	2/6	Chelsea Electricity Supply Ordinary	7½ 8½	7½ 8½	3 10 7	March	7¹⁵⁄₁₆	...
£100,000	Stock	4½%	* Do. 4½ per Cent. Debenture Stock (red.)	110 112	110 112	4 0 11	June and December	...	...
$1,200,000	$1,000	5%	Chicago Edison 1st Mort. 5% 30 year Gold Bonds (red.)	100 110	100 110	4 10 11	April and October	...	...
60,000	10	7/0	City of London Electric Lighting Ordinary	10½ 11½	10 11	5 8 9	February and August	10⅜	...
40,000	10	6%	Do. 6 per Cent. Cumulative Preference	13 14	13 14	4 5 9	January and July	13¾	13½
£400,000	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	122 127	122 127	3 13 9	June and December	...	...
40,000	10	...	County of London and Brush Prov. Ordinary	9½ 10½	9½ 10½	...	...	10	9¹⁵⁄₁₆
30,000	10	6/0	Do. 6 per Cent. Cumulative Preference	12½ 13½	12½ 13½	4 8 11	March and September	...	...
£200,000	Stock	4¼%	Do. 4¼% Deb. Stock Certs. (all pd.) (red.)	109 112	109 112	4 0 11	...	...	...
15,000	5	10%	Kensington and Knightsbridge Ordinary	12 13	12 13	4 1 6	...	...	...
10,000	5	6%	Do. 6 per Cent. 1st Preference	7 7½	7 7½	4 0 0	January and July	...	...
110,000	3	..	London Electric Supply Ordinary	1⅜ 2⅛	1⅜ 2⅛	...	...	...	...
48,050	5	3/0	Do. 6 per Cent. Preference	4⅝ 5	4⅝ 5	6 0 0	...	...	...
£250,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures	101 103	101 103	3 18 1	Mar., June, Sept., Dec.	...	...
62,500	10	5/0	Metropolitan Elec. Supply Ord. (Nos. 1 to 62,500)	14 15	14 15	3 6 8	April and October	14⅛	14⅛
22,500	10	3/7½	Do. (Nos. 62,501 to 85,000)	14 15	14 15	3 5 8	...	...	...
£220,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage	114 117	114 117	3 16 11	June and December	...	...
£125,000	Stock	24/8	Do. 3½ per Cent. Mort. Deb. Stock (red.)	95 97	95 97	3 13 2	...	96½	...
6,452	10	6/0	Notting Hill Electric Ordinary	16 17	16 17	3 10 7	March	...	...
10,000	5	5/0	Oxford Electric Ordinary	6¾ 7½	6¾ 7½	3 9 0	,,	...	...
800,000	1	8%	Rand Electric	⅜ ⅝	⅜ ⅝	10 13 4	...	...	...
£130,070	Stock	5%	River Plate El. Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb.	75 85	75 85	5 18 0	...	...	...
150,000	$100	$2	Royal Electric Company of Montreal Shares	150 170	150 170	4 14 2	...	...	...
£123,200	100	4½%	* Do 4½ per Cent. 1st Mortgage Debentures	104 106	104 106	4 5 6	April and October	...	...
31,980	5	9/6	St. James's and Pall Mall Electric Ordinary	15 16	15 16	4 10 8	February and August	15⅜	15
20,000	5	3/6	Do. 7 per Cent. Preference xd	9 9½	8½ 9½	3 13 6	,, ,,	...	...
65,000	5	..	South London Electric Supply Ordinary (fully paid)	4 4⅛	4 4⅛	...	...	4⅛	4
79,900	5	8/0	Westminster Electric Supply Ordinary	14 15	13½ 14½	4 9 8	March and September	14½	14
			ELECTRIC MANUFACTURING, &c., COMPANIES.						
125,000	1	7½d.	Aron Electricity Meter 6 per Cent. Cum. Pref.	⅜ ½	⅜ ½	6 17 2	...	⅜	...
45,000	1	...	British Electric Works Co. Ordinary	⅛ 1 1/16	⅛ 1 1/16	...	...	...	...
50,000	1	...	Do. 6 per Cent. Cumulative Preference	½ 1	½ 1	...	...	...	...
£50,000	100	4½%	Do. First Mortgage Debentures	99 101	99 101	...	...	...	...
40,000	5	15/0	British Insulated Wire Ordinary xd	13 14	12 13	4 4 2	...	...	...
27,500	5	3/0	Do. Preference xd new	6 6½	6 6½	3 16 11	...	...	...
90,000	2	2/0	Brush Electrical Engineering	1⅞ 2⅛	1⅞ 2⅛	4 14 1	September	2	1⅞
90,000	2	1/2⅝	Do. 6 per Cent. Pref. Non-Cumulative	2⅛ 2⅜	2⅛ 2⅜	4 16 0	,,	2⅜	...
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Deb. Stock xd	110 115	108 113	3 19 8	February and August	...	...
£50,000	Stock	4½%	* Do. 2nd Debenture Stock (red.)	102 105	102 105	4 5 9	June and December	...	...
20,000	5	5/0	Callender's Cable Construction Ordinary	14 15	14 15	5 0 0	,, ,,	...	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5½ 6	5½ 6	4 3 4	...	6¹⁵⁄₁₆	...
£90,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb. (red.)	110 115	111 115	3 18 3	November and May	...	...
300,000	1	0/9⅜	Castner-Kellner Alkali Co. (fully paid)	1⅛ 1⅜	1⅛ 1⅜	5 16 5	...	...	...
60,000	1	0/7½	Chadburn's Ship Telegraph Ordinary	⅛ 1⅛	⅛ 1⅛	5 6 8	...	...	...
60,000	1	0/7½	Do. 6 per Cent. Cumulative Preference	⅛ 1⅛	⅛ 1⅛	5 6 8	...	...	...
32,098	3	1/9⅜	Crompton and Co. (Nos. 1 to 32,098)	3½ 4	3½ 4	4 10 9	January and July	4	...
£100,000	100	5%	* Do. 5 per Cent. First Mortgage Deb. (red.)	98 101	98 101	4 19 0	,, ,,	...	...
60,000	1	0/3	Davis and Timmins 6 per Cent. Cum. Pref.	¼ 1	¾ 1	...	...	...	...
99,261	5	1/9⅜	Edison and Swan United ("A" Shares) (£3 paid) xd	2 2⅛	2 2⅛	7 3 9	February and August	2⅛	2⅛
17,139	5	2/9⅜	Do. (£5 paid) xd	3⅛ 4⅛	3½ 4½	6 13 4	,, ,,	...	...
£344,023	Stock	4%	Do. 4 per Cent. Mortgage Deb. Stock (red.)	93 95	93 95	4 4 3	June and December	...	...
26,100	5	5/11½	Edmundson's Electric Corporation Ord. (fully pd.)	4⅜ 5⅛	4⅜ 5⅛	5 14 3	Half-yearly	...	...
112,100	2	1/2⅞	Electric Construction Co. (Limited)	2⅛ 2⅜	2⅛ 2⅜	4 16 0	January and July	2⅜	...
25,000	2	2/9⅜	Do. 7 per Cent. Cumulative Preference	2⅛ 3⅛	2⅛ 3⅛	4 6 2	July	3⅛	-
182,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	103 106	104 107	3 15 2	January and July	...	...
30,000	5	...	Henley's Telegraph Works Ordinary	14 15	14 15	...	February and August	14⅛	14⅛
15,000	5	...	Do. 4½ per Cent. Preference	5½ 6	5½ 6	3 15 0	,, ,,	5¹⁵⁄₁₆	...
£50,000	Stock	4½%	Do. 4½ per Cent. Mortgage Deb. Stock (red.) xd	111 114	110 114	3 18 11	,, ,,	...	...
50,000	10	10/0	India Rubber, Gutta Percha, &c., Works	21 22	21 22	4 11 10	,, ,,	21⅛	2¹⁵⁄₁₆
£300,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	100 104	100 104	3 16 11	March and September	...	...
37,350	12	12/0	Telegraph Construction and Maintenance	37 41	37 41	4 7 9	March and July	38½	...
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909	102 105	102 105	3 16 2	...	104⅛	102⅜
20,000	5	3/0	Do. Manufacturing Ordinary	9 10	9 10	3 10 0	...	...	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5½ 6	5½ 6	4 3 4	...	...	...
30,000	5	5/0	Williams and Robinson Ordinary	9½ 10½	9½ 10½	4 5 9	April and October	10⅛	10⅛
30,000	5	3/0	Do. 6 per Cent. Cumulative Preference	7½ 7⅝	7½ 7⅝	3 17 5	,, ,,	7¹⁵⁄₁₆	7⅞
£100,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Debentures	104 106	104 106	4 0 2	May and November	...	...
			ELECTRIC RAILWAYS, TRAMWAYS, &c.						
12,000	10	10/0	Blackpool and Fleetwood Tramways xd	17½ 18½	17 18	4 8 11	...	...	...
£167,900	100	5%	Brisbane Tramway 5 per Cent. Debentures	104 106	104 106	4 14 4	...	...	...
50,000	10	8%	Bristol Tramways and Carriage Ordinary xd	22½ 23½	22½ 23½	...	February and August	...	...
25,000	10	...	Do. Cumulative Preference (£6 paid)	6½ 6⅝	6½ 6⅝	...	...	...	...
£100,000	Stock	4%	Do. 4 per Cent. Debentures	117 118	117 118	3 7 3	...	...	...
12,000	10	...	British Columbia Electric Railway 5% Pref.	...	10⅛ 10⅜	...	...	10⅛	10⅛
30,000	10	9/0	British Electric Traction Ordinary (Nos. 1 to 30,000)	16 17	16⅛ 17⅛	3 8 7	...	17⅜	16⅞
£15,000	10	...	Do. (Nos. 60,001 to 75,000)	15½ 16½	16 17	...	...	...	...
30,000	10	6/0	Do. 6% Cum. Pref. (Nos. 30,001 to 60,000)	13½ 13⅝	13½ 13⅝	4 7 3	...	13⅝	13½
£200,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures	125 129	125 128	3 18 6	...	...	...
40,000	5	1/9	Buenos Ayres & Belgrano 6% "A" Cum. Pref.	4⅞ 5⅛	4⅞ 5⅛	5 17 1	...	...	...
27,500	5	...	Do. "B"	4 4½	4 4½	...	...	...	...
320,000	Stock	5%	Do. 5 per Cent. Debentures	105 108	105 106	4 12 7	...	107	...
213,553	10	3/0	Central London Ordinary	9½ 10	9½ 10	3 0 0	June and December	9⅝	9⅜
£865,000	Stock	1½%	City and South London Railway Con. Ordinary	58 61	59 62	3 0 6	January and July	62	59⅜
37,500	10	...	Do. (Nos. 22,501 to 60,000) (£5. 10s. paid)	4 5	4 5	...	...	...	...
£150,000	Stock	5%	Do. 5 per Cent. Perpetual Preference (1891)	140 145	140 145	3 9 0	January and July	...	...
£200,000	Stock	5%	Do. (1896)	132 137	132 137	3 13 0	...	...	...
£187,701	Stock	4%	Do. 4 per Cent. Perpetual Debenture	125 130	125 130	3 1 11	May and November	...	...
20,000	10	7½%	†Imperial Tramways Ordinary	23 24	23 24	...	March and September	...	...
10,000	10	6%	† Do. 6 per Cent. Preference	15 15½	15 15½	3 16 2	,, ,,	...	...
£300,000	Stock	4½%	† Do. 4½ per Cent. Debenture	113 115	113 115	3 17 11	January and July	...	...
30,000	10	1/3	Kidderminster & District E. L. & Tr'ct'n 5% Pref.	10	10	5 0 0	May and November	...	...
37,500	10	2½%	Liverpool Overhead Railway Ordinary xd	9⅝ 9¹⁵⁄₁₆	9⅝ 9¹⁵⁄₁₆	3 19 4	February and August	...	...
10,000	10	5%	Do. 5 per Cent. Preference xd	13 13½	12½ 13	3 16 11	,, ,,	...	...
125,000	Stock	4%	Do. 4 per Cent. Debenture	105 107	106 107	3 14 11	January and July	...	...
24,000	5	...	New General Traction Ordinary	3½ 4	3½ 4	...	...	...	...
30,000	5	6/0	Do. 6 per Cent. Cumulative Preference	4½ 5½	4½ 5½	5 14 3	May	...	...
4,000	10	...	Oldham, Ashton and Hyde Elec. Tramway Ord.	18 19	18 19	...	February and August	...	...
4,000	10	5/0	Do. 5 per Cent. Preference	10⅜ 10⅞	10⅜ 10⅞	4 11 11	,, ,,	...	...
13,334	10	...	Potteries Electric Traction Ordinary	11½ 12½	11½ 12½	...	...	...	...
20,000	10	5/0	Do. 5 per Cent. Cumulative Preference	10 11	10 11	4 10 11	...	...	...
£540,000	Stock	3%	Waterloo and City Ordinary	101 104	101 104	2 17 8	June and December	103	102⅜

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.
† The London Stock Exchange Committee refuses to quote these.

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THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED. First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,138. [No. 20. Vol. XLIV.] FRIDAY, MARCH 9, 1900. PRICE SIXPENCE (by post, 6½d.), Abroad, 8d., or 15 cents, or 20/r., or 7m/.

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NOTES.

In a recent issue we referred to the progress made by the Post Office with regard to their exchange system in London which is to compete with that of the National Telephone Co. As a supplement to the technical particulars we gave, the information supplied by Mr. Hanbury to Mr. Kimber in the House of Commons last week is of interest. Large contracts, it appears, have already been made, and others are shortly to be concluded for the equipment of exchanges and the laying of wires in the greater part of central London north of the Thames and in outlying districts and suburbs to the west and south-west on both sides of the river. Mr. Hanbury's statement is given in full in another column of this issue. From the last sentence it is evident that the Post Office is doing its utmost to support the London County Council in the refusal of this authority to grant the National Telephone Co. underground wayleaves unless the company affords intercommunication facilities between its exchanges and those of its trade rival.

Persistent and widespread agitation of a rational nature, combined possibly with the happy influence of the news of the relief of Ladysmith, induced the House of Commons last Thursday to adopt a more favourable and logical attitude towards the principle of electric supply wholesale over large areas by private enterprise. In view of its previous hostility to this principle, the *volte face* indicated by the second reading of no less than four bills involving immense schemes on the principle in question came as a pleasing surprise. There exist, fortunately, indications that our legislators are being taught, by their accredited leaders and by enlightened public opinion, to discern the cloven hoof in the ridiculous pretensions of municipal authorities that all their opposition is in the interest of ratepayers, and the general public. It was refreshing to hear Parliament deride the sacred dogma of the municipalisation party, that "where municipalities have borrowed money on the security of the rates with the consent and sanction of Parliament, they should not be subjected to the competition of private traders." Mr. Galloway's dogma of tyrannous monopoly is not his own invention; it has been preached before. But the sands in the hour-glass of municipalisation have considerably fallen in the interval between the time when Parliament first heard and acted on it, and the debates of yesterday week.

The trouble which has been experienced in the employment of baths containing potassium cyanide for electro-plating has led to many unsuccessful attempts to supersede this salt entirely, and the double cyanide compounds, such as potassium cuprocyanide and potassium zinc cyanide, have also been experimented with, but without success, owing to their extreme deliquescence and instability. With a view to overcome the objections to the use of potassium cyanide, Dr. Courant, of Berlin, proposes to employ for the purpose triple cyanide salts, for which he claims great stability and that it is only necessary to dissolve them in water to furnish the requisite bath. The triple copper salt is prepared by dissolving pure cuprous oxide in potassium cyanide, with the formation of the body $Cu_2Cy_24KCyK_2O$. This compound is treated with just sufficient sulphurous acid accurately to saturate the K_2O contained in it. By this means the triple salt $Cu_2Cy_24KCyK_2SO_3$ is obtained. This triple salt, which is most stable, forms, when dissolved in water, a copper electrolyte of remarkable purity and great conductivity. In like manner the triple salts of gold, silver, nickel, and zinc may be produced. Bronze and brass baths, which will give a deposit of any required shade of colour, may be obtained by suitably mixing the solutions of the copper and zinc triple solutions. It is claimed that the use of these triple salts enables the amount of metal in the baths to be readily controlled, and that old baths can be easily regenerated.

The *American Electrician* recently proposed that aluminium might be employed in the place of lead for the sheathing of cables in three-wire systems with a bare middle wire, as it combined better conductivity than lead with sufficient flexibility. This suggestion has called forth an interesting letter from the Pittsburg Reduction Co., which says that

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it would be quite possible to squirt aluminium in the same way as lead is squirted to form a covering for cable. The company doubts the ability of ordinary lead presses, however, to squirt aluminium, on account of the fact that aluminium would require somewhat higher heat to render it plastic than is required with lead, and because the power required to squirt aluminium would be more than would be required to squirt lead. Nevertheless, aluminium has been successfully squirted, and the company is building a squirting machine for an altogether different purpose, but with which it intends to squirt large sections of aluminium. As to the flexibility, the company points out that aluminium would be, of course, inferior to the lead, but it sees no reason why the metal should not be flexible enough to answer the purpose.

ALUMINIUM-COVERED cables instead of lead-covered cables seem to be a far-off idea at present, but if the price of copper maintains its high figure, while that of aluminium continues to decrease, the latter metal would appear eminently suitable for the outer conductor of a concentric cable, particularly of a triple concentric, in which the outer conductor has a small section for the diameter of the cable. Flat wires of aluminium in this position would scarcely increase the total diameter of the cable.

WE summarise this week the directors' reports of three London electric supply companies—viz., the Metropolitan Electric Supply Co., the City of London Electric Lighting Co., and the Brompton and Kensington Electricity Supply Co; and we give reports of the meetings of shareholders of the Chelsea Electricity Supply Co. and the Notting Hill Electric Lighting Co. All these undertakings are well maintaining the steady growth in their business which has been the good fortune of electricity supply concerns throughout the land. A descriptive article in our present issue indicates, in fact, the amazing increase in business of one of these undertakings, and the consequent necessity to erect the large power station recently opened at Willesden. It is satisfactory to note that the Chelsea Co. is still paying a dividend of 6 per cent., although its capital was increased by £40,000 at the end of 1898 and by £50,000 last October.

The French Association for the Advancement of Science.—The next meeting of this association will be held at Paris, on Aug. 2–9, under the presidency of Gen. Sebert.

The Instituto Lombardi.—Among the subjects for prizes just announced by the institution is one "On Differential Equations occurring in Electrical Problems," the competition for which closes on April 1, 1901.

The Royal Society.—The subject of the Bakerian lecture for 1900, which was delivered yesterday afternoon by Prof. W. A. Tilden, F.R.S., was "The Specific Heat of Metals and the Relation of Specific Heat to Atomic Weights."

The Isaac Newton Studentship.—This valuable studentship in physics and optics has this year been awarded by the University of Cambridge to Mr. J. H. Jeans, of Trinity College. Mr. Jeans was bracketed senior wrangler in 1898.

Opening of the Dublin-Lucan Electric Tramway.—Yesterday the section of the Dublin tramways system extending to Lucan was reopened to the public, this section having been converted from steam to electric traction. A 45 minutes service will be run.

The Smith's Prizemen for 1899-1900.—The Smith's prizes have been awarded by the University of Cambridge to Mr. J. F. Cameron, of Caius College, for an essay "On Molecules considered as Electric Oscillators"; and to Mr. R. W. H. T. Hudson, of St. John's College.

Royal Institution.—The Right Hon. Lord Rayleigh, F.R.S., will not deliver the second of his course of lectures on "Polarised Light" at the Royal Institution on Saturday afternoon next (the 10th inst.), owing to the sudden death of his mother, the Dowager Lady Rayleigh. There will be no lecture on Saturday afternoon.

Cable Interruptions:—

	Date of Interruption
Latakia—Cyprus	June 21, 1899
Cayenne—Pinhieros	Oct. 11, 1899
Tangier—Tarifa	Jan. 3, 1900
Paramaribo—Cayenne	Feb. 16, 1900
Ceara—Maranham	Feb. 20, 1900
Môle-St. Nicolas—Cap Haitien	Mar. 7, 1900

Wireless Telegraphy in Victoria.—According to the *Australian Mining Standard*, the Victorian Postmaster-General has offered facilities to Mr. H. W. Jenvey, a local telegraph engineer, who has developed a system of wireless telegraphy as a result of experiments on Marconi's system, to subject his system to a practical trial. The cost of erecting the apparatus is estimated at £200, and is, we understand, to be borne by the Government of the colony.

Searchlights for Use at Fires.—According to the *Western Electrician* of Chicago, a new portable searchlight has recently been added to the equipment of the New York Fire Brigade. It is intended for use at night fires, or where the smoke is very dense. It takes 35 amperes, and is rated at 6,000 c.p. Ultimately it is hoped that these searchlights will be supplemented by small incandescent lamps for use in searching cellars and other dark places.

Electrical Engineers (R.E.) Volunteers Send-off Dinners.—On Saturday evening last the detachment of Electrical Engineers Volunteers for the war were entertained at a "send-off" dinner at Prince's Restaurant, Piccadilly. Lord Kelvin occupied the chair, and the toast list was in the charge of a number of distinguished electrical engineers. On Monday last the detachment were entertained at another banquet at Chelmsford, where they are at present quartered. The mayor of Chelmsford presided. A list of the names of the detachment appeared in our last issue.

Interruption on the City and South London Railway.—An unfortunate stoppage occurred yesterday morning on the City and South London Railway soon after seven o'clock, at a time when such an incident was particularly inconvenient. A short-circuit on the line caused the cut-out to act, and was so serious that a temporary shut down of the line was necessary. On running up again, it was found that one of the old generators had developed a fault in its armature, and, as the new spare plant is not quite completed, a total stoppage of the line for about two hours was necessary until things could be got into running order again.

Electric Launches on Venetian Canals.—It is satisfactory to learn that the objectionable steamboat, locally known as a "tramvia," is about to be replaced on the Venetian canals by the electric launch. For some time the new vessels will run in competition with the steamboats, but the ultimate extinction of the latter is practically certain. There has existed much local disapproval of the steamboats, owing to the injury the wash from them causes to the gondolas and to the foundations of buildings beside the canals. Trial trips on the new electric launches have recently been made with encouraging success.

The Institution of Junior Engineers.—Last Saturday a large number of members visited Messrs. Maudslay, Sons and Field's Belleville boiler works, at East Greenwich. They saw all the machinery for the preparation of the different parts and the method of erection, and the construction, were explained. The Cowper-Coles apparatus for galvanising the tubes, &c., was also seen and the system of working it described. At the conclusion of the inspection the vice-chairman (Mr. E. A. Berry) expressed the acknowledgments of the Institution for the interesting visit which had been made.

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American Pacific Cable Scheme.—Reuter's agency announces that the Committee of the United States Senate on Naval Affairs has issued a favourable report on a bill for the construction of a Pacific cable under the direction of the naval department, the cable to be a Government one. The bill provides for immediate construction only from San Francisco to Honolulu, but contemplates an ultimate extension to the Philippines and Hong Kong. The Commerce Committee of the House of Representatives has ordered a favourable report on the bill for the private construction of a cable between the United States, Hawaii, the Philippines, and Japan.

A New Mercury Interrupter.—According to *Nature*, Messrs. Isenthal, Potzler and Co. have just put on the market a mercury jet interrupter, for use in connection with radiography and wireless telegraphy, which is one of the most perfect breaks yet designed, and is more serviceable than a Wehnelt interrupter. In it a fine jet of mercury forms one contact piece, and a series of teeth cut in a cylindrical surface surrounding the jet forms the other contact piece. The axis of the cylinder is vertical, and the teeth taper downwards. When the cylinder is made to revolve, by means of a small motor to which it is connected, contact is made when the jet impinges on a tooth and broken when it comes into the interspace. By raising or lowering the jet, the ratio of contact to interruption may be varied from zero to infinity, and thus the mean current strength may be adjusted to any required value without interposing resistances. The number of interruptions may be varied through a wide range, and with 24 contacts and the motor geared up to 3,000 revolutions it reaches 72,000 per second, which suffices for practically every purpose.

Dangers of the Trolley Wire.—At the request of the "Royal Imperial Lower-Austrian Stadtholdership," the Austrian Elektrotechnischer Verein has answered eight questions submitted to it as to the danger of the overhead trolley wire. The committee appointed to draft the answers consisted of Herr Frisch, Herr Hochenegg, and Dr. Sahulka. The committee points out that the overhead network is constructed with a factor of safety of 5, and that thus the wire is no more liable to fall than the component parts of ordinary buildings. Telephone and telegraph wires break more frequently, and where possible they should not be placed over trolley wires. Where this is inevitable, guard nets or insulating wooden guards should be fixed between. Moreover, when a wire does fall, contact with persons is infrequent, and if it does occur usually arises through the person himself taking hold of the wire; and lastly, if such a contact does occur a dangerous shock is highly improbable. As to possible danger to the fire brigade, the committee considers that none exists, as the brigade is to be provided with means for switching off the trolley wire at any of the section boxes.

Pacific Cable Blue Book.—A blue book giving further correspondence relating to the proposed construction of a cable across the Pacific Ocean has just been issued in continuation of Parliamentary Paper C. 9,288 of May, 1899. The correspondence commences with a communication from the Anglo-American Telegraph Co. to the Colonial Office, May 9, 1899, and concludes with the Treasury minute on the Pacific cable scheme, Nov. 2, 1899, with a copy of the instrument appointing a committee to consider the scheme suggested by the committee of 1896. A sketch map showing the Canadian land lines and their connections to the Atlantic cables accompanies a communication from the High Commissioner for Canada dated May 10, 1899. The interest which the subject of the Pacific cable is receiving is shown by the fact that the blue book now issued contains no less than 77 distinct communications dealing with this question, including a report of the conference held on 4th July last, at the House of Commons, presided over by Mr. Chamberlain, when a board of eight members was appointed to elaborate the scheme and the management of any line of cable for the Pacific that might be decided upon; the board to consist of three members representing the Home Government, three for Australasia, and two for Canada. It will be remembered that at this conference Mr. Chamberlain laid it down as a provision upon which the Home Government insisted that the route between this country and Australia should be all-British: this provision to apply to lines across the Atlantic and America as well as to the Pacific cable. A careful study of this blue book will put the public in possession of the chief points of interest in connection with the development of Pacific cable enterprise.

Electric Traction in the East Indies.—Some months ago we stated that an electric tramway had just been completed at Batavia (Java). From an illustrated description in the *Street Railway Journal* of New York we now supply the following additional particulars: There are three lines at present in operation, the total length of which is 8·6 miles. The gauge is 3ft. 11in., and grooved rails laid on tie-rods of Indian oak are employed. The lines at present are single tracked, but second tracks are eventually to be built. The trolley poles were designed to facilitate double tracking when necessary, and two-trolley wires have been erected the entire distance, thus making unnecessary the use of overhead cross-overs, and effecting a saving in feeder cables. Hard-drawn copper wire of 0·082 sq. in. section was used for the trolley wire. The overhead construction is divided into sections 550 yards long, for convenience of localising disturbances, each switch serving as a feeding point, and each section being protected by a lightning arrester. The rails are bonded with copper bonds of 0·166 sq. in. sectional area, and in addition are cross-connected every 55 yards with wire of the same sectional area. The engine room contains three generating units, each consisting of an horizontal tandem compound engine, rated at 150 H.P. at 285 revs., belted to a 6-pole continuous current 500-volt generator. The generators were supplied by the Union Electricitäts-Gesellschaft. Each engine has two fly-wheels, one carrying the generator belt and the other the governor belt, and the engines can run either condensing or non-condensing. A surface condenser of the Worthington type has been installed. There are two Worthington feed pumps, each having capacity of 2,500 gallons per hour, two injectors having capacity of 800 gallons per hour, with a lift of 20ft., and a storage tank. The boiler room contains three boilers. The fuel employed is Australian coal, which is to be shortly replaced by petroleum waste, obtainable locally at very low price. The furnaces are arranged so that the hot waste gases may be passed either through the economiser or through an unobstructed flue direct to the chimney. The complete plant is stated to be an excellent one in every respect, and the constructional work outside, built mainly by Malay workmen, would, our contemporary says, do credit to an American town.

A Large Electric Derrick.—What is claimed to be the heaviest lifting derrick in the world operated by electricity has recently been built, says *The Engineer*, by the engineers of the Newport News, Va., Shipbuilding Co., for use in the construction of warships at that port. The derrick is constructed of steel, is worked by electricity throughout, and has a maximum lifting capacity of 150 tons deadweight. It is composed of a steel tower or framework, carried on pile foundations. This tower, which is circular, is fitted with a track for the rollers, which carry the movable or revolving portion of the derrick. The revolving portion consists of a heavily-framed structure, circular in general form, and carrying a movable jib, from the outer end of which the several hoisting blocks descend vertically. The revolving portion of the derrick carries all the motors and machinery required for the various movements, as well as the balancing weights required to offset the tilting tendency of the jib. The revolution of the derrick is effected by means of two pinions, which engage with a circular rack fixed to the stationary tower or framework. Each of these pinions is driven by a General Electric motor, capable of developing 20 H.P. The racking movement of the jib is effected through the means of wire ropes leading over the sheaves at the top of the jib, and wound on large drums, which are placed in the revolving structure of the derrick. The inner and lower end of the jib has a pin connection to the revolving structure, so that by winding up the rope the outer end is raised and brought in towards the centre, while unwinding

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the ropes lowers the outer end and moves it out from the centre. The hoisting blocks are carried, as before mentioned, from the outer end of the jib, and the leads from these blocks run down the jib to drums, which, like the others, are operated by electric motors. There are three hoists from the jib, two main and one whip. The hoisting blocks in the low position of the jib are 69ft. above mean high water, and on revolution of the derrick describe the circumference of a circle 207ft. in diameter. With the jib in its highest position the hoisting blocks are 118ft. above mean high water, and will describe the circumference of a concentric circle 88ft. in diameter, thus permitting the derrick to handle weights lying within the circular ring whose maximum and minimum diameter are 207ft. and 88ft. respectively. The maximum load of 150 tons can be handled only within a ring whose maximum and minimum diameters are 147ft. and 88ft. respectively; but weights up to 70 tons may be handled throughout the entire field of the derrick's operation. Tests of the derrick show that from 10 H.P. to 12 H.P. are required for revolution; from 64 H.P. to 90 H.P. for the elevation of the jib, and from 29 H.P. to 54 H.P. for the main hoists, with load varying up to a maximum of 68 tons. For the whip 90 H.P. is required for a load of 19 tons, the load being hoisted at the high speed of 52ft. per minute.

Improved Primary Batteries.—Messrs. Siemens and Halske have brought out an improved Leclanché battery, which has all the conveniences of portability which belong to the dry cell. Within a rectangular or cylindrical cardboard vessel is inserted a zinc vessel of similar shape, whose bottom is either made of zinc, or may be made of asphalte material, firmly united to the zinc sides so as to prevent any escape of liquid. Within this zinc vessel is placed the carbon electrode, which is surrounded by a porous depolarising mass secured to it by a gauze bag. The electrolyte, which consists of a concentrated solution of sal-ammoniac, is contained in the interspace between the carbon electrode and the zinc vessel, and is sealed hermetically with a layer of asphalte, so that the gases generated in working can only escape into the atmosphere through a gas chamber in the upper part of the cell by passing through the porous depolarising material, on which their passage has a continuous loosening action. The gas chamber is filled with rice husks, and above this is a layer of asphalte, which closes the cell and secures all the parts permanently in their relative positions, while small capillary glass tubes passing down into the husks through this layer allow the escape of gas but not of liquid. A vulcanite tube, cemented into the top layer of asphalte and secured by a cover, extends into the lower chamber, and serves for the introduction or removal of the electrolyte.—Although the Leclanché cell has been in use for a long period, and for many purposes is without a rival, it suffers from the great defect that it only yields a small current, which falls off rapidly, principally because the depolarisation afforded by the manganese dioxide in cells as ordinarily constructed is not sufficiently rapid. This defect is due to insufficiency of depolarising material and to the want of proper contact between it and the carbon rod, and to remedy this Herr A. Pfannenberg has devised his "Reform" cell; which has been brought out by a company. In this cell there are two carbons united at the top by a bridge piece, and each encased in a manganese mixture, and the zinc is in the form of a long strip which is bent round outside the carbons, while the end of it is turned in between them so as to form a partition. The zinc is supported between two insulating blocks, which prevent its coming in contact with the bottom of the cell or with the carbons. Herr Zacharias has subjected cells of this construction—20cm. high—to severe tests, and reports that he discharged two cells for 12 hours, starting with an E.M.F. of 1·48 volts and a current strength of 1·10 amperes, and at the end of the time the current had only fallen to 1·7 amperes and the E.M.F. to 1·07 volts. After 20 hours discharge the E.M.F. was 1·01 volts, the current strength 0·65 amperes; and in these tests it was discovered that cells containing an electrolyte composed of a mixture of calcium and ammonium chlorides gave better results than those which contained the ordinary solution of ammonium chloride alone.

Fires.—A serious fire occurred at the Maiden-lane works of the Charing Cross and Strand Electricity Supply Corporation during the small hours of Saturday morning last week. At 1:40 a.m. the man in charge of the night shift noticed a smell of burning coming from the vaults below the station, where the cables enter. Other men had passed through this part of the building a short time before and had noticed nothing wrong. Going in the direction of the smell, the man noticed signs of fire, and immediately brought the resident foreman, who on his way observed that the machines were running all right and that there was no sign of any short-circuit. The fire had run up a brick flue in which the cables are led from the vault to the engine room, the switchboard was catching fire, and the flames had taken such good hold that there was only time for the men to shut down the plant and leave the station. It may be mentioned that the cables coming in to the station are some of vulcanised bitumen, and others lead-covered and armoured cables with fibrous insulation; that the switchboard is of slate mounted on an iron frame; and that the high-pressure supply from the Lambeth station had been shut down for the night some hours previously to the outbreak, so that none of the cables were charged at a higher pressure than that of the 2 × 100 volts three-wire system. The fire was soon extinguished by the fire brigade, and all was over in less than two hours. The damage to the building itself is practically confined to the interior. The switchboard was completely demolished, the cables within the building were rendered absolutely useless, the generating plant (seventeen motor generators and five steam dynamos) was all damaged, and the leads from the accumulators to the switchboard all fell together, so that presumably the battery will have been considerably injured. The fire did not extend to the battery room, boilers, or offices. Mr. Patchell, the company's engineer, and Mr. Seale, the secretary (who has had the heavy work of communicating with all consumers), have displayed wonderful energy and ability in this emergency. Mr. Patchell and each individual of his staff have been working almost unceasingly, and they are to be congratulated on the wonderful speed with which they have re-established the supply. All cables leading into the Maiden-lane station had first to be disconnected, as they were short-circuiting the network, and the stations at Lambeth and Short's-gardens then took all the load until the evening, when it was found possible to start two of the steam dynamos in the damaged station. On Tuesday, when we visited the station, four more machines had already been tested, and had been put on to the network. About thirty theatres, &c., are connected to the company's mains, and it was possible to supply current to all those which had *matinées* on Saturday afternoon, and to maintain the supply continuously to all of them. At first several consumers had to be disconnected, but all their fuses have gradually been replaced—the majority already by Saturday night—and the consumers are doing their best to keep their demand within as low limits as possible. Their good humour in this respect is probably in part due to the success of our arms in South Africa, and partly to the fact that the company has had no serious interruption to the supply for ten years.

The fire, reported in the daily papers to have taken place in a sub-station of the London Electric Supply Corporation in Jackson-street, Lambeth, on Sunday night, was nothing more than the blowing of a fuse. We are informed that the only damage done was the breakage of a lock—by the fire brigade.

MEETINGS OF SCIENTIFIC AND ENGINEERING SOCIETIES, &c.

(TO-DAY) FRIDAY, March 9th.

PHYSICAL SOCIETY.

5 p.m. Meeting in the rooms of the Chemical Society, Burlington House. Agenda: (1) "On the Damping of Galvanometer Needles," by M. Solomon; (2) "On the Distribution of a Gas in an Electric Field," by G. W. Walker; (3) "Exhibition of a Surface Tension Lecture Experiment," by C. E. S. Phillips.

MONDAY, March 12th.

SOCIETY OF ARTS.

8 p.m. Cantor Lecture II.: "Photography of Colour," by E. Sanger Shepherd.

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THE METROPOLITAN ELECTRIC SUPPLY CO.'S NEW WORKS.

The district supplied with electrical energy by the Metropolitan Electric Supply Co. covers an enormous area in the very heart of London. Its extent is marked on the map, Fig. 1. When commencing its business in 1888, however, the scale of the company's operations was as small as it is now large, and the first station was placed in a position under the road in front of Whitehall Court. This station, built by the late Mr. J. E. H. Gordon, with the assistance of Mr. Frank Bailey, contained direct-coupled fast-speed sets, and distributed current at 100 volts on the two-wire system. The station is still running, and continues to supply current on the two-wire system to a few consumers (mostly large ones) in its immediate neighbourhood.

The first of the alternating-current stations were those in Sardinia-street, opened in 1889, and the Rathbone-place station, started in September, 1887, by Messrs. G. E. Pritchett and Co., and taken over by the Metropolitan Co. in 1889. At Sardinia-street, American plant and, to some extent, the methods then prevalent in America were employed, for Westinghouse engines were placed on the ground floor and were belted to Westinghouse alternators on the floor above. Next, as the load continued to grow, new stations in Manchester-square and Amberley-road were started. In Manchester-square the Willans engines had generating stations, already enumerated. Their position and that of the sub-stations is marked on the map (Fig. 1), in which also the boundary of the company's supply area is shown, and the outlying Willesden works, with the trunk mains connecting the latter to the London stations. Apart from the peculiarity of the low primary pressure, which seemed to be justified in the early days by the frequent failures of high-pressure plant, and which has evidently been retained through a disinclination to make a sweeping change in the distributing plant and material, a feature of the system is that the alternators are all run on separate circuits and are not paralleled. In January, 1897, there was a lamp connection to the company's mains equivalent to 310,000 8 c.p. lamps, the plant capacity being equivalent to 350,000 8 c.p. lamps. (These figures include the small continuous-current part of the system in connection with the Whitehall Court station.) The directors that year decided to build the additional works at Willesden, for although at that date there was plenty of margin of plant to cope with the load, the lamp connections were increasing at such a rate that it was evident that considerable extensions to the generating plant would soon be necessary. Events have more than justified this view, for in January, 1898, the lamp connection was 355,000, in January, 1899, 430,000, and

FIG. 1.—MAP SHOWING THE METROPOLITAN CO.'S SUPPLY AREA, AND POSITION OF WORKS, SUB-STATIONS AND TRUNK MAINS.
Scale, 1 inch = 1 mile.

to be replaced by Parsons steam turbines, on account of the residents in the neighbourhood complaining of the vibration; and in fact all the stations have undergone alterations from time to time, the one in Rathbone-place now undergoing partial conversion to the continuous-current system. Full descriptions of the various stations have appeared on various occasions in our columns,* and they well repay perusal now, for, taken in conjunction with the present article, they afford a typical example of the progress in the design of electricity supply stations and distributing systems during the last decade.

Leaving out of consideration the comparatively small Whitehall Court section, the system of the Metropolitan Electric Supply Co. before the starting of the new works at Willesden was an alternating-current transformer system at 1,000 volts high pressure and 100 ~ per second frequency, and 100 volts low pressure, the latter being still to a large extent supplied by individual transformers (about 1,000) in houses, although there are a number of sub-stations, some of which supply three-wire, others two-wire networks. There are four

* *The Electrician*, Vol. XXII., p. 452; Vol. XXIV., p. 237; Vol. XXV., pp. 703, 737; Vol. XXVI., pp. 9, 69, and 107; Vol. XXX., p. 541.

to-day almost exactly 500,000. A curve, showing the rate of increase of the company's lamp connections since 1891, in comparison with those of other metropolitan supply undertakings, was published in our issue of January 5th last (p. 369).

The resolve to build new works was immediately carried into effect, and by the autumn of 1897 plans had been prepared, tenders let, a site bought at Willesden, and building operations commenced. Mr. Frank Bailey, then engineer-in-chief to the Metropolitan Electric Supply Co. as well as to the City of London Electric Lighting Co., designed the works, and decided on a two-phase generating system, transmitting the current from Willesden to London at 10,000 volts two-phase and transforming down at the existing generating stations. The advantages of this system for the particular object in view are many. A two-phase system, in the first place, enables an employment of the existing distributing network and transformers, by transforming the pressure down to 1,000 volts in London and dividing the load equally on the two phases. To balance a three-phase system effectively under similar conditions is more difficult. A single-phase system would of course have been as good, if not better, for this purpose, but the intention of the company is ulti-

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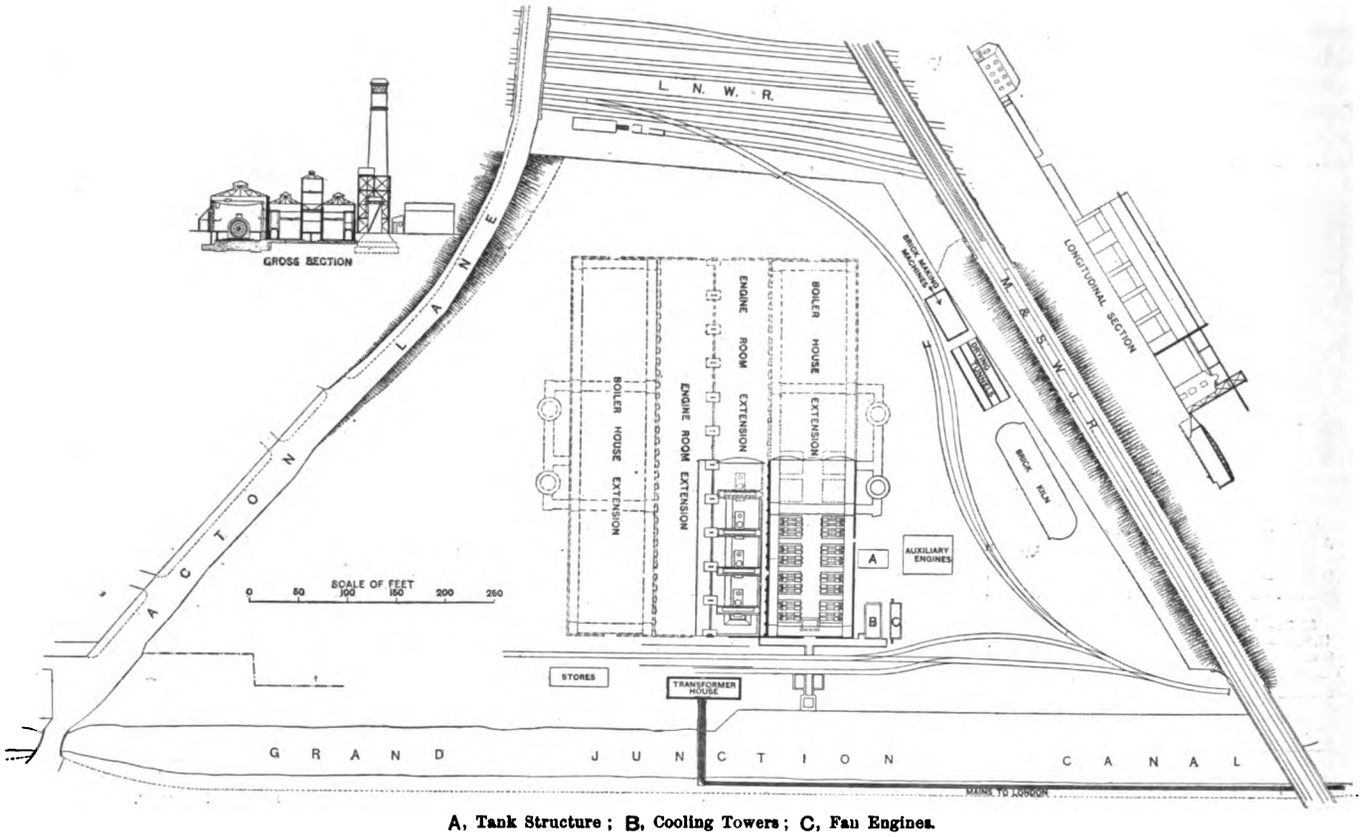
mately to replace the alternating-current distribution by continuous current, utilising motor-generators to effect this conversion. For this purpose two-phase current is of course preferable to single-phase. Another point in favour of two-phase current over three-phase is in the special circumstances of extra high pressure underground transmission. A salutary rule, backed up by the Board of Trade, is that a point on every system be permanently earthed. In single-phase systems this is reduced to delightful simplicity by earthing the outer conductor of the concentric cable at the station and utilising single-pole switches throughout on the extra high pressure mains. In two-phase systems the employment of an independent concentric cable for each phase, earthing the outer conductor of each cable, is an equivalent expedient, and the one Mr. Bailey adopted. It places the two phases in exactly equal conditions as regards inductance and capacity, a desideratum which would not have been attained in a concentric system, and it is simple and probably no more costly than the employment of three-core cable containing one conductor for each phase and a common return of greater section. Possibly there is actually a saving over the latter, as a single concentric cable serves as spare for both phases. If a three-phase system had been chosen for the underground transmission, it would probably have necessitated the earthing of the neutral point of the transformers at the station, and the insulation for high pressure of three conductors instead of two.

Another debateable question of design is whether to generate directly at extra high pressure or to transform up. Mr. Bailey chose the latter alternative; Mr. Ferranti would no doubt have chosen the former. The choice is between a slightly lower efficiency in combination with the extra cost of step-up transformers, and more expensive insulation on the dynamos, with the inconvenience of synchronising large machines running at extra high pressure. Perhaps the advantages and disadvantages of either method are equally balanced.

A third matter is in connection with the excitation. With large units, and therefore comparatively slow speeds, direct-driven exciters on the alternator shaft render the design somewhat difficult; but, on the other hand, each machine having its own exciter has advantages over excitation from independent machines. The exciters are directly connected to the alternators at Willesden, and they are multipolar and compound-wound in order to give the necessary E.M.F. at the slow speed of revolution.

Although started in the end of 1897, from November, 1898, to March, 1899, the erection of the buildings was practically at a standstill for want of roof material, while a great part of the machinery had already been delivered and was waiting to be unpacked. Very great delay also occurred in the delivery of the steam pipes, so that it was only by the end of last year that the trial runs of the plant could be made. Mr. R. R. Todd, now engineer-in-chief to the Metropolitan Co., has been responsible for the carrying out of the work, which has been done under the able supervision of Mr. Holbrow, the resident engineer.

Site.—A plan of the works is shown in Fig. 2, in which are also given two sectional views on a small scale. The site occupies about nine acres, partly in the Willesden parish and partly in Acton. It is freehold. The railway to the north is the London and North-Western main line, and on the east is the Midland and South-Western junction line from Child's Hill to Gunnersbury. On the south is the Grand Junction Canal. It is thus seen that there are ample facilities for the supply of coal either by water or rail.



A, Tank Structure; B, Cooling Towers; C, Fan Engines.

FIG. 2.—PLAN OF THE WILLESDEN WORKS.

Buildings.—One of the most noticeable features in the design of the buildings is the use of screens on travelling carriages for the temporary ends of the engine and boiler houses. Ultimately the buildings will extend to the dimensions shown by the dotted lines in the plan, when they will consist of two boiler houses, one on either side of the engine room, each 384ft. long by 88ft. wide, the engine room being the same length and 112ft. wide, this main block covering over 2½ acres of the whole area. The part of the buildings already erected is shown by the full lines. As is seen, only about one-sixth of the works are built at present, but foundations for the extensions are already being excavated. There will eventually be four chimney shafts, but one only has been built so far. The clay excavated is said to be of a very good quality for brick-making, and the company has had the good idea of building

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brick kilns, which will shortly be put into operation and for which there is already a sufficient supply of clay for two or three years to come, so that the company will at any rate be able to make all the necessary bricks for its own extensions.

The ironwork has been done by Sir. Wm. Arrol and Co., the brickwork by the company itself. The chimney shaft is 165ft. high, has a cast iron cap and an internal diameter of 18ft. 3in. at the top.

ment of this conveyer is shown in Fig. 3 and Fig. 4. The transporter lifts the loaded skips (containing each about 15 cwt.) out of the barge to the elevation of the transporter beam, a height of about 55ft., at a speed of 200ft. per minute. When the skip reaches the transporter beam it is carried by the traveller (illustrated in Fig 5) at a speed of from 600ft. to 800ft. per minute, the hoisting rope being supported at intervals of 55ft. by rope carriers. The full skip *en route* to the boiler

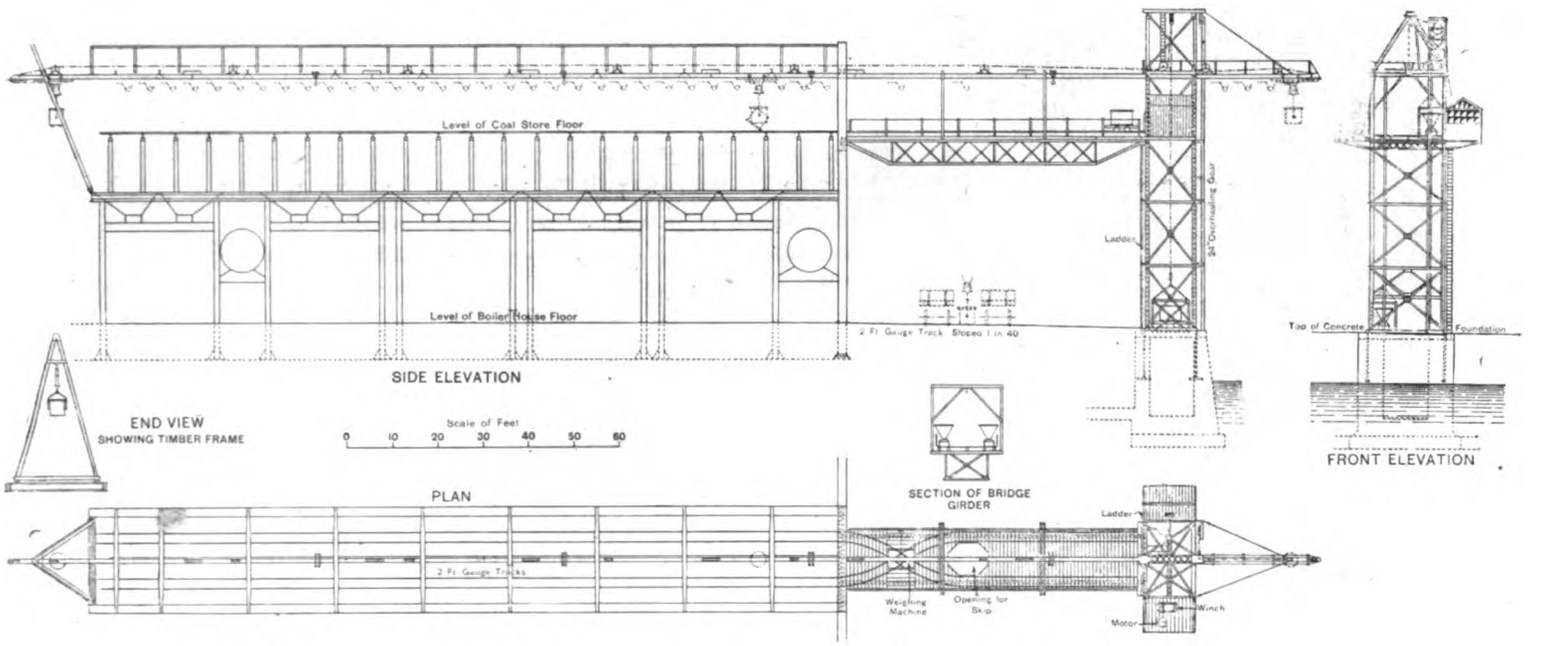

FIG. 3.—GENERAL ARRANGEMENT OF COAL TRANSPORTER BUILT BY THE TEMPERLEY TRANSPORTER CO.

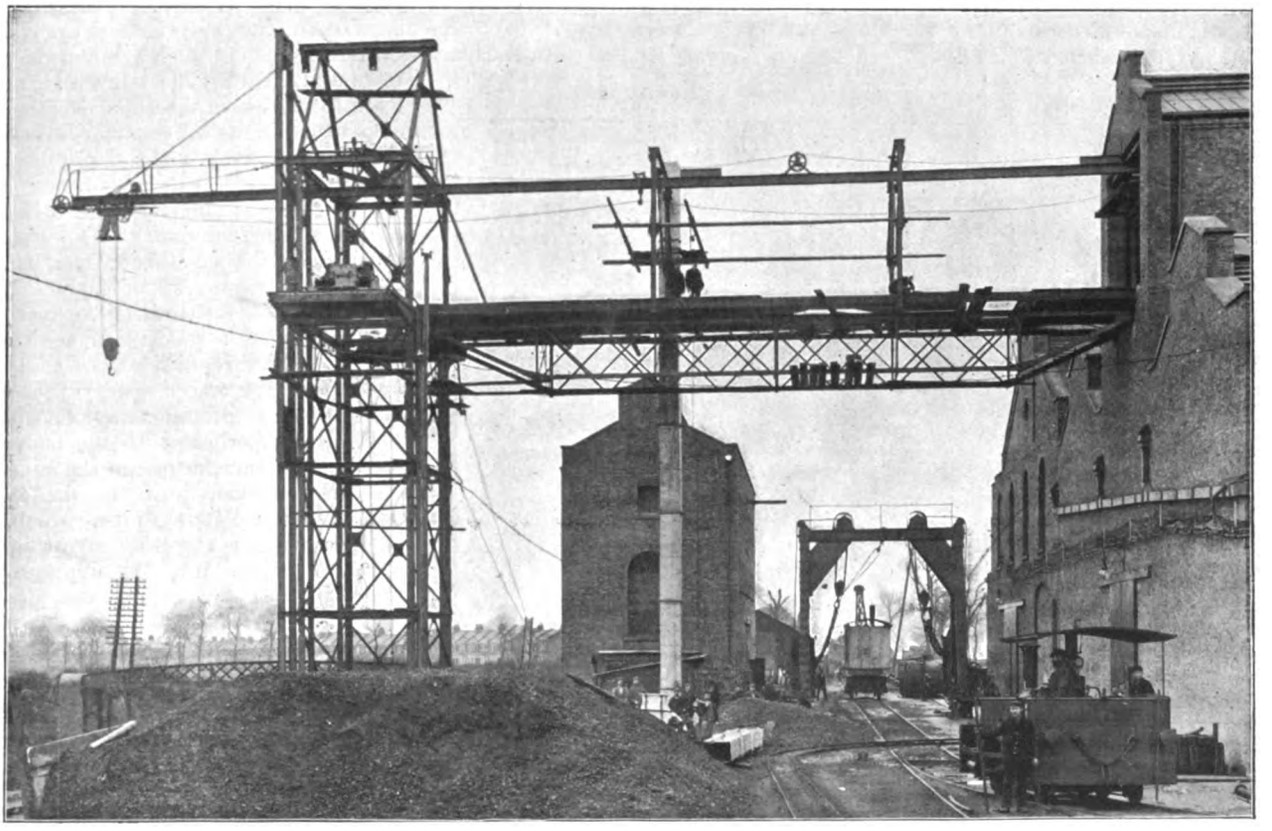

FIG. 4.—GENERAL VIEW OF COAL TRANSPORTER.

Coal Transporter.—The coal can be conveyed either from the canal or the railway siding by means of a conveyer constructed by the Temperley Transporter Co., which carries coal directly into bunkers situated on the roof of the boiler house. These can store about 1,000 tons of coal. The general arrange-

house is stopped over the weighing machine shown on the bridge, and after being lowered upon the machine for weighing, is again taken up by the transporter and continues its journey.

The position of the carriage is shown on the driver's

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platform at the end of the beam by an index, on whose dial the position of the bunkers is marked. By an ingenious mechanism contained in the block, the skip is automatically tipped after it has been lowered to the bunker. The empty skip is returned along the beam by the overhauling gear at a speed of from 800ft. to 1,000ft. per minute. Arriving at the end of the beam projecting over the barge it is lowered gently by means of a brake. The maximum distance to be travelled by the loaded skips at present is 274ft., but the machinery is arranged for an extension of the building to double this amount. If the coal arrives in railway wagons, it is discharged into skips which are lifted by the transporter through an opening in the platform of the bridge, as seen in the drawing.

The electrically-driven winch which drives the transporter (Fig. 6) is fixed within the housing shown on the right-hand side of the tower, elevated at a position which gives a commanding view of the barges, the railway tracks, and the bunker house. Within the tower a pair of elevators are provided for taking up Decauville wagons containing coal. The wagons upon reaching the level of the bridge are traversed over the weighing machine and afterwards tipped at any portion of the coal bunkers, the empty wagons being returned in one elevator whilst the full wagon is being raised in the other. The transporter is also employed for conveying the ashes from the far end of the boiler house to the barges or railway trucks.

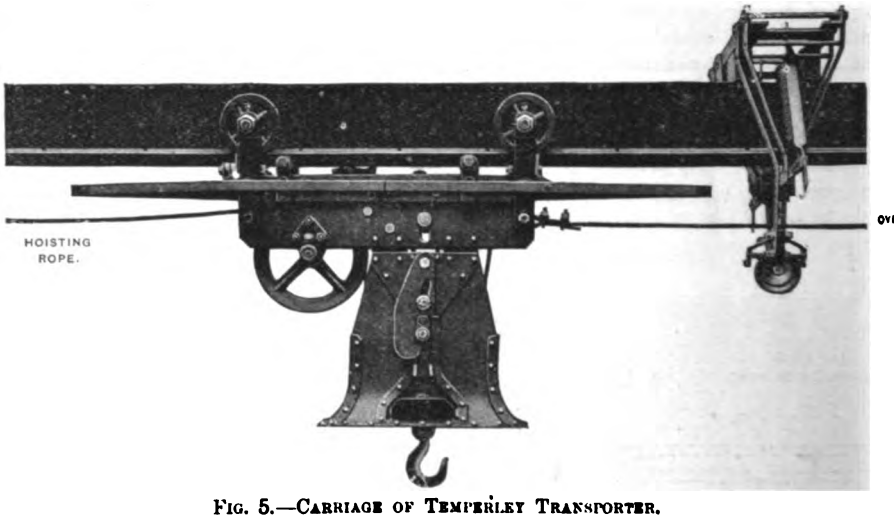

FIG. 5.—CARRIAGE OF TEMPERLEY TRANSPORTER.

Boiler House.—The present length of the boiler house is 164ft. It contains 16 Babcock-Wilcox boilers, each with a heating surface of 3,500 sq. ft., set in batteries of two boilers each, as shown in the plan. It is needless to go into the design of these in detail, as it follows the lines always adopted by the Babcock-Wilcox Co. In each boiler are 16 sections or slabs, each composed of 10 tubes 4in. diameter, expanded into the continuous staggered headers at the ends. Opposite the end of each tube is a hand-hole in the header, to permit cleaning or removal of the tube, and these hand-holes are covered by caps fastened with a bolt, clamp, and cap nut. The sections above mentioned are connected at each end to two steam and water drums, and at one end with a mud drum, by means of tubes 4in. in diameter. Each boiler has two steam and water drums 42in. in diameter. These two drums are connected by a cross drum 24in. in diameter and 7ft. 6in. long. The boilers are constructed for the working steam pressure of 160lb. per square inch.

Babcock-Wilcox superheaters are fitted to the boilers, each having a heating surface of 896 sq. ft., and being fitted with 14 groups of four steel tubes 1½in. in diameter. The superheaters were specified to be capable of imparting 100 to 120°F. of superheat to the steam produced by the boiler. The superheater is placed in the middle of the angular space between the water-tubes and the steam drum, in a position where there is practically no deteriorating condensation of the furnace gases, and where the temperature is sufficiently high. There it is not subject to the immediate action of the fire, as the furnace gases must first pass through the front part of the boiler before reaching it. The tubes of the superheater are bent into the shape of an elongated U, and are connected at both ends with manifolds, one of which receives the natural steam and the other delivers the superheated steam to the valve placed above the boiler. All the tube joints are expanded, there being no flanged joints. As the manifolds are not rigidly connected with each other, and the tubes are free at one end, there is sufficient freedom for expansion. While steam is being raised, the superheater can be flooded with boiling water, when it practically becomes part of the heating surface of the boiler. This is a precaution against overheating. A three-way cock enables the water from the water space of the boiler drum to be let into the lower manifold and to fill the superheater to the boiler water level. Any steam formed in the superheater tubes is returned into the boiler drum through the collecting pipe, which, when the superheater is at work, conveys saturated or natural steam into the upper manifold. Before opening the superheater stop valve and using superheated steam, the water is drained away from the manifolds by the flooding pipe.

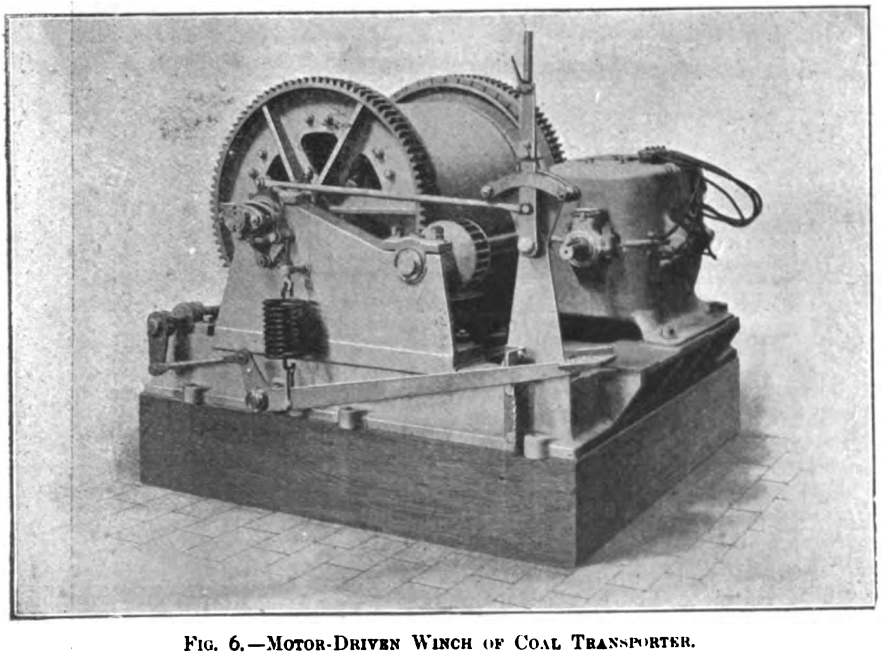

FIG. 6.—MOTOR-DRIVEN WINCH OF COAL TRANSPORTER.

Six of the boilers are hand fired, eight are fitted with Vicars automatic stokers, and the remaining two are being fitted with Babcock-Wilcox chain-grate stokers. The coal is fed from the overhead bunkers into the stoker hoppers by chutes. The Vicars stokers present no new features. The coal is pushed on to the dead plate and then on to firebars by reciprocating plungers. All the bars travel in towards the back of the furnace together, but in returning first every alternate bar returns, and when these are at rest the remainder follow. The coal, after it has arrived at the maximum state of incandescence, falls off the moving bars on to the dead grate, where combustion is completed. At certain

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intervals the clinkers are taken from the dead grate and fall into the pit under the boilers. An air box is provided on the front of the stoker, to provide for complete combustion of the volatile hydrocarbons. The stokers are driven by underground shafting supported by dust-proof Mohler bearings. Two Bumsted and Chandler engines supply the power, and the speed is reduced to 20 revs. per min. by worm boxes in which the worm wheel runs in a bath of oil. By means of a cross shaft and clutch gear either engine can drive the stokers on either side or both sides of the boiler house.

The Babcock-Wilcox stoker was recently described and illustrated by Mr. Crompton at the Institution of Electrical Engineers (see *The Electrician*, Dec. 8, 1899). It will be remembered that it consists of an endless chain of short cast-iron grate bars, linked together and actuated by passing over drums at the front and rear. Gearing is provided to enable the stoker to be brought out clear of the boiler, the frames being fitted with wheels running on rails placed at the side of the ashpit. The coal is fed over the whole width of the grate, the thickness of the coal layer being regulated by the vertical slide arrangement of fire doors. The ashes fall into skips running on rails below the boilers, and are pushed along to the far end of the boiler house, where they are taken up by the transporter.

Little need be said of the feed arrangements. They merely consist of three Blake-Knowles pumps and no injectors. No economiser has been fitted. The boiler house is rather dark, owing to the position of the coal bunkers, and artificial light (four enclosed arc lamps) has to be employed almost continuously. The boiler house also contains two Cameron pumps for the ordinary water service. All water used is taken from the canal, and an emergency connection is being made to the West Middlesex waterworks. The steam mains were supplied by Messrs. Jas. Russel and Sons, of Wednesbury. They are of steel, with heavy loose flanges and copper ring joints. They form a complete ring. Two main flues of steel lined with firebrick traverse the boiler house, about 10ft. from the ground, on their way to the chimney.

Engines and Dynamos.—The present dimensions of the engine room are 175ft. × 72ft.; its ultimate dimensions, shown dotted in the plan, will be 384ft. × 112ft. The one bay now built will gradually be extended to its full length, and later, as more plant is required, the second bay and second boiler house will be added. A substantial brick wall divides the boiler house and engine house, and the other wall of the building is of light construction, as it is only temporary. The room is light, the iron and glass construction of the roof being visible in Figs. 8 and 9.

These illustrations show in the foreground one of the three large Westinghouse sets, all of similar construction. The machines are designed for an output of 1,500 kw., the pressure of each phase being 500 volts. The field poles are of laminated steel, and number 62. Their coils are wound with copper strips, and the pole-pieces fit into slots and are bolted through to the frame. This casting is divided vertically into two halves, which can be drawn back on either side, sliding on the bedplate, so that the armature can be got at. The flywheel on which the armature is built is constructed in two halves, fixed to the crank shaft by heavy rings of mild steel shrunk on to the bosses of the shaft. Each rim is secured by two bolts and a shrinkage ring at each joint. Arms and rims are of cast iron. The steel laminations forming the armature core are laid on one another "half lap," with ventilating plates about every three inches, and are dovetailed and slipped into corresponding slots in the armature spider. The chord armature winding is not divided into two distinct parts, one for each phase, but forms a continuous closed circuit, with the four leads to the collector rings taken off at equidistant points. There are nine windings per pole, and one winding only in each slot of the armature core. The diameter of the armature is about 16ft. and its width about 8ft. Spring brass brushes are used on the collector rings. Although designed for a frequency of 60 ~ per sec., the speed corresponding to this (116 revs. per min.) is somewhat exceeded at present, in order not to differ too much from the present frequency of the company's system. The armature has been tested at 5,000 volts, and the specified efficiency at full load is 95 per cent. The machine runs with practically no hum, and, owing to the excellent ventilation, is cold after an evening's run at full load.

The engines are of the Westinghouse vertical compound enclosed marine type, with 36in. and 55in. cylinders and 3ft.

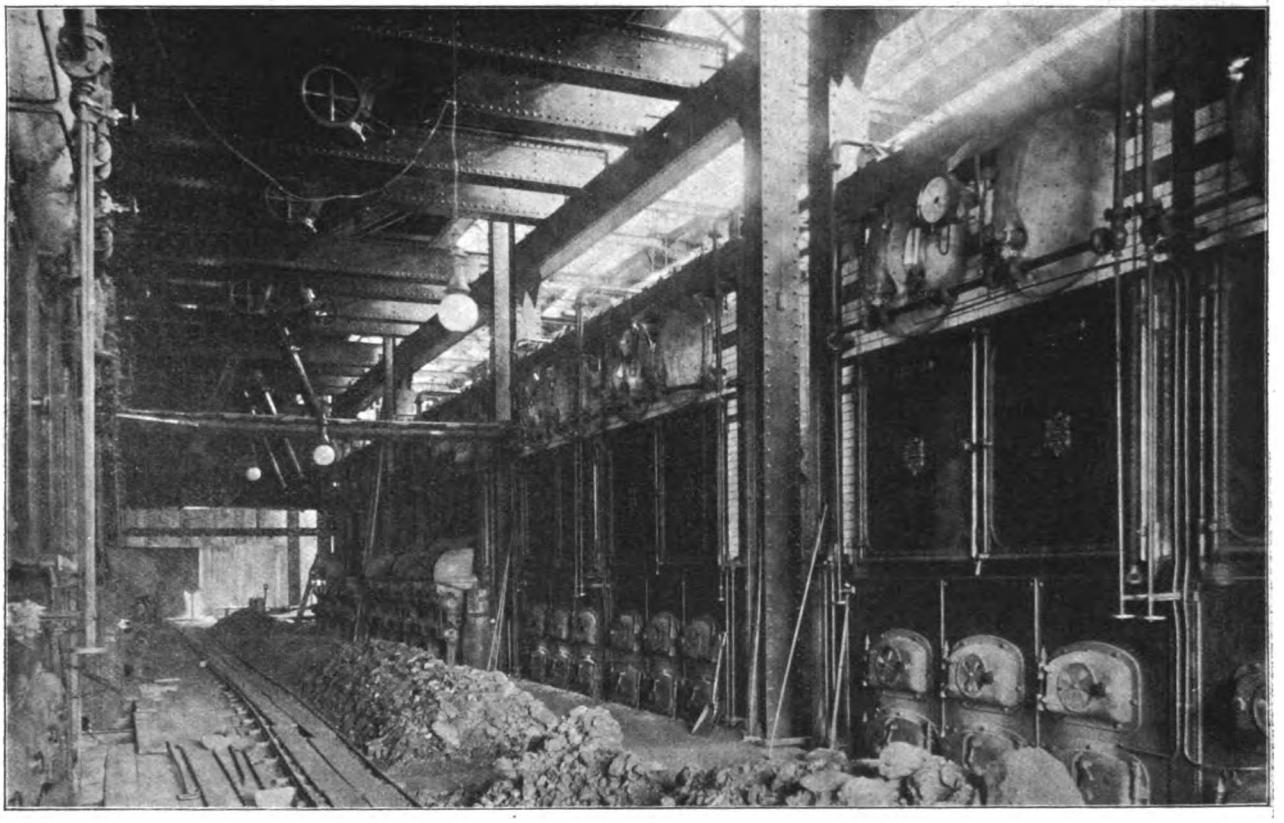

FIG. 7.—GENERAL VIEW OF BOILER HOUSE.

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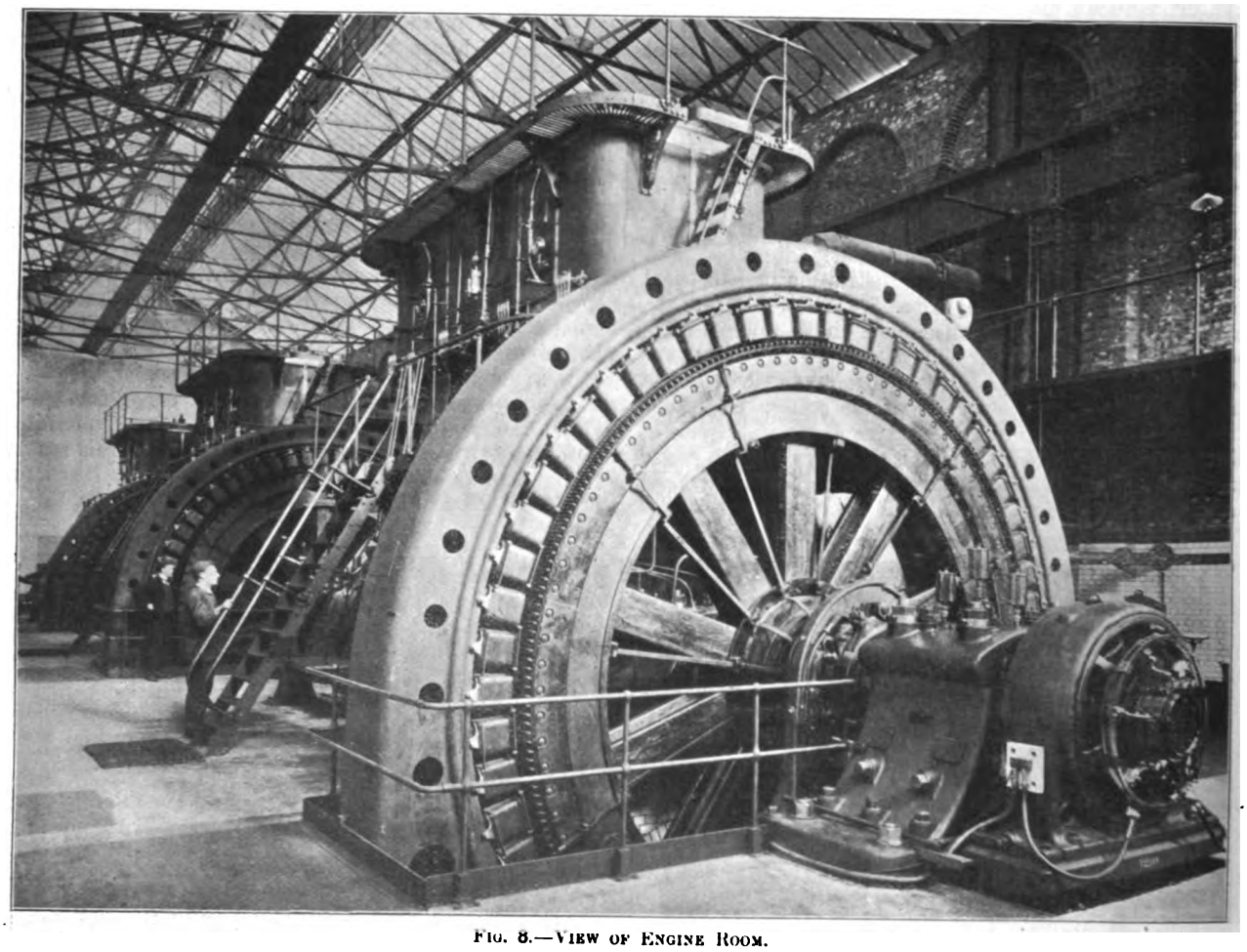

FIG. 8.—VIEW OF ENGINE ROOM.

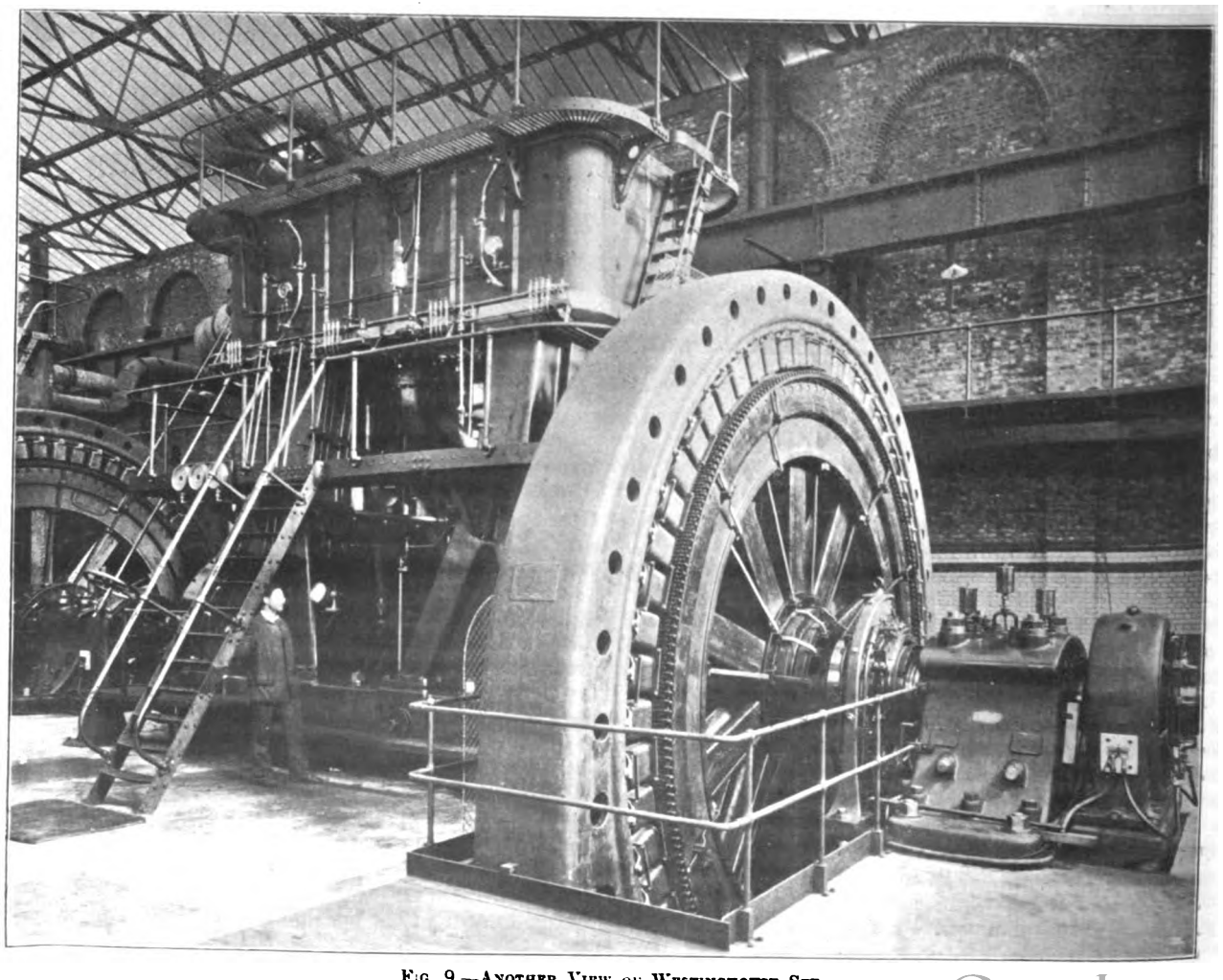

FIG. 9.—ANOTHER VIEW OF WESTINGHOUSE SET.

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stroke, and piston valves—one for the high-pressure cylinder and two for the low-pressure cylinder. As seen in the illustration, there are four bearings to the engine, one on either side of each crank, and a fifth out-board bearing between the alternator and the exciter. The bearings are of cast iron with white metal liners; they are 14in. diameter and 42in. long. The governor acts on the high-pressure cylinder, and the governor wheel is overhung. It is specified to be capable of adjustment to a variation of 10 per cent. during working, and to govern within 8 per cent. As a matter of fact, this latter figure is not approached, 1 per cent., we are informed, having been the variation between no load and full load on some tests made by the makers' engineers. The lubrication is from a tank on the top of the cylinders, to which oil is forced by a pump driven off an eccentric on the main shaft.

Although it was necessary, to obtain early delivery of the machines, to order them in America, they have afforded a proof that even American manufacturers are not infallible, and that English engineers are their equals in quick repairing

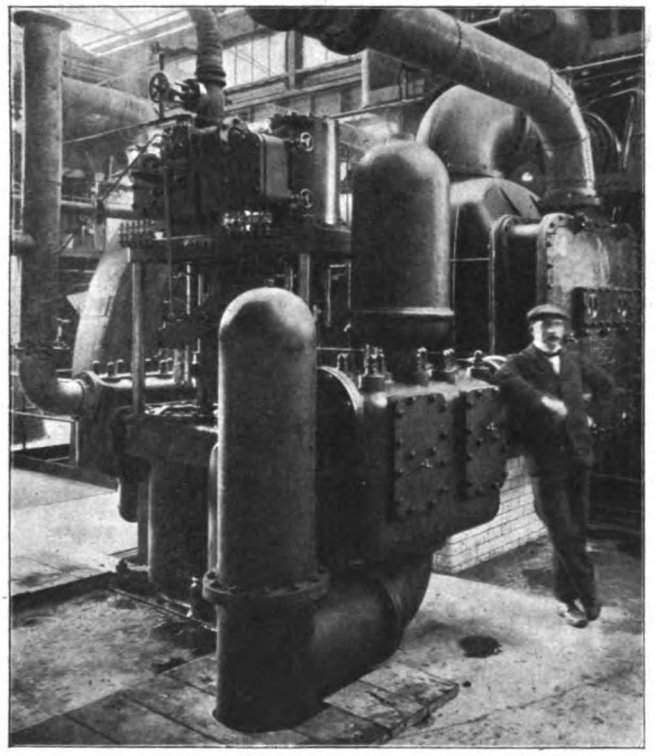

FIG. 10.—CONDENSING PLANT.

work. A short time after one of the engines had been running, a flaw was discovered in the crank shaft. The shaft was immediately taken out, sent off by special train to Sir Thos. Richardson and Sons, at Hartlepool, repaired, returned by special train, replaced in the engine and running again on full load, in less than a week.

The exciters have already been referred to. They are six-polar, with short commutators and six brushes. The fields are compound-wound, and the armatures drum-wound, four windings being contained in each slot of the armature cores. They generate a maximum current of 450 amperes at 100 volts, and each is of sufficient capacity to excite two alternators on an emergency.

Condensing Plant.—There is a surface condenser (Fig. 10) placed behind each engine. These have been supplied by the Wheeler Condenser and Engineering Co., are of their Admiralty pattern, and each has a cooling surface of 4,000 sq. ft. In connection with each is a Blake-Knowles combined air and circulating pumps, the two pumps being connected to the same rocking lever. Between the engine and pump is an automatic valve operating a by-pass to an open-air exhaust if the vacuum in the condenser fails. The circulating water is cooled by three Barnard cooling towers, capable of cooling 8,000 gallons of water per hour from 130°F. to 80°F. Their dimensions are 12ft. 3in. × 12ft. × 37ft. each. The fans are driven by small Bumsted-Chandler engines.

Auxiliary Electrical Plant.—A small station of auxiliary 100 volt plant, consisting of some that is no longer required in the London stations and some experimental motor-generators and converters, is situated in a small building by itself, and is supplied with steam from its own Babcock-Wilcox boiler. This plant supplies current for lighting the works, and has done so during the building operations. It is also represented by two contacts on each of the exciting panels of the station switchboard.

Engine Room Switchboard.—This is built on the lines of a traction switchboard, and forms the connecting link between the generators and the high-pressure switch room. Its general design is seen in Fig. 11. Three vertical white marble panels, one for each machine, are bolted to an iron frame. At the bottom of each panel are two rheostat hand-wheels, one within the other. The inner one adjusts the resistance in the shunt of the exciter, the outer one a resistance in series with the field coils of the alternator. Above this is a four-pole main switch for the two phases, and above this switch a throw-over switch for the exciter, which connects the field of the alternator either to the exciter terminals or the auxiliary supply. This switch has a central spring contact for discharging the field through a resistance. The wattmeters, ammeters, and voltmeters are seen in the illustration; there are the usual voltmeter plugs, and at the top of each panel are three automatic cut-outs adjustable to any current between 1,200 and 1,800 amperes. This cut-out has a peculiar action, contact being made by two flat vertical

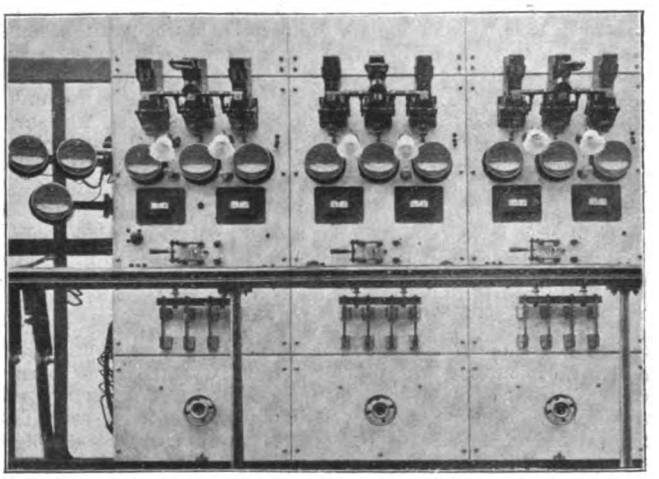

FIG. 11.—ENGINE ROOM SWITCHBOARD.

copper surfaces, pressed together by a strong spring in such a way that a slight rubbing together takes place during the switching-on. The contacts are topped with carbon plates to take the spark on break. One pole of one phase is earthed, so that only three cut-outs are necessary. The main circuit connections at the back of the board are bare, the main 'bus bars being built up of copper strip 8in. by $\frac{1}{8}$in.

Battery.—A battery of 124 K^{LP} 33-plate E.P.S. cells is placed on the first floor of the building which contains the high-pressure switching gear. This is charged by the auxiliary plant, and is connected to the auxiliary terminals of the field switches of the alternators. The cells are in wooden boxes, lead-lined, supported by wooden bearers and cross bearers standing on insulators. Their capacity is 1,000 ampere-hours at a 500 ampere-hour discharge rate.

Cranes.—Spanning the engine room is an overhead travelling crane by Messrs. Higginbottom and Mannock. It is driven from the auxiliary plant by one continuous-current motor for all three motions, and has proved most useful and has worked satisfactorily during the erection of the plant. The span is 50ft., and the crane is rated at 35 tons, having been tested to 50 tons. A 60-ton Goliath crane outside the engine room has also been employed continuously during the erection of the works.

(To be concluded.)

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ON THE APPLICATIONS OF ELECTRICITY IN MEDICAL AND SURGICAL PRACTICE.*

BY H. LEWIS JONES, M.D.

It was with very great pleasure that I received a communication from your President last autumn, asking me to write you a Paper on medical electricity. And it is a pleasure to me for several reasons: first, because it is a recognition by the Institution of Electrical Engineers of the existence of their somewhat humble sister medical electricity; secondly, because it gives me an opportunity of putting on record the position which medical electricity holds at the end of the nineteenth century; and thirdly, because I hope to be able to give you some information which may be new to you.

To a certain extent there is a correspondence between the work of an engineer in the repairing shop and that of a medical man in his practice; and this was brought quite forcibly to my mind a little while ago, when I had occasion to write and ask a member of the Institution kindly to come and advise me with regard to a motor which was in feeble health. When he came he said that he had been sitting up all night with an engine which was on the point of breaking down. It seemed to me to be closely the kind of work which the medical man is often called on to do, substituting only the human being for the machine. The medical side of electricity has been prominent from the early days of the science. Its physiological effects were among the first observations made. In particular, the experiments of Aldini upon the muscles of recently killed animals seem to have created a deep impression upon the people of his day, and to have held out hopes of the discovery in electricity of valuable healing properties

Electrical departments were in existence in some of the London hospitals a hundred years ago. At St. Thomas's in 1799 the electrical department was under the charge of a surgeon, Mr. Birch, who has left a very interesting "Letter on Medical Electricity," which is printed in a book called "An Essay on Electricity," by George Adams. The copy of this work which I possess is the third edition, printed in 1799, and having for frontispiece a woodcut representing a medical man applying electricity in a manner which clearly shows considerable scientific knowledge.† Among other interesting observations of Mr. Birch, there is one which may cause us to smile, or rather to sigh, at the change between his time and ours. The surgeon writes, "The ingenuity with which these simple modes of application may be varied, to puzzle and deceive the observation of a bystander, is unbounded, and would have formed a grand basis for empiricism if they had been artfully employed; but as electricity has escaped abuses, I trust," &c. John Freke, F.R.S., who was elected surgeon at St. Bartholomew's in 1729, is incidentally referred to in Fielding's well-known novel, "Tom Jones," as an authority on the subject of medical electricity.

It is now 150 years since the beginning of medical electricity. During the whole of that time it has had to fight its way in the face of many difficulties, and the most serious of these has been the passive resistance of medical men themselves. The vitality which the subject has shown under adverse circumstances is most significant. Medical electricity advances steadily, and the progress during the last decade has been very great. The commercial application of electricity and its house-to-house distribution by electric lighting companies have called into existence a large number of new instruments and new methods of treatment, and is helping the spread of the study of medical electricity by simplifying the means of obtaining the current when required. The accumulator has been of great service by affording a trustworthy source of currents for the use of surgeons in their galvano-cauteries and exploring lamp instruments. The discovery of the X-rays and their application to surgery and medicine have also done good to the cause of medical electricity by bringing electrical apparatus into more extended use, and the founding of X-ray departments in hospitals gradually leads to the development of electro-therapeutic departments in places where these are not already in existence. Most of the London hospitals now have electrical departments, and these are of manifest utility. At St. Bartholomew's Hospital we have about six hundred cases referred yearly to the electrical department from all quarters of the hospital, exclusive of the cases for X-ray photography, the numbers of which are even greater. And the results of our treatment will compare favourably with those in any other branch of medical practice.

It is a little difficult to speak on a medical subject before a non-medical audience without incurring the suspicions of those who are always on the alert for signs of unprofessional behaviour, and there is no branch of medical practice upon which the fierce light of criticism shines more sharply than upon medical electricity. I shall therefore have nothing to say on such matters as the relation of cases, statements of cures, and so forth, which might be thought to be unsuitable to my audience, but will try to meet you on the common ground of apparatus and methods, and in particular I shall try to lay before you some of the difficulties and problems which arise in the course of our medical work, in the hope that some of them may be solved by the advice and suggestions of those who are here present. From conversations which I have had at various times with engineering friends, I am disposed to think that the number and extent of the applications of electricity to medical practice are not generally realised by electrical engineers. Indeed, when I have observed any reference at all to medical electricity in the proceedings of this and of kindred societies, the reference has usually been one of disavowal and dislike. I therefore feel that in making the present communication to you I am undertaking the task of trying to show that electrical applications have a large and legitimate field of usefulness in medical practice; that it is quite possible to practise medical electricity without thereby becoming an outcast, and that the advertisements of electropathic or magnetic appliances do not represent the position of medical electricity any more than, shall we say, Keeley represented all that was best and truest in electrical engineering.

If what I have to say to you may seem to be about trifling matters, I hope you will bear in mind that our unit is the milliampere, while yours is the kilowatt, and that the currents which we handle and use would make but a small figure if their energy were expressed in terms of horse-power. Nevertheless, in the small technical matters which have to do with the management of various kinds of small electrical apparatus, the medical man requires a thorough proficiency, because it is absolutely necessary that he shall be able to make his apparatus work. On that account we may appear, in certain matters, to take elaborate precautions which might seem to you to be hardly necessary. With our coils and batteries we require unfailing methods for increasing or decreasing the current sent through the patient, without stops or jerks. We have to deal with the electric light mains, either direct or alternating, or both. And we have evolved for ourselves a long array of contrivances for utilising the public supplies of electricity for medical purposes. Small transformers, portable accumulators, resistances to provide slopes of potential, which can be tapped as desired for varying voltages, contrivances for using the mains for all sorts of medical purposes are all enlisted in medical work. The statical machine is also coming again into favour, and to use a statical machine one must know enough about its management to be quite sure that after a patient's arrival there shall be no awkward failure of the machine to excite. Otherwise we are likely to be condemned as not understanding our apparatus, and the patient may be lost. All these little matters can only be learned gradually, and through a course of failures and disappointments. And when they have been learned thoroughly, they constitute a very fair claim to the title of electrician.

The use of electricity in the production of hot-air baths with incandescent lamps or electrically heated coils of wire as the source of heat is a development of some promise, while in the immediate future we can see the approach of new methods of treatment by the light of the arc lamp. Each of these will demand a fresh extension of the field of electrical operations which the medical man will have to learn. And now I feel sure that some of you are ready to ask what can be done with all these numerous forms of apparatus. You might be inclined to ask me, as a patient of mine asked me the other day, whether I had ever done anybody any good by electricity. We will take the simplest things first. No doubt it is familiar to all of you that an electric shock produces a muscular contraction, but possibly you may not all be aware of the extent to which the study of the muscular contractions has been developed. The muscles and their nerves are tested by the application of the induction coil current, and by the direct current of a battery of cells; the effects at opening and at closing of the circuit, the comparison of the action of the positive pole with that of the negative, and the measurement of the current needed to produce visible contractions are all examined, and in this way a system of electrical testing has been devised which affords the most valuable indications in the diagnosis of diseases of the nervous system. An important part of the work in the electrical department of a hospital is the testing and reporting upon cases of injury or disease of the various portions of the nervous system and of the muscles, and the accuracy of the answers given by electrical testing is something to delight one. For exactness and simplicity in its responses, one might compare electrical testing to the processes of measuring with a yard measure or weighing in a pair of scales; and numerous cases which are quite obscure until tested electrically become as clear as daylight as soon as the test has been made.

The behaviour of a muscle under electrical stimulation is peculiar, and I think it may be useful to describe it. A simple shock, such as a single discharge of an induction coil or of a condenser, or a spark from the prime conductor of a static machine, causes a single muscular twitch, which within certain limits is proportionate to the energy of the discharge; the contraction lasts about one-tenth of a second. A rapid succession of shocks causes a succession of contractions which become fused so that the muscle enters into a permanent state of contraction which lasts as long as the stimuli are applied. Stimulation applied to a nerve causes contraction in its corresponding muscles, and when the stimuli are applied to the muscle itself, it is through the agency of its nerves that the stimulation acts. With a continuous current the behaviour is different.

* Paper read before the Institution of Electrical Engineers, March 8.

[† The woodcut in question was exhibited at the meeting.—ED. *E.*]

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Here there is a twitch at the moment of closing the circuit through the nerve or the muscle. The muscle then remains quiescent and almost completely relaxed, while the current still flows, and another twitch is produced when the circuit is broken. This is the sequence of events with the currents of about 5 milliamperes which are used for testing. With currents four or five times as strong the muscle enters into permanent contraction with continuous currents. These contractions at make and break may seem to recall the phenomena of electromagnetic induction, but the analogy is more apparent than real.

In certain kinds of paralysis these reactions change, and all irritability of the muscle to coil currents disappears. Stimulation of the nerves gives no response either to coil or cells, but the contractility of the muscle remains for currents from the cells applied directly, and may be more easily excited than in health, while the contraction itself changes in character from a rapid twitch, lasting one-tenth of a second, to a slow sluggish movement, lasting three times as long. Stated briefly, the above are the observed facts of what is known as the reaction of degeneration. Its value depends upon the fact that it occurs only when the cause of the paralysis occupies certain definite portions of the nervous system. By its presence or absence we can therefore determine with great nicety the seat of the disease or injury. A point which is not yet explained is why the coil discharge should become ineffective on muscle which retains the power of responding to the battery current. What are the electrical differences between the two modes of stimulation?

Next as to electrical treatment. Progress in medical treatment usually moves along two lines. One of these is based upon experimental physiology—that is to say, upon a study of the various processes in healthy tissues, and depends on the application of the facts observed to various morbid states. The other line of advance is by direct experiment in a more or less haphazard manner upon the sick. In medical electricity, as in medicine generally, both these lines have been followed. If we consider the first, we can apply the observed fact that electricity is a stimulus to certain living tissues by asking how stimulation may be made use of in disease. The fact that electricity is a stimulus is easy to perceive in the case of nerve and muscle and in the case of the sensory nerves of the body, and it is not difficult to prove that it acts in this way upon all living tissues; and the employment of electricity in disease is very largely an application of this process of stimulation. Beard and Rockwell in the United States, and Débédat in France have shown experimentally that in young animals the rate of growth can be accelerated by suitable electrification. The former electrified daily two young puppies, and found that they grew faster than those of the same litter which were not electrified. Débédat in the same way proved an increase of weight in certain muscles of rabbits as compared with other non-electrified muscles in the same animals; the latter thus showed a local effect from localised electrification, the former a general effect from general applications; and this division into general and local treatment is a useful one. Thus for general diseases one gives a general treatment, and for local diseases a local application. D'Arsonval, by calorimeter observations and chemical analysis of expired air, has established the fact that electrification increases the activity of the tissue exchanges of the body. Capriati recently has shown by careful dynamometric researches that the application of electricity to the central nervous system in the form of a continuous current along the spine does undoubtedly increase the muscular power, and that applications to the muscle of a limb have the same effect. In the United States it is becoming fairly common for athletes to undergo electrical treatment when preparing for a contest. General electrification applied to cases of simple failure of nutrition, such as debility after illness or debility of any kind, produces a rapid improvement in the condition of the patient. In rickets, which is a comparatively simple form of defective nutrition, electrical applications have been shown by many observers to have a very high value. The more complex forms of defective nutrition, such as rheumatism, gout, and diabetes, are not yet completely controlled by electricity, but indications are not wanting that in time good results may be expected. Already electricity is doing much for these conditions. In the field of paralytic conditions there are certain strict limitations to the utility of electrical treatment, and it is here that electricity has lost credit quite undeservedly. People have expected electricity to work miracles, and because it could not do so have condemned it as useless altogether. When paralysis is due to some mechanical obstruction or destructive process in the nerve centres of the brain or the spinal cord, or when it is due to certain progressive degenerations in the quality of those parts, then electricity is powerless to help. So, too, when paralysis is due to a breach of continuity in a nerve trunk, electricity can do nothing until the surgeon has intervened and reunited the severed ends. In the latter case electricity comes in quite properly afterwards to promote the recovery of functions which had fallen into abeyance; in the former the surgeon cannot help, neither can electricity. Therefore it is very important to insist that in paralysis there are cases suitable for electricity and cases which are unsuitable. Happily, the number of those which are greatly benefited by electricity is a considerable one.

Another field in which electricity is useful is in the relief of pain. Oftentimes it acts by influencing the circulation in the painful part and relieving congestion and pressure in the blood-vessels. This I believe to be its mode of action in sciatica, lumbago and rheumatism, and in some neuralgias. At other times it seems to relieve a neuralgic pain by some direct influence upon the nerve-trunk in which the pain is felt. Effects upon the circulation are probably the important factor also in the relief of sprains, and in removing the chronic stiffness which may be felt in or around joints as the result of injury or disease. In this there is scope for considerable development. The good results which can be obtained are undoubted, although it is not generally known that this is the case. Electricity can also be used to promote the passage of drugs into or through the skin; and this has a few minor applications in medical practice, among others for the introduction of cocaine to produce a local insensibility in minor surgery. Electrolysis, again, is often useful in many small matters of surgery. It is used almost exclusively as a means of destroying tissue. Small tumours of various kinds can be very conveniently treated by electrolysis. The process is carried out by the introduction of metallic needles into the tumour, the products of electrolysis being thus liberated in contact with the tissue to be destroyed. The chief convenience is the ease with which one can regulate the strength of current, and the amount of caustic chemical liberated, in exact proportion to the work required to be done. So fine and so delicate an application can be made, that the root of a single hair can be destroyed without leaving any visible scar, and the removal of superfluous hair in this way is a matter for which electrolysis is continually applied. Electrolysis with copper or zinc anodes with the object of procuring the liberation of salts of these metals in the diseased tissues has been recommended abroad, but does not seem to have received much attention in this country.

One of the most encouraging points at the present time in medical electricity is the improved quality of the scientific work which is being done in it. Last year, the French Government having declared the subject to be of public utility, a section of medical electricity was inaugurated at the Boulogne Congress of the French Association for the Advancement of Science. I attended the meetings of the section during the greater part of the congress, and was struck by the number and high scientific quality of the communications which were made in it. It was one of the best attended sections of the whole association. France, indeed, takes a long lead in the subject of medical electricity. They have at the present time three periodicals devoted entirely to the subject, and abundance of material seems continually forthcoming to fill the pages. One of them, the *Archives d'Electricité Médicale*, is quite indispensable to students of medical electricity, for in addition to its original matter it provides its readers with abstracts and a bibliographical index which keep one in touch with all that is being done in medical electricity all over the world.

The progress in the small matters of detail, particularly with regard to apparatus, which has taken place during the last ten years, is considerable. I say ten years, because that represents the time during which my attention has been specially directed towards medical electricity. It will be interesting to consider and compare the types of apparatus in common use to-day with those used formerly.

Electrodes.—The current is applied to the body of the patient by means of electrodes. These may be of the most varied forms, particularly with electrodes for internal applications. The cylindrical brass handles, fitted with sponges and held one in each hand, are obsolete or deserve to be, and for most external applications their place is now taken by a plate of flexible metal enclosed in wash-leather, and a disc of metal also covered with wash-leather and screwed into a wooden handle. The former is called the indifferent electrode, and serves chiefly to complete the circuit through the patient's body; the other, or active electrode, is the one which is manipulated and applied over the affected region. For testing, the active electrode is fitted with a closing key. Examples of electrodes and other forms of medical electrical appliances are shown upon the table. Bare metal must never be allowed to touch the skin, unless electrolytic or painful effects are desired. Sores are easily produced in a few minutes by a few milliamperes of current if at any point the metal of the conductor touches the skin directly. For this reason some water-holding material, such as wash-leather, is always used to cover the metallic surfaces of medical electrodes.

The Battery.—The chief requirements in a medical cell are that it shall need no attention and will not spoil on open circuit. The past few years have seen the almost complete disappearance from medical work of open acid cells such as as the Smee cell, the Bunsen, and the bichromate cell. Formerly, when electrical treatment had to be carried out by means of ponderous oak boxes filled with cells of one or other of these kinds, the trouble and dirt associated with them was enough to discourage all except enthusiasts. At the present day the Leclanché cell is the only type of battery which a medical man need consider, and even these are rapidly being abandoned, except for fixed installations, in favour of the modern, cheap, and convenient dry cell. With these small dry cells for currents of small magnitude and with a few accumulator cells for those medical purposes which require a current of an ampere or more, as for example for the heating of

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galvano-cauteries and the illumination of small exploring lamps, the medical man is sufficiently equipped, and is no longer compelled to handle and prepare caustic solutions. Large bichromate batteries still survive in remote districts for the occasional production of large currents, but they are every year becoming less numerous, as secondary cells and the means of charging them from dynamos become more general over the country. All this simplification tends very greatly towards the increased popularity of medical applications of electricity, because perhaps one chief cause of its neglect has been hithero the trouble of the management of the apparatus. The batteries needed for medical work divide themselves into two distinct classes, batteries for applying currents to patients for testing and treatment, and batteries for galvano-cautery and lamp apparatus. The former is essentially a physician's battery, the latter is more for the surgeon. Most of the surgeon's requirements are met by a portable accumulator of four cells, for the little surgical lamps are for the most part 8 volt lamps, taking about an ampere, though usually they are overrun most cruelly. For galvano-cautery the currents average from 5 to 10 amperes, but the cautery circuit has a low resistance, and a pressure of 8 volts is much more than is required. Sometimes the four-cell accumulator is arranged so that a switch will recombine it as two sets of two in parallel for cautery work, or else it is left as a four-cell battery in series, the volts being expended in a resistance. For medical work a battery is fitted with 25 to 40 small dry cells connected in series and having wires led off from them to a circle of studs, from which a moving pointer takes up into circuit as many cells as are required. It is usually fitted with a milliampere meter permanently in circuit and a commutator for reversing the poles, also with an induction coil driven by a separate dry cell. The average working resistance of the human body and skin is about 2,000 ohms when properly moistened with hot water. Salt or soda may be added to the water to reduce the skin resistance, but plain water is best, as it corrodes the electrodes less.

Next in importance to the battery of primary cells comes the induction coil. Indeed, if generality of use be considered, the induction coil should come first, as it is the form of electrical application which has the widest employment. The medical induction coil has developed in certain special directions, the chief requirement with such an apparatus being a means of careful regulation of its strength. Of the various ways of obtaining this regulation, the one best suited to our purpose is the plan of using a sliding secondary coil, which can be brought close to the primary or can be removed farther from it, as desired. Much has been done of late years to improve the induction coil, and more has been written about the various effects to be got from coils of different sorts and construction. Attention has been given to the improvement of the vibrating spring or contact-breaker, and the best American coils are now fitted with two vibrators, one of slow speed and one of high speed. In the United States, where the construction of electro-medical apparatus has been much elaborated, it is quite customary to supply coils with several interchangeable secondaries. The same is done to a less degree by makers elsewhere. The various effects which have been ascribed to different windings of secondary are best considered as being due to the very great differences in their self-induction, according as they are made with windings of great length and many turns, or of short length and few turns. The slower rise and fall of wave which is found with the high self-induction of the long coil of many windings has the effect of making the shock less sudden and less painful in its effects. So too in very long fine secondaries a large part of the volts are dropped inside the coil, and the E.M.F. at the terminals, though high on open circuit, may fall almost to nothing when closed through a comparatively low resistance. On this account very long coils with very high speed contact-breakers have been much written about as affording painless currents for internal applications, but in my opinion the painlessness is due to the fact that very little current comes out of them. For practical purposes I have usually found it sufficient to use one secondary coil, which is tapped at one-third of its length, and so can give long coil and short coil effects from the one instrument. Medical induction coils are not fitted with condensers. When simple stimulation is required in the treatment of a case, the induction coil is probably the most convenient and cheap method of procuring it. The battery current has a superiority in certain things: for example, it gives a wider range in degree and quality of stimulation; and certain living tissues respond better to battery currents slowly increased and decreased than they do to the sudden jerks of the coil. The intense effect of the coil on the sensory nerves of the skin makes it difficult to use coil currents of sufficient strength to penetrate to the deeper parts of the body, and for deep parts currents of large magnitude are necessary to make up for the weakening effect of diffusion.

The strength of current used in treatment ranges between 4 and 40 milliamperes for the most part, though smaller and larger currents are sometimes used. The larger the currents, the larger should be the surfaces of the electrodes. The measurement of induction coil currents presents difficulties which have not hitherto been surmounted, and the rough comparisons which are made by means of a scale of millimetres at the side of the sliding secondary cannot be translated into units, and cannot be trusted to be alike for two consecutive days. Instruments which measure the mean current are of no use, because the physiological effect does not depend upon mean current but upon the rate of change and the maxima. The use of a sinusoidal current from a dynamo, to take the place of the induction coil, might enable one to evade the difficulty; but the dynamo current of the mains, in certain cases at least, produces such painful skin effects as to be very unpopular with patients. It is difficult to say why this is so, but the subject wants further study. Possibly the use of condenser discharges, the condenser being automatically charged and discharged rapidly, might meet the difficulty of producing a current which would resemble that of the coil in its physiological action and would allow of measurement. I would like to ask the advice of members of the Institution on this point. Would not the curve of discharge of a condenser have a close resemblance to the discharge curve of an induction coil? Could not one arrange a condenser of small capacity, such as a Leyden jar of diminutive size, and employ some very fine adjustment of spark gap for measurement and regulation? I have thought that in this way, using high voltages and small capacities, the disturbing factor of varying skin resistance would become comparatively unimportant.

Current from the Mains.—After its introduction into commerce the current of the electric lighting mains was quickly introduced into medical practice, and we make large use of it in the electrical department of St. Bartholomew's, which is connected with the mains of the City of London Electric Lighting Co. The current impulses from the alternating mains have a physiological action resembling those of the induction coil; that is to say, the effect upon nerve and muscle is to produce a permanent contraction so long as the current is applied. But it is superior to the induction coil in being a less violent stimulus to nerve and muscle by reason of the more even and gradual rise and fall of its waves. Larger currents can be borne than from the induction coil, and, judging from its effects in a long series of cases, it appears to be more thorough and more useful in its effects. Nearly all the cases formerly treated by the induction coil at the hospital are now treated by the current from the mains, the voltage being lowered to suit the requirements of the case (to about 10 volts as an average); and indirectly we have gained largely, in that the department is now free from the noise of eight or ten induction coils all vibrating and buzzing at once. Formerly the effect of that noise during a long afternoon was most trying. There is one marked difference in the effect of the alternating current which limits its use, and that is that if applied in the ordinary manner, through moistened electrodes to the surface of the skin, it has a peculiar, disagreeable, burning effect. The more thoroughly the skin is moistened the less this is noticed, and when the current is conveyed to the patient through the medium of water, as in a bath, this disagreeable cutaneous effect disappears entirely. Consequently a mode of treatment by means of baths and the sinusoidal current has been developed to a very considerable extent and with decided advantage to our patients. Large numbers of our cases are cases of paralysis of the upper limbs from injury or disease of the nerves of the upper extremities, and for these we use an arm bath. The arm bath is a stoneware trough of suitable shape, having a metal electrode at each end; it is filled with warm water, into which the patient plunges the forearm and hand. The use of hot water as a medium for conveying electricity to a patient has many advantages The current is much better borne, and therefore a stronger current can be used. Manipulation of the electrodes and personal handling of the patient is done away with, and the affected part is kept warm during the application. For these reasons we use it largely, and I continue to advocate its use as one which again is likely to increase the popularity of electricity among the medical profession, because it tends to simplify its mode of application. In addition to small local baths for parts of the body, we have a large bath, in which the whole of the body is immersed; and for general morbid conditions, as distinguished from local ones, the electric bath with the induction coil current, or, better still, with the sinusoidal current of the mains, is an extremely useful contrivance. In that section of medical electricity which comprehends general applications for general systemic diseases—a field of work which is only now being thoroughly explored—the electric bath is perhaps superior to any other mode of applying general electrification. The other modes of doing this are by the statical machine, or by the high-frequency and high-potential methods of Tesla and of D'Arsonval. The chief advantage of both these latter methods is that the patient need not disrobe; but, on the other hand, the electric bath has the great advantage that the currents which are being used can be more readily measured and adjusted to suit individual needs. Chance very largely decides the choice of one or other of these methods of general electrification. Whereas the sinusoidal current and the bath suits one medical man best, the other forms may be more convenient to the conditions of practice of another one. The electric bath, unfortunately, has been rather under a cloud during recent years, in this country at least, by reason of its association with those peculiar "massage" establishments which sprang up so thickly in London a few years ago. Now, however, most of these establishments have disappeared, and one may venture to speak of the definite

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advantages of the electric bath without feeling that one's words may reappear in the columns of some journal in association with advertisements of undesirable houses. At St. Bartholomew's Hospital, excluding arm baths, about one thousand baths, mostly with the sinusoidal current, are given each year, particularly for diseases like debility, rheumatism, sciatica, neuritis, lead poisoning, and various forms of paralysis. No electrical department can be considered properly equipped without the electric bath, for in many morbid states its action is most valuable. The bath with direct current has also certain useful applications, although not so many as the induction coil or the sinusoidal current bath. The direct-current bath, local or general, is useful in the relief of gout, rheumatism, sprains, chronic inflammations, and generally as an absorbent for the removal of fibrous adhesions or thickenings in or about the joints and limbs. It is also indicated in painful states, when a varying current is too stimulating to be well borne, as for example, in acute sciatica, neuritis with pain, and so on. The alternating current of the mains also lends itself extremely nicely to such uses as for galvano-cauteries and for the small exploring lamps used by surgeons, and where alternating current is laid on they now for the most part have small tranformers for use in this way. Instruments containing lamps and telescopes are now used for examining the interior of such cavities as the bladder and the stomach, which previously have been inaccessible to the sight, as well as for the illumination of more accessible parts, such as the throat, the ear, the nostrils, &c.

The arrangements at St. Bartholomew's for the distribution of our current from the mains consist of a transformer, tapped at intervals in its secondary winding and led to a row of binding screws, from which any voltage between half a volt and 50 volts can be taken at will. The three rooms in which treatment is given are wired in three circuits as for electric lighting, and the voltage required can be switched on to any of the three rooms from the transformer. Thus we have at command low voltage currents for galvano-cauteries and small lamps, and higher voltage currents for applications to patients. We use 3 or 4 volts for cauteries, 8 or 10 for lamps, 10 to 20 for the baths. Several of our old sledge-pattern induction coils with sliding secondaries are now converted for use as subsidiary regulating devices for the baths. I cannot say much of the use of direct-current mains in medical practice from personal experience. Although I have been instrumental in connecting three places to the lighting mains, I have never been in touch with direct current circuits. The use of the direct current from the mains for applications to patients, and for other applications requiring low voltages, is carried out either indirectly by means of charging accumulators from the mains and using them, when disconnected, for the patients, or else by means of shunt resistances. The latter method is to provide a resistance of several thousand ohms, which is connected across the mains. The resistance is a bare wire coiled on a support, and is fitted with a travelling contact shoe which can be moved so as to tap the windings at any point. The patient is arranged in a shunt circuit in parallel with any convenient length of the resistance. When only small currents are required, a lamp is arranged permanently in series with the wire resistance. The slope of potential which can be tapped at different points by the movements of the slider permits fine regulation of current in the shunt or patient's circuit. With shunt resistances of suitable magnitude current can be obtained for treatment, for working induction coils, or for galvano-cauteries. In the latter case the waste is considerable, and it is my belief that an accumulator charged through a lamp would be much better, but in many cases the shunt circuit is preferred, in spite of its waste at the rate of more than a horse-power, whenever 10 amperes are wanted. Possibly something like a step-down induction coil might be devised for heating cauteries off the direct-current mains. One of the drawbacks of electric light supply is that those who have continuous current laid on cannot also have alternating. And so a medical man residing in a district supplied by direct current will have to generate any sinusoidal current needed by means of a motor dynamo. These instruments can be bought, and are in use. On the other hand, a medical man supplied with alternating current will often sigh and wish that he could easily generate for himself a little continuous current. And here is a point which perhaps might be worth the attention of this society—viz., the contrivance of some simple rotatory converter which could be attached to a lamp socket in a house supplied with alternating current, and which would give out continuous current sufficient to recharge a portable accumulator from time to time. Not much would be wanted, and perhaps it is just on that account that the instrument I have indicated is not easy to get; presumably it would not pay to make it. Still, a little rotatory transformer, which would give out say an ampere at 10 volts of continuous current, would be welcomed by many medical men who live in districts of alternating supply. The mechanical efficiency of the machine is in no way important, considering the smallness of the needs. That which would be important with such an instrument is that it could be left to run for periods of an hour or two at a time without needing its owner to stand over it and watch it, and that it would not become overheated nor make a great noise.

The Statical Machine.—This form of apparatus—the first introduced into medical practice—is showing very decided signs of a revival. In the United States the statical machine is already very largely employed, and I am told that in New York alone there are no less than three firms busily engaged in turning out statical machines at the rate of two or three a week. Those who are only acquainted with the effects produced by small statical machines can have no idea of the difference between small and large instruments of this kind. The effects produced by a large statical machine are most decided, and it is only necessary for one to experience them once to see that treatment by them is by no means a mere treatment through the imagination. The most apparent effects of the statical machine are the profound and peculiar cutaneous sensory stimulation which can be produced by it, and the forcible muscular contractions which can also be produced by it when the administration is in the form of sparks. Its special field of usefulness probably lies, first, in its action as a general excitant; secondly, in conditions of neuralgia and other superficial pains; thirdly, in the conditions of muscular pain. In all these cases it acts quickly and thoroughly. It is quite common to receive a patient stiff and lame from lumbago or muscular rheumatism, and to see him leave in 10 or 15 minutes quite free, for a time at least, from his lameness or his stiffness. All this promises to be extremely valuable. The difficulty of understanding how a simple electrification by the static machine can influence the body makes many of us disinclined to believe that there can be any effect; but after watching cases carefully for some time, I can now say with certainty that some direct action does take place. I have only had a proper static machine for a year and a half, and therefore still feel rather a beginner with it. A very interesting matter is that, whereas on the other side of the Atlantic the influence machine which is used is invariably a modified Holtz's, on this side it is the Wimshurst which is considered the best. The American Holtz' machine certainly has been developed into a most beautiful instrument; and although it has one drawback when compared with the Wimshurst—that of not being self-exciting—that is a point so easily got over by means of a small accessory exciting machine in the corner of the case as to have no real importance. Size for size, I am disposed to believe that the Holtz gives a better output than the Wimshurst. It appears to be a more cheaply constructed machine, and needs no countershaft nor cross belts. Recently a large American Holtz machine has been presented to St. Bartholomew's Hospital, so we shall have an opportunity of testing and of comparing its work with that of a large Wimshurst machine which I have recently had constructed for my own use. As a good Holtz machine is, so far as I know, a curiosity in this country, I shall have much pleasure in showing our machine to any members of the Institution who might wish to see it. The accessory apparatus and the technique of the statical machine have been very greatly simplified by the work of American physicians.

The application of high-frequency currents to medical practice has not had much extension. In France it is used a little. The currents are taken from leads connected to the ends of the primary helix, and no secondary coil is used. An induction coil is generally used to charge the Leyden jar condensers of the system. The applications are either by a sort of spark or brush discharge from one terminal to the patient, or the patient lying on a couch is attached to one pole, the other being connected to a sheet of metal under the couch. This is called the condenser bed. Finally, the patient may be enclosed in the actual helix connecting the jars, and his body thus made the seat of induced currents by "auto-conduction." Its chief applications have been as a mode of general electrification, but the brush discharge is also applied locally to the skin, and has seemed efficacious in curing certain skin diseases.

Ozone.—The use of electricity for generating ozone for medical purposes is attracting some interest. It is not so much that these applications of ozone are entirely new, as that the apparatus is now becoming sufficiently improved to make its applications easier. But the rapid development of electricity in so many directions of late years has given medical men just at present so many fresh things to handle, that ozone in its medical applications is, as it were, waiting until some one has time to attend to it. The workers in medical electricity, in this country at least, are so few.

Perhaps the most striking of all the applications of electricity to medical work in recent times has been due to the discoveries of Prof. Röntgen. The introduction of the X-rays has revived very greatly the interest in medical electricity. The Röntgen-ray work makes a very considerable addition to the work done in our electrical department at St. Bartholomew's Hospital, as it is in almost daily use for purposes of diagnosis in surgical cases. Physicians hitherto have paid but little attention to Röntgen rays, but its application to the diagnosis of diseases of the chest must be mentioned as perhaps one of the most promising things for the future. Certainly it is possible to diagnose pulmonary consumption and some other diseases of the chest more satisfactorily, and at an earlier stage of the disease, by the X-rays than is possible with the stethoscope; and this one point alone appears to me to be of the highest importance. For example, recently I saw the X-ray photograph of a patient's chest.

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She was suspected of having pulmonary disease, and was sent to one of my colleagues for an X-ray photograph; examination by the ordinary methods of auscultation and percussion had given an uncertain reply. But the negative taken with X-rays showed without any possible doubt the presence of tubercles in the lung. If there were more time to spare, I could go into the question of X-ray work more deeply on the grounds of its great development by medical practitioners, the localisation and stereoscopic methods of Dr. Mackenzie Davidson and others being singularly beautiful in their results; but I have the idea that most of us are a little sated with X-ray work just now, so I shall say no more except to refer to the extreme beauty of the fluorescent screen effects which are given by large static machines.

ELECTRICITY WORKS ACCOUNTS.

Westminster Electric Supply Corporation (Ltd.).

In the first of our tables this week is given an analysis of the accounts of the Westminster electric supply undertaking during last year. The figures we are able to give indicate excellent results generally.

The equivalent total lamp connections at Dec. 31st last stood at 421,445 8 c.p. lamps. It is to be noted that the actual number of additional lamps applied for and connected during the year was 54,691. The balance of the apparent increase since 1898 (viz., 26,768 lamps) represents the results of a re-examination of consumers' connections which has been made lately, and which showed that the actual number connected to the mains was to that extent in excess of the originally applied for and approved number. The true increase was therefore about 14·9 per cent. It is stated in the directors' report that 99 per cent. of the consumers are now supplied at 200 volts, and it is hoped that the work of changing over to this higher pressure will be completed during the present year, as until that consummation is reached the company will not reap any advantage, although consumers at 200 volts enjoy a reduction in price.

The company is to be congratulated on the splendid increase in the output—viz., 25 per cent.—raising the total to 6,829,544 units sold.

A reduction of 0·42d. per unit has taken place in the revenue from supply, while the total from all sources has dropped close on 0·47d. In spite of this, however, the reduced costs, in combination with the higher output, have resulted in an increased working profit of £11,399, the total representing practically 12 per cent. on the mean capital of the year.

It is highly satisfactory to find that all the items of expenditure, with the one exception of "repairs and renewals of mains," have dropped. The result is that the total costs have decreased about 0·26d. per unit, and now stand at the excellent figure of 2·07d. per unit. These costs run the St. James' very closely, and it must be remembered that the latter concern enjoys the higher load factor of the two. This difference has probably a predominating effect on the costs compared with the difference in the output at such high outputs as obtains at these stations.

After meeting interest charges amounting to £6,461, £2,500 of the gross profit was carried to the sinking fund, £1,617 to the debenture redemption account, and £16,952 to the depreciation fund. There was thus, with the balance from 1898, a sum of £53,977 available for distribution, out of which an ordinary dividend of 13 per cent. for the year was paid.

The following table is interesting, as showing the progress which has been made since the starting of operations:—

Year.	No. of consumers.	Equivalent lamp connections.	Units sold.	Max. supply demanded. KW.	Load factor. %	Plant capacity. KW.	Ord. div. %
1891	763	62,800	627,500	700	10·2	...	...
1892	1,255	98,646	1,217,871	1,200	11·6	...	3½
1893	1,730	131,563	1,704,615	1,400	13·9	...	4
1894	2,259	167,700	2,173,298	1,917	12·9	...	5
1895	2,890	210,980	2,830,396	2,130	15·2	3,765	7
1896	3,480	249,318	3,503,054	3,000	13·3	3,765	9
1897	4,000	290,561	4,355,781	3,650	13·6	4,533	12
1898	4,550	366,754	5,065,195	4,400	13·1	5,658	12
1899	5,100	421,445	6,329,544	5,420	13·3	6,198	13

Charing Cross and Strand Electricity Supply Corporation (Ltd.).

Hardly less satisfactory than that of the Westminster undertaking has been the progress of the Charing Cross concern during 1899. During the year the equivalent lamp connections have risen from 134,286 to 182,689 8 c.p. lamps—an increase of over 36 per cent. The output at 3,862,128 units sold marks an advance of 615,897 units, or close on 19 per cent., and was productive of a total revenue of £70,787, or an average of 4·4d. per unit.

After meeting the working expenditure of £35,109 there was left a gross profit of £35,678, representing 7·86 per cent. on the mean capital over the year. Out of this profit £3,451 was absorbed in interest and £8,000 by the depreciation fund, leaving a total balance of £27,519 available for distribution.

Among the costs, all the generating charges, except "repairs and maintenance at the station," have shown a very gratifying diminution, with the result that in the aggregate the costs have fallen from 2·33d. to 2·18d. per unit. At the latter figure the total costs are highly satisfactory, even considering the combination of large output and high load factor (of 17·6 per cent.) which characterises the concern. The only item of generating costs which is above the average is that of repairs and maintenance at the station, and we hope its position thus is only temporary.

At their present figure, management and property charges are just what we should have considered normal under the circumstances.

During the year 24½ miles of mains have been laid, making altogether 126 miles, while the further extension of the Lambeth station is being proceeded with and will soon be completed, affording accommodation for an additional 2,500 H.P. of generating plant, which has been ordered. Arrangements have been made for the acquisition of 7½ acres of land at Bow for a separate station under the City provisional order.

The following table indicates the growth of the business since it was started:—

Year.	Equiv. lamp connections.	Units sold.	Plant capacity. KW.	Max. supply demanded. KW.	Load factor. %	Ord. div. %
1892	29,500	652,703	...	...	...	5
1893	34,570	934,276	...	...	...	4½
1894	41,216	1,115,609	..	540	23·6	4½
1895	51,302	1,383,813	1,050	750	21·1	5
1896	73,464	1,944,402	2,250	1,065	20·8	6
1897	107,542	2,615,508	2,540	1,377	21·7	7
1898	134,236	3,246,231	3,120	2,176	17·1	8
1899	182,689	3,862,128	3,620	2,512	17·5	9

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

Aberdeen (Municipal)	Jan. 12, 1900	Kingston-on-Thames (Mun.)	April 21, 1899
Ayr (Municipal)	Sept. 22, 1899	Lancaster (Municipal)	Jan. 19, 1900
Bath (Municipal)	Feb. 9, 1900	Leeds (Municipal)	Dec. 1, 1899
Bedford (Municipal)	May 19, 1899	Leicester (Municipal)	Jan. 26, 19 0
Belfast (Municipal)	Sept. 15, ,,	Leyton (Municipal)	Sept. 8, 1899
Birmingham (Company)	Sept. 15, ,,	Liverpool (Municipal)	June 9, ,,
Blackburn (Municipal)	Jan. 19, 1900	Londonderry (Municipal)	Feb. 16, 1900
Blackpool (Municipal)	Sept. 29, 1899	Manchester (Municipal)	Aug. 11, 1899
Bournemouth (Company)	April 28, ,,	Newcastle and District (Co.)	Oct. 6, ,,
Bolton (Municipal)	Nov. 24, ,,	Newcastle-upon-Tyne (Co.)	April 14, ,,
Bradford (Municipal)	April 14, ,,	Newport (Mon.) (Municipal)	Dec. 15, ,,
Brighton (Municipal)	May 12, ,,	Northampton (Company)	Oct. 20, ,,
Bristol (Municipal)	July 14, ,,	Norwich (Company)	Nov. 17, ,,
Burnley (Municipal)	Aug. 25, ,,	Notting Hill (Company)	Mar. 17, ,,
Burton-upon-Trent (Mun.)	April 21, ,,	Nottingham (Municipal)	July 21, ,,
Bury (Municipal)	Sept. 22, ,,	Oldham (Municipal)	Dec. 1, ,,
Cambridge (Company)	Mar. 10, ,,	Oxford (Company)	May 19, ,,
Cardiff (Municipal)	Dec. 15, ,,	Pontypool (Company)	May 5, ,,
Charing Cross (Company)	Mar. 17, ,,	Portsmouth (Municipal)	July 14, ,,
Chelsea (Company)	Mar. 31, ,,	Prescot (Company)	Dec. 8, ,,
Cheltenham (Municipal)	Nov. 10, ,,	Preston (Company)	Sept. 29, ,,
Chester (Municipal)	June 23, ,,	Reading (Company)	Oct. 13, ,,
City of London (Company)	May 12, ,,	Richmond (Company)	Oct. 13, ,,
Clerkenwell (Company)	Aug. 18, ,,	Salford (Municipal)	Feb. 13, 1900
Coventry (Municipal)	Feb. 23, 1900	Scarborough (Company)	Nov. 3, 1899
Croydon (Municipal)	Feb. 9, ,,	St. Helens (Municipal)	Dec. 8, ,,
Derby (Municipal)	Jan. 26, ,,	St. James' & Pall Mall (Co.)	Feb. 16, 1900
Dewsbury (Municipal)	Nov. 24, 1899	St. Pancras (Vestry)	May 26, 1899
Dover (Company)	June 2, ,,	Sheffield (Municipal)	Dec. 29, ,,
Dundee (Municipal)	Jan. 12, 1900	Shoreditch (Vestry)	Oct. 27, ,,
Eastbourne (Company)	Feb. 2, ,,	Southampton (Municipal)	Nov. 10, ,,
Edinburgh (Municipal)	Nov. 17, 1899	Southport (Municipal)	July 7, ,,
Exeter (Municipal)	Aug. 5, 1898	South Shields (Municipal)	July 7, ,,
Glasgow (Municipal)	Sept. 1, 1899	Stafford (Municipal)	Dec. 29, ,,
Guildford (Company)	May 5, ,,	Sunderland (Municipal)	July 28, ,,
Halifax (Municipal)	July 21, ,,	Taunton (Municipal)	June 16, ,,
Hammersmith (Vestry)	May 26, ,,	Tunbridge Wells (Mun.)	Sept. 1, ,,
Hampstead (Vestry)	Aug. 25, ,,	Wakefield (Municipal)	Dec. 1, ,,
Hanley (Municipal)	April 28, ,,	Walsall (Municipal)	June 23, ,,
Harrogate (Municipal)	Oct. 20, ,,	Wandsworth (Company)	Aug. 18, ,,
Harrow (Company)	June 16, ,,	Westminster (Company)	Feb. 24, ,,
Hast'gs & St. Leonards (Co.)	Feb. 2, 1900	Whitehaven (Municipal)	July 28, ,,
H'use-to-H'useCo.(K'ns'gt'n)	Mar. 31, 1899	Windsor (Company)	Dec. 22, ,,
Hove (Company)	Mar. 10, ,,	Woking (Company)	Dec. 22, ,,
Huddersfield (Municipal)	Oct. 6, ,,	Wolverhampton (Municipal)	June 30, ,,
Islington (Vestry)	Oct. 27, ,,	Woolwich (Company)	Jan. 13, ,,
Kensington & Knightsbr'(Co.)	Mar. 3, ,,	Worcester (Municipal)	April 7, ,,
Kingston-upon-Hull (Mun.)	June 9, ,,	Yarmouth (Municipal)	Nov. 3, ,,

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	WESTMINSTER.		CHARING CROSS.	
Undertaking Worked by	Westminster Electric Supply Corporation (Ltd.)		The Charing Cross and Strand Electricity [Supply Corporation (Ltd.).	
Date of Commencement of Supply	November, 1890.		1890.	
System of Supply	Continuous-current, three-wire, with batteries.		Three-wire continuous-current.	
Chief Engineer	A. B. W. Kennedy.		W. H. Patchell.	
YEAR ENDED	DEC. 31, **1898.**	DEC. 31, **1899.**	DEC. 31, **1898.**	DEC. 31, **1899.**
QUANTITIES—				
Units generated	5,847,595	7,361,745	3,985,481	4,788,498
„ **SOLD (TOTAL)**	5,065,195	6,329,544	3,246,231	3,862,128
„ sold to consumers	5,065,195	6,329,544	3,241,331	3,837,449
„ sold for public lighting, &c.	nil	nil	4,900	24,679
„ used on works	64,216	62,680	709,865	903,142
UNITS SOLD PER 8 C.P. LAMP CAPACITY	28·6	32·7	33·3	34·2
Maximum supply demanded	4,400	5,420	2,176 kilowatts	2,512 kilowatts
Number of public lamps	—	—	13 arcs	13 arcs
Number of consumers	4,550	5,100	956	1,150
Connections to mains in 8-c.p. lamps	339,936	421,445	134,236	182,689
CAPACITY OF PLANT IN 8-C.P. LAMPS	176,700	193,500	97,500	113,000
CAPACITY OF PLANT IN KILOWATTS	5,658	6,198	3,120	3,620
CAPITAL—	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.
AUTHORISED (TOTAL)	£649,500 / £115	£649,500 / £105	£400,000 / £128	£500,000 / £138
Share	399,500 / 70·6	399,500 / 64·5	250,000 / 80·2	350,000 / 96·9
Loan (including Debenture charges)	250,000 / 44·2	250,000 / 40·3	150,000 / 48·1	150,000 / 41·5
RECEIVED (TOTAL)	598,800 / 106	649,500 / 105	377,500 / 121	374,200 / 104
Share	399,500 / 70·6	399,500 / 64·5	250,000 / 80·2	350,000 / 96·9
Loan (including Debenture charges)	199,300 / 35·2	250,000 / 40·3	127,500[a] / 40·9	24,200 / 6·70
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	50,700 / 8·96	nil / —	22,500 / 7·22	125,800 / 34·8
Share (unissued)	nil / —	nil / —	nil / —	nil / —
Share (uncalled)	nil / —	nil / —	nil / —	nil / —
Loan (including Debentures)	50,700 / 8·96	nil / —	22,500 / 7·22	125,800 / 34·8
REPAID (TOTAL)	— / —	— / —	— / —	— / —
RESERVE OR SINKING FUND	18,795 / 3·32	21,951 / 3·54	9,603[b] / 3·08	24,267[h] / 6·72
DEPRECIATION FUND	55,913 / 9·87	60,280 / 9·73	20,000 / 6·41	28,000 / 7·76
EXPENDED (TOTAL)	626,366 / 111	683,563 / 110	403,384 / 131	498,174 / 138
Lands and buildings	175,143 / 30·9	189,916 / 20·6	172,553[c] / 55·3	181,567[c] / 50·3
Plant	203,581[a] / 36·0	214,506 / 34·6	107,085 / 34·3	147,172 / 40·8
Mains	233,609 / 41·3	264,970 / 42·3	123,089 / 39·5	162,481 / 45·0
Miscellaneous	14,033[b] / 2·48	14,176[b] / 2·29	6,657 / 2·13	6,955 / 1·93
BALANCE OF CAPITAL ACCOUNT	−27,566[c] / −4·88	−34,068[c] / −5·50	−31,881[d] / −10·2	−123,974[d] / −34·3
REVENUE—	Total. / Per unit sold	Total. / Per unit sold	Total. / Per unit sold	Total. / Per unit sold
TOTAL	£116,178 / 5·510d.	£132,939 / 5·042d.	£59,973 / 4·435d.	£70,787 / 4·400d.
Revenue from supply	111,001 / 5·262d.	127,574 / 4·840d.	58,935 / 4·360d.	69,701 / 4·330d.
„ meters, &c.	4,759 / 0·226d.	5,144 / 0·195d.	777 / 0·057d.	994 / 0·062d.
„ public lighting	— / —	— / —	— / —	— / —
„ sale of lamps, &c.	— / —	— / —	— / —	— / —
„ miscellaneous sources	417[d] / 0·020d.	221[h] / 0·008d.	210 / 0·016d.	92 / 0·006d.
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	£49,249 / 2·334d.	£54,606 / 2·072d.	£31,462 / 2·326d.	£35,109 / 2·182d.
WORKS COSTS	30,818 / 1·461d.	34,736 / 1·318d.	24,540 / 1·814d.	27,722 / 1·723d.
Generation of electricity	*28,563 / 1·353d.*	*31,531 / 1·196d.*	*22,235 / 1·645d.*	*24,532 / 1·524d.*
Fuel (including cartage, &c.)	14,643 / 0·694d.	17,710 / 0·672d.	13,354 / 0·988d.	13,766 / 0·856d.
Oil, waste, water, stores	1,845 / 0·087d.	2,145 / 0·081d.	1,202 / 0·089d.	929 / 0·058d.
Wages at station	7,480 / 0·355d.	7,974 / 0·302d.	5,052 / 0·374d.	5,616 / 0·349d.
Repairs and maintenance at station	4,586 / 0·217d.	3,702 / 0·140d.	2,626 / 0·194d.	4,221 / 0·262d.
Distribution of electricity	*2,255 / 0·107d.*	*3,205 / 0·122d.*	*2,305 / 0·171d.*	*3,190 / 0·198d.*
Wages, &c.	1,719 / 0·082d.	1,513 / 0·057d.	841 / 0·062d.	1,127 / 0·070d.
Repairs, renewals of mains, &c.	535 / 0·025d.	1,692 / 0·064d.	1,464 / 0·108d.	2,063 / 0·128d.
Public lighting	— / —	— / —	— / —	— / —
Attendance	— / —	— / —	— / —	— / —
Renewals	— / —	— / —	— / —	— / —
MANAGEMENT AND PROPERTY CHARGES	18,431 / 0·874d.	19,870 / 0·754d.	6,922 / 0·512d.	7,387 / 0·459d.
Royalties	*nil* / —	*nil* / —	— / —	— / —
Rent, rates, taxes	*5,575 / 0·264d.*	*6,646 / 0·252d.*	*2,657[e] / 0·197d.*	*2,730[e] / 0·170d.*
Management	*12,856 / 0·610d.*	*13,224 / 0·502d.*	*4,265 / 0·315d.*	*4,657 / 0·289d.*
Salaries	10,458[e] / 0·496d.	10,916[i] / 0·414d.	3,109 / 0·230d.	3,514 / 0·219d.
Stationery, &c.	396 / 0·019d.	487 / 0·018d.	224 / 0·017d.	197 / 0·012d.
Establishment charges	597 / 0·028d.	670 / 0·025d.	418 / 0·031d.	400 / 0·025d.
Law charges, &c.	1,405[f] / 0·067d.	1,151[j] / 0·044d.	514[f] / 0·038d.	546[i] / 0·034d.
FINANCIAL RESULTS—	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded
WORKING PROFIT FOR YEAR	£66,929 / 11·27%	£78,328 / 11·96%	£28,511 / 7·46%	£35,678 / 7·86%
Sum carried to Depreciation Fund	15,350 / 2·586%	17,014 / 2·596%	7,134 / 1·86%	8,000 / 1·76%
Sum carried to Reserve or Sinking Fund	3,030 / 0·510%	4,117 / 0·628%	— / —	— / —
Net interest on loans (incl. Debenture charges)	6,557 / 1·107%	6,461 / 0·986%	4,600 / 1·20%	3,451 / 0·76%
BALANCE FROM LAST ACCOUNT	3,119 / 0·526%	1,001 / 0·153%	3,015 / 0·786%	3,292 / 0·725%
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	47,343 / 7·98%	53,977 / 8·240%	19,792 / 5·16%	27,519 / 6·06%
Deficit	— / —	— / —	— / —	— / —
ORDINARY DIVIDEND PAID	12% / —	13% / —	8% / —	9% / —
PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE	42·4%	41·1%	52·5%	49·6%
Expenditure per kilowatt capacity	£8. 14s. 1d.	£8. 16s. 4d.	£10. 1s. 7d.	£9. 14s. 0d.
REVENUE PER KILOWATT CAPACITY	**£20. 10s. 10d.**	**£21. 9s. 2d.**	**£19. 4s. 0d.**	**£19. 10s. 10d.**
Expenditure per 8-c. lamp capacity	5s. 6¾d.	5s. 7¾d.	6s. 5½d.	6s. 2½d.
REVENUE PER 8-C.P. LAMP CAPACITY	**13s. 2d.**	**13s. 9d.**	**12s. 3½d.**	**12s. 6½d.**
REVENUE PER 8-C.P. LAMP CONNECTED	**6s. 10d.**	**6s. 3¾d.**	**8s. 11d.**	**7s. 9d.**
Price charged for lighting, per unit	6d.[g]	6d.[g]	6d. to 4d.[g]	6d. to 4d.[g]
Price charged for power, per unit	3d.[g]	3d.[g]	4d. to 2d.[g]	4d. to 2d.[g]
Price charged for public lighting	—	—	—	—

WESTMINSTER.—REMARKS—*a* Includes £40,883 to meters and cost of calibrating. *b* Includes £10 133 to purchase of City of Westminster Electrical Syndicate. *c* Over-expended. *d* Includes £319 profit from supply of steam. *e* Includes directors' fees £3 000. *f* Includes £644 to insurance. *g* With rebates. *h* Includes £163 profit from supply of steam. *i* Includes directors'fees £3,000. *j* Includes insurance £649, law and parliamentary charges £315, auditing £85, and experiments and costs *re* smoke abatement £92.

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Published every Friday, Price Sixpence; Post Free, Sixpence-Halfpenny.
Editorial Publishing and Printing Offices,

1, 2 & 3, SALISBURY COURT, FLEET ST., LONDON,

Telephone: 949 Holborn. *Telegrams:* "ELECTRICIAN NEWSPAPER LONDON."

All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher "THE ELECTRICIAN," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN" *Printing and Publishing Company, Limited, and be crossed "Coutts and Co."*

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THE PRESENT POSITION OF WIRELESS TELEGRAPHY.

We commented briefly, in our issue last week, upon the speech of the chairman of the Wireless Telegraph and Signal Co., which also appeared in that issue. There are, however, several matters of importance dealt with in that speech for which we were unable at the time to find space to comment upon, and to these we desire now to direct the attention of our readers. Broadly speaking, we wish to compare the remarks made by the chairman, Major S. FLOOD PAGE, with the present position and immediate prospects of practical wireless telegraphy. The comparison is instructive and, as CARLYLE would say, is "significant of much."

It is probably an accurate description of Major PAGE's speech to say that it formed a series of pictures. There were pictures of wireless telegraphy at the present time, as the speaker viewed it; other pictures revealed what Major PAGE believes wireless telegraphy might easily have become, at the present time, had it not been for the stupidity and indifference of almost every authority with which the Wireless Telegraph Co. has undertaken negotiations; and, lastly, there are highly-coloured chromos of the future of the invention. Wireless telegraphy has undoubtedly made very encouraging progress up to the present time. The number of signal stations has increased, the applications of it have become more and more varied, in many respects the apparatus has been improved, and the radius of possible action from any station has been steadily augmented. For all this Mr. MARCONI and the officials of the company deserve great credit. But considerable though the progress has been, there has always existed one serious defect in the Marconi system. We have frequently referred to it in these pages; and we do so once more because, although the defect still remains in all its nakedness, Major PAGE made no reference to it, but, on the contrary, tacitly assumed in all his pretty pictures that it has no existence at all. Among numerous minor difficulties in the way of the general spread of the Marconi system, it stands out prominently and vividly as the one hitherto insuperable barrier; it is the interference that must exist between the individual instruments in a group of stations. From time to time we have heard vague rumours that in some measure this difficulty has been overcome, as for example at the group of three stations associated with the South Foreland lighthouse.

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But not only have no particulars been disclosed, it is quite evident that in whatever manner anything in this direction may have been accomplished, the results are not sufficiently satisfactory to allow of promiscuous signalling between any considerable group of instruments. Take, for instance, Major PAGE'S picture of the way the Marconi system might be employed to dispense with flag signalling at sea. Observe that this is a picture of what he believes could now at any time be accomplished :—

I now come to the last of my four divisions of this business, and for the moment it is the most important—the maritime, which is ready for work. What is the maritime business? Ships at present come close in to the shore in order to signal, and the vast amount of business that is done in signalling shows that all vessels when they are coming in are very anxious to be reported. Of course, the business that is done at present is important, but I verily believe that it is insignificant compared to the business that will be done through the Marconi system. The ships crowd in at present close to shore, and especially in foggy weather, and there are two serious dangers involved: they come close in to the shore, and they crowd into a very limited space. Under the Marconi system they can telegraph 10 or 20 miles from the shore, and just as usefully in a fog.

We have passed the Cape St. Vincent signal station, at Sagres, when there have been no less than seven large vessels close in and all anxious to signal. Within 10 or 20 miles radius there probably were twice that number of vessels. With what description of receiving apparatus, we ask, would Major PAGE equip the Sagres station, so that that number of ships might communicate with it without confusion? Even could this be accomplished between that number of *fixed* stations—which it emphatically could *not*—the motion of the ships in various directions and at diverse speeds would add serious difficulties to the selective or focussing arrangements. There is no need to multiply instances, but we could go through the entire series of Major PAGE'S pictures, present and prospective, and in almost every case it would have to be admitted that owing to the interference effect we have spoken of, the pictures are idealistic rather than realistic. Of what use is it to talk of trans-oceanic telegraphy and of communication from ship to ship, or from ship to shore, when the conditions are such that the roar of the trans-ocean signal must deafen every ship and shore receiver to the whispers of nearer and feebler instruments? Or why is Major PAGE glad that the vessels of the North German Lloyd may soon be fitted with Marconi apparatus, when he must know that signalling between two of them in the vicinity of his company's coast stations would interfere completely with the working of those stations? Indeed, it would almost seem to be a misfortune for wireless telegraphy that it can be made to work over long distances. Major PAGE rejoices in his opinion that nothing more can be learned from signalling only 12 miles, since it is now possible to signal many times that distance. We are not sure that, until the unfortunate interference effect is obviated, a physical impossibility to signal more than 12 miles—or even a much less distance—would not have been a blessing in disguise. The Marconi system as it is at present constituted, in fact, is not for the ambitious work of uniting continents and spanning oceans, nor even for the responsible duty of telling off vessels as they crowd past the headland or island signal stations; but for the present it may find much useful work of a humbler kind in linking shores with lightships and island lighthouses, and in providing ships at sea with a reliable and not difficult mode of communication when only a few miles apart. In the meantime we hope for, and patiently wait for, a satisfactory means of completely abolishing interference between wireless telegraph stations, though no solution of the problem has yet presented itself.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

New Magneto-Optic Effect.—A partial polarisation of the light emitted by vacuum tubes under the influence of a magnetic field has been discovered by R. Dongier. It is best observed in the case of the red rays emitted by hydrogen under the spark discharge. With a magnetic field if 4,000 units acting at right angles to the axis of the tube, an ordinary spectroscope only shows a diminution in the intensity of the radiation. But a Savart polariscope reveals the fact that the radiation has become partially polarised. The light emitted in a plane normal to the axis of the tube differs according to its azimuth. The greatest proportion of polarised light is found in a direction normal to both the tube and the field. There are two such directions, and they again differ in optical properties among themselves. That direction shows the maximum of polarised light which is such that the observer can, by a right-handed rotation of 90deg., bring the vector representing the magnetic field into coincidence with the vector of the electric field inside the tube. The fringes observed can in fact be made to appear and disappear by commutating either the current or the field. A red glass should be used to intercept the other rays. Similar effects, though less well marked, are observed in nitrogen, carbonic acid, argon, and chlorine.

[R. DONGIER, *Comptes Rendus*, Jan. 29, 1900.]

Fluorescent Screens.—In some fluorescent screens used for Röntgen ray work, notably those made of Sidot's zinc sulphide, a certain time effect is observed at each operation. The bones of the hand are not visible at once on the screen. They gradually separate out from the flesh. This effect is only partially due to a change in the radiation impinging upon the screen. We know that a "hard" tube gives more decided radiographs, and the effect might be attributed to the hardening of the tubes while in action. But, on the other hand, a gradual and distinct brightening of the screen is observed, which is quite independent of any change in the radiation and is unaccompanied by any change of colour or of chemical constitution that could be discovered by any means at present available. J. Precht has studied the time effect both in sulphide and in platino-cyanide screens. He finds that the time required for a good development of the radioscopic picture is on the whole shortest at the highest discharge potentials. It varies from a few seconds to a minute. The most obvious explanation lies in an allotropic modification of the substance of the screen, as postulated by Becquerel for radium rays. But the author puts forward an emission hypothesis of Röntgen rays.

[J. PRECHT, *Ann. der Physik*, No. 2, 1900.]

Wavy Spark Discharge.—There are two distinct forms of discharge which are obtained by using a Wehnelt interrupter and a spark-gap between a point and a disc. At larger distances apart single strong sparks cross the gap, while at short distances a curved flame crosses from the point to the disc. E. Ruhmer describes a peculiar form of discharge which occurs at intermediate distances. It consists of a large number of thin spark lines branching out from the point and extending towards the disc like a brush. Every one of the lines has a sinusoidal wave shape, due in reality to a spiral form of the spark-path. When the sparks are successively photographed by a mutograph, it is seen that they are very similar in outline, but that they are successively displaced with respect to each other in the direction of the disc. The author does not give a theory of the phenomenon, beyond discarding the suggestion of a magnetic influence and vaguely hinting at an attraction and repulsion of two simultaneous sparks owing to differences of phase. The displacement towards the disc is, however, explained by the "electric wind" blowing from the point, which displaces the spiral chains of temporarily conducting dust and air particles towards the disc. The displacement is at the rate of about 1m. per second.

[E. RUHMER, *Electrotechn. Ztschr.*, Feb. 22, 1900.]

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Age Coating of Incandescent Lamps.—Various theories have been advanced to account for the deposit of carbon on the inner walls of incandescent lamps in the course of time. Moissan's hypothesis of a slow evaporation of the carbon of the filament is placed in doubt by the fact that the deposit does not depend upon the degree of exhaustion. Berliner's idea that gases are occluded in the filament and escape with explosive rapidity as soon as incandescence sets in, is invalidated by the observation that the deposit is the same in continuously glowing lamps and in those which are often relighted. J. Stark attributes the disintegration of the carbon to vagrant currents between various parts of the carbon filament, which traverse the intervening gas as in a Crookes tube. These vagrant currents can be placed in evidence by probes, but they are often made evident to the eye by an "aureole" between the arms of the filament which is nothing but the positive glow of a gaseous discharge. The internal currents are the stronger the greater the difference of potential between successive portions of the filament—*i.e.*, the higher the voltage of the circuit. The disintegration of the carbon is strongest at the cathode part, which turns black very soon and wears through quickly where continuous currents are used.

[J. Stark, *Elektrotechn. Ztschr.*, Feb. 22, 1900.]

Lichtenberg Figures inside Vacuum Tubes.—E. Riecke recently described a method of studying the distribution of surface charges on vacuum tubes by means of Lichtenberg figures. He has since found that these figures can be seen, without the help of sulphur and red lead, by narrowly observing the structure of the various fluorescent patches. On watching the main patch opposite the cathode, it is seen that it is surrounded by tongue-shaped projections, changing in shape more or less gradually. After a while the tube becomes "hard," and the discharge begins to pass through the air outside. By suitable commutation it is possible to made the discharge set in again. But now the appearance of the patch is considerably altered, delicate branchings having taken the place of the tongue-like projections, the transition much resembling that from the negative to the positive Lichtenberg figures. Both sets of figures appear dark on a lighter ground. They are evidently due to some accumulation of negative charges, which repel the cathode particles and so lessen the fluorescence. The projections are due to the leakage of these charges towards the positively charged spaces. When the outline of the charged patches becomes jagged and irregular, the projections assume a branched appearance.

[E. Riecke, *Ann. der Physik*, No. 2, 1900.]

Protection of Magnetic Observatories.—At a recent meeting of the Electrotechnischer Verein of Berlin, von Bezold entered a powerful plea for the protection of magnetic observatories from disturbances due to earth returns of electric railways. He showed that terrestrial magnetism was the parent and precursor of electric telegraphy and of the whole of electrotechnology, that it involved enormous commercial interests, and that it was in imminent danger of being made a science impossible to prosecute. For the purposes of modern navigation it is essential that magnetic charts should be republished every five years, and the revision cannot be successfully carried out without fixed points analogous to the fundamental points of a trigonometrical survey. In countries where, as in the United States, the boundaries of territories and states are fixed by the compass, endless legal difficulties are occasioned by slight errors in the magnetic variation. Earth returns have already ruined the work of the Washington, Toronto, Vienna, Nice, Copenhagen, and Batavia observatories; and others are threatened. It is practically impossible to secure sites away from possible disturbances, unless magneticians of high standing are to share the fate of lighthouse keepers. Metallic returns appear to be the only efficient safeguards. The association appointed a joint committee of magneticians and engineers to discuss the best means of settling the questions at issue.

[von Bezold, *Elektrotechn. Ztschr.*, Feb. 22, 1900.]

ELECTRIC LIGHTING ACT, 1882, AMENDMENT BILL.

We give below the text of Sir William Houldsworth's bill to amend the Electric Lighting Act, 1882. It is stated in the memorandum of the bill that the bill seeks to affirm the principle that public authorities ought not to incur any additional trouble and expense in rebuilding or repairing any of their bridges merely because a company has been permitted to utilise the bridge for carrying their electric mains or pipes. The provisions of the bill are stated to be analogous to those contained in the Tramways Act (33 and 34 Vict., chap. 78, sec. 32) with respect to roads:—

Be it enacted by the Queen's most Excellent Majesty, by and with the advice and consent of the Lords Spiritual and Temporal and Commons, in this present Parliament assembled, and by the authority of the same, as follows:—

1. Notwithstanding anything in the Electric Lighting Act, 1882, or in any provisional order granted under that Act, any local or other public authority or company may, in the exercise of their lawful powers of repairing, altering, enlarging, or rebuilding any bridge repairable by or under the control or management of such authority or company, alter the position of or temporarily interrupt any electric lines or works of the undertakers being in, under, or upon such bridge and the approaches thereof; and such authority or company shall not be liable to make any compensation for any loss or injury which may be occasioned to the undertakers by reason of the lawful exercise of any such power as aforesaid:

Provided that such authority or company shall take all reasonable precautions to avoid any such loss or injury, and shall, before commencing any works that may affect the mains or other property of the undertakers, give to the undertakers (except in the case of emergency) 28 days' notice of their intention to commence the same, and shall afford to the undertakers all reasonable temporary facilities for continuing the use of their mains and other property during the execution of any such works as aforesaid.

2. This Act may be cited as the Electric Lighting Act Amendment Act, 1900, and shall be read and construed together with the Electric Lighting Acts, 1882 and 1888.

THE STANDARDISATION OF ELECTRICAL ENGINEERING PLANT.

The following is the conclusion of our abstract of the discussion at the Institution of Electrical Engineers in connection with Mr. R. P. Sellon's Paper on the above subject. The Paper was published in our issue of Feb. 9th, and the first portions of the discussion in our issues of Feb. 16th and March 2nd:—

Thursday, Feb. 22nd (concluded from page 657).

Mr. Stuart Russell thought that the author of the Paper, by laying so much stress on the standardising of sizes of units, had begun rather at the wrong end. Mr. Esson had already spoken of the variety of speeds of engines. The engine makers had had the start of dynamo makers, and fixed on the speeds and sizes of engines before dynamo makers had come to any standards at all. They could scarcely ask the engine builders to change round. One maker perhaps ran 10 per cent. faster than another, but they could not expect him to give up that 10 per cent.—and reduce the output of his engine 10 per cent.—so as to allow the dynamo makers to have standards. In the matter of direct-coupled plant he did not think there could be any standardisation of sizes, while with regard to the smaller belt-driven plant or motors, fixing the sizes would not be a very great advantage. Every manufacturer would fix his own sizes, and would make a certain number of machines which would fit these, but there was no advantage in all the manufacturers making the same sizes of machines. The advantage, on the contrary, would be all the other way. One particular manufacturer would lose orders because his machine did not fit what the user wanted, but this would balance out because he would have the advantage another time. He believed, however, that the fixing of a standard pressure would certainly be an advantage. They had, as the author stated in the Paper, very readily accepted the standard pressures of traction, &c., introduced from America, and in doing so had very much handicapped their own manufacturers, because it was very common now to find in lighting stations machines which were to serve sometimes on the lighting circuits and sometimes on the traction circuits. They got, therefore, quite commonly, lighting specifications by which a 200 kw. machine had to give that output at any voltage from 440 to 500 when running as a shunt machine on the lighting circuit, and to give the same output at 550 volts or 560 volts when running on the traction circuit. It was quite evident that this so-called 200 kw. machine was really a 250 kw. or 260 kw. machine, driven by an engine which would only develop 200 kw. The user could not avail himself of the full output of that dynamo, and moreover, when he was running it on the lighting circuit he was running it under decidedly unfavourable conditions as to strength of field. He had seen specifications where the overload was to be given at 440 volts, although probably at this lower pressure the machine would never be required to give any current worth talking about. The net result was that this machine was nearly a 300 kw. machine before they had done with it, but they would never get more than

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200 kw. out of it, because the engine was limited to that. If they could but get some uniformity between traction and lighting voltages, it would mean a considerable saving in the cost of machinery. There were several other minor points not mentioned by the author—the question, for instance, of the heating of machines. The rating of machines was a somewhat vague matter at the present time. A maker said a certain machine was a 50 kw. machine, but they did not really know what conditions it was going to work under. They should come to a decision and say that a 50 kw. machine was one that would give 50 kw. continuously for a certain number of hours without rising more than a certain number of degrees in temperature at the end of that time. Reference had been made to the Admiralty specification and undoubtedly this, when it came out, did much to improve the matter. When it was first issued it set a harder task than most manufacturers could meet, but the Admiralty had changed their specification, since then, and specified exactly what was wanted as regards the rise of temperature. Their difficulty as manufacturers was that one man said he wanted 10°F. and another man 7°F., while sometimes, especially in foreign and Continental orders, they were asked as much as 90°F. Therefore, if they made all their machines to suit a standard of 50deg. or 60deg. and competed in a specification for a 90deg. machine, they were giving a very much better machine than their competitors, and got no advantage in consideration for it. He would also like to see something definite decided with regard to the insulation resistance of dynamos. They sometimes had specifications in which people asked for 10 megohms, an absurdly high figure, which was never maintained in practice. Again, others were content with quite a small insulation resistance as measured in megohms, but they specified a high pressure test. Most people were content with 1,000 volts for a 500 volt machine, and this was quite high enough. Such questions as these were the ones to be attacked first. The larger questions, and those presenting very serious difficulties, might well be left until after the smaller ones were settled. Some people seemed to think that to specify constructional details was a good thing, while others were of decidedly the opposite opinion. There were cases undoubtedly where no good purpose could be served by the specification of details. He had seen, for instance, specifications in which the number and width of brushes had been detailed, the width chosen being one which was not adopted by the majority of makers. It only meant that they had to change their patterns and charge a higher price for the machine or lose money by it. With regard to bearings, consulting engineers did not specify the size, but they said the length must be say four times the diameter. If a maker had a bearing 3in. by 11in., it was a very serious matter to make this 3in. by 12in. It meant altering the shaft as well as the bearing. It was rather a temptation to make it 2¾in. by 11in. As a matter of fact, this was sometimes done, to the detriment of the machine and simply to conform to the specification. If consulting engineers realised the trouble they sometimes put the manufacturers to, they would eliminate from their specifications many little things of that kind which, although of but small importance from their own point of view, may yet trouble the manufacturer very much.

Mr. L. BIRKS exhibited the tables shown in the next column, and drew attention to the fact that the periodicity was standardising itself very quickly to 50 ∽ per second. He also drew attention to the very large proportion of 440 volt continuous-current stations started in recent years.

Mr. A. E. LEVIN said that the Continent was usually regarded as a sort of terrestrial paradise, where consultants ceased from troubling and designers were at rest; but standardisation had not made very much progress there. There was not even a standard system of screw threads. Some manufacturers used the Whitworth pure and simple, and others had adopted a metrical pitch, which was the most logical arrangement. In electrical matters, although the periodicity was lower than was usually the case in England, yet there was by no means uniformity in the exact value of the periodicity. In Switzerland stations ran with periodicities of 35, 38, 40, 52, &c. He ventured to differ from Mr. Esson when he said that the question of periodicity was not an important one. [Mr. Esson: Within limits.] Although a difference of two or three periods may not affect motors or transformers at all, yet the difference between say 40 and 55 was sufficient to handicap seriously the stocking of small motors in large numbers. The moral which he believed was to be drawn from this was that standardisation must begin with the larger plant and not with the small. Every large generator which was built and turned out with an abnormal frequency created a demand for motors and transformers which would probably attain a much larger value, expressed in total cost price, than the generator itself, so that the evil once started would go on increasing. The tendency, so very distinctly shown in the tables prepared by Mr. Birks, to bring into use a standard frequency of 50 was a very healthy sign, and no doubt it would make itself still more felt in the future.

Mr. G. L. ADDENBROOKE agreed with Mr. Esson that it was a mistake for the Institution to have endeavoured to define the frequency as it had. There was no doubt that the electrical industry in this country, owing to legislative action, has been forced out of its natural lines. For instance, they knew that the fact that most of the work was done by municipalities had led to a very large number of very young men, who had had very little commercial experience, being appointed as engineers to these municipal stations. The usual run of things was, of course, to start with a consulting engineer, but after a time the County Council thought his services superfluous, and that they had better trust their engineer. These young men, it was true, had been very successful, and they had begun to draw up such specifications as *they* thought proper; but the drafting and handling of a specification were most difficult. At present it did not matter about these things, for as Mr. Hammond had said, the consulting engineers whom the Corporations sometimes liked to consult were really the putters-through of jobs on the most economical lines for their customers. Later on, when the interests of electrical undertakings got larger and huge sums

Central Stations of Great Britain.

Year.	Alternate current.					Direct current.		Totals.
	100 ∽	83 ∽	Oth'r frequencies.	60 ∽	50 ∽	H.T.	L.T.	
To 1888 ...	2	2	...	1	...	...	4	9
1889 ...	3	1	1	...	...	1	5	11
1890 ...	3	1	2	...	...	...	2	8
1891 ...	4	...	2	...	1	1	4	12
1892 ...	1	1	1	1	1	1	4	10
1893 ...	3	2	4	...	...	2	9	20
1894 ...	3	2	4	1	3	1	5	19
1895 ...	2	...	7	...	2	2	6	19
1896 ...	...	...	...	3	2	...	9	14
1897 ...	3	...	...	1	3	1	4	12
1898 ...	...	...	...	1	3	1	11	16
1899 ...	...	...	1	1	6	2	20	30
1900 ...	...	...	...	1	4	...	41	46
Totals	24	9	22	10	25	12	124	226
Number of generators	170	77	160	43	124	92	698	1,364
Total kw.	38,746	16,280	20,614	11,791	25,396	13,852	95,007	221,586
Mean power of stations	1,615	1,810	938	1,179	1,030	1,155	766	978
Mean power ofgenerators	228	212	129	274	202	151	136	162

Frequencies of Alternate-Current Stations of Great Britain.

Frequency. ∽	No. of stations.	No. of generators.	Total power. Kw.
125	1	5	140
100	24	170	38,746
93	2	25	3,953
90	2	20	1,943
87	2	11	1,300
83	9	77	16,280
80	3	23	2,920
77	1	9	425
75	4	13	1,595
70	1	14	4,210
68	1	6	680
67	1	3	375
66	1	3	235
60	10	43	11,791
50	25	124	25,396
40	3	28	2,838
Totals.....	90	574	112,827

of money must be spent on them, perhaps there might be a good demand for really scientific and good advice. On the other hand, he thought that municipal engineers had led to a great deal of work being done in this country, a result which he did not think would have been brought about if shareholders had been risking their own money in the undertakings. He thought the matter was settling itself to some extent, and although Mr. Sellon's Paper would do a great deal of good, it would be a pity to go too far, on the part of the Institution, in endeavouring to absolutely standardise things. It seemed to him that this was more the manufacturer's matter. There were a huge number of things, such as the sizes of shafts and bearings, which the manufacturers should see were the size specified and not left to the man at the lathe. At present as long as it was within $\frac{1}{32}$in. it was passed. There was a great amount of that class of work which could be very well standardised. Mr. Stuart Russell had spoken on the question of standardising traction work with lighting work, but if they were to attempt work of that kind probably they would prefer 600 volts to 500. It would mean an enormous saving of copper and drop, and a great many other advantages.

Mr. C. E. GROVE thought there was a good deal of human nature in this problem, and that there lay the principal difficulty. If an engineer in one place put down plant to do electrical work, he brought into play his own education, knowledge, and opinions; another man in another place, having a similar problem to solve, brought *his* knowledge and education into play. One man might have a fancy for Lancashire boilers, the other for water-tube; one for slow-speed and the other for high-speed engines. With the facts equally well known or equally well at disposal, different engineers would arrive at different conclusions, and he imagined that the electrical industry would have to be a good many years older than it was before these questions would be thoroughly threshed out and anything like a consensus of opinion as to the conditions to determine the use of one type of boiler or engine, or continuous or alternating current, would be arrived at. Until these questions were settled, the broad question of standardisation would have to stand over. A manufacturer who allowed himself to make a range of machines could, and did to a much larger extent than appeared to be known, standardise the parts. As to the question of specialisation, there was room for a good deal to be done in this country, but it must be done by some species of combination or agreement. At present they had electrical works all over the country that were doing nearly everything in one works. They could not sud-

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denly and by the will of anybody be eliminate . There was the capital being employed ; there were the objects and personal ambitions of the capitalists and engineer to be considered. But he thought one result of this discussion was that it might set people moving in the direction of agreeing more or less among themselves that one manufacturer should undertake one class of work only. The man who made switches should be encouraged by other manufacturers who required switches.

Prof. W. E. AYRTON did not agree with Mr. Esson that America was like England in having no standardisation. This idea arose from people not having analysed exactly what was the American system. Quite recently he had discussed the matter with several Continental electrical engineers who, like himself, had travelled in America, and had come to the conclusion that undoubtedly there was in American electrical work something that did not exist in this country—viz., standardisation. Standardisation, from the American point of view, did not in the least mean no progress. They were, as everybody knew, an extremely Radical people, but, on the other hand, they were extremely Conservative. His meaning was that if at any particular time one went to an American electrical factory, they would see there one type of a particular thing, and the manufacturer would not change it for anybody. That was the type ; you could take it or leave it as you like, and if you wanted small changes made the manufacturer said, "No, we cannot do that." You had to take their type or go elsewhere. But all this did not mean that the factory itself was not making experiments and endeavouring to improve the type. But they did not bring the improved type into the market for some considerable period. Mr. Stuart Russell had pointed out that consulting engineers stated all sorts of slightly different requirements which prevented anything like standardisation and prevented our having anything like the American system. But where lay the remedy ? The difficulty arose from the fact that the manufacturers did not tell us that such-and-such were their sizes, and that they would make no other for anyone in the world for the time being. Take the insulation resistance of dynamos. Some engineers wanted 10 megohms. It might be very inconvenient to the manufacturer, but he should state in his circulars or price list that "my dynamos have 5 megohms and no more : I will not guarantee more. If you want me to guarantee more, go elsewhere ; my dynamos have that particular insulation." If the manufacturer would state exactly what were the qualities and properties of every detail of his machine, it would be ridiculous for a consulting engineer to say he wanted something slightly different, although he knew it would cost more to make it. But if the manufacturers did not know, how could consulting engineers—he himself did not—know what was the standard insulation made by each dynamo firm ? [Mr. Esson : There is none.] They why did not Messrs. Johnson and Phillips, Mr. Esson's firm, say they could supply a particular insulation and nothing else ? In the matter of measuring instruments, Mr. Evershed had pointed out that it was perfectly absurd to talk about 2 per cent. accuracy near the zero. But then in the case say of ordinary ammeters or voltmeters measuring instrument manufacturers should say that they guaranteed them correct to 2 per cent. or 4 per cent. at the middle of the scale. That should be the qualification for a particular price of instrument. If they did this, and the consulting engineer specified for 1·8 per cent., the risk of an enormously higher price being asked would be on his own head. But if he had no means of finding out in a general sort of way what was the limit of the accuracy of each manufacturer, then it was quite likely that he might specify a slightly higher limit than the particular firm was accustomed to produce. It seemed to him, therefore, that the manufacturers had the matter very much in their own hands. It was most important that they should get the American standard of standardisation, which did not mean stagnation. It only meant conservative radicalism. Let the manufacturer tell them honestly what were the qualities of every detail of their manufactured articles, and he would undertake to say that the consulting engineers would ask for exactly these qualifications.

Mr. W. B. ESSON remarked that the Board of Trade had already fixed a standard. They said that every dynamo should be capable of withstanding a pressure of 50 per cent. above its working pressure for one hour. But consulting engineers would not have this ; they wanted something else. Sometimes they wanted ten times the working pressure.

Mr. STEPHEN SELLON said that by some peculiar reason the author appeared to say that he (the speaker) and other consultant engineers were banded together in some unholy league to prevent the standardisation of electrical engineering plant. The tone of the paper throughout seemed to be like a voice crying in the wilderness, "Mr. Consultant Engineer, will you please let me standardise!" That was to say, if the consulting engineer had come to stop. He hoped that the author had, during the interval since the reading of the Paper and the previous discussion, taken the trouble to look round the portraits in the Institution there ; and if he had, could he then suggest that the consultant engineer was some mushroom, something which had just cropped up, some sort of noxious poison suddenly introduced into the electrical world, that he was desirous should be immediately obliterated ? They should have some little regard for men who had aided in improving the trade and commerce of this country to the extent the consultant engineer had. What had the consultant engineer to do with standardisation ? Was it not entirely a manufacturer's question ? Prof. Ayrton had pointed out that evening that it was entirely in their hands. If they had a good standardised article, they might be quite sure the consultant engineer would adopt it. The buyer asked that he should be protected by the consultant engineer in such a manner that the plant purchased had gone beyond the experimental stage, and that the manufacturer should not experiment at the buyer's expense. In the field of electric traction many mistakes had been made by manufacturers who, instead of starting where Continental and American manufacturers had ended, had commenced in this country at the bottom of the ladder, and consequently they had all the failures that the Continental and American people had had six and ten years ago. When electric traction began in this country, no manufacturer was ready for it. No machines could be said to be reliable for the purpose for which they were intended, and the consultant engineer was ever bound to specify what he wanted for his own particular ends, or else he had to buy or specify something which could be obtained better on the Continent. Much of the tramway plant that was put up in this country in the first instance had been scrapped. He had been engaged himself during the last few years in scrapping the plant which had been put in in the past on tramways, and had installed something of a modern and much more satisfactory type. They were now going in largely for electric traction plant of Continental design, because the manufacturer had neglected to take the advice and also the experience of Continental enterprise and standardise something worth standardising. If the consulting engineer would state his wants, the manufacturer will supply the next best thing to it, said the author ! If there were certain manufacturers to make certain things, and only these certain things, all well and good ; but at present manufacturers seemed to be ready to supply anything, whether they were able or not. Where the consultant engineer came in was that he was able by experience to know the best plant for the purpose to be obtained. If there were no rogues, they might be sure that no consulting engineer would take the trouble to write a specification. He was not necessarily backing up the young engineer, who was more capable of playing "50 up" than getting out a specification. Neither was he trying to champion the cause of the engineer who was employed by the financier and contractor alike, and who was there simply as a respectable blind to hide the real relationship between the buyer and seller. But he was championing the cause of those who had assisted and made the present electric traction industry what it was now. He was championing the cause of those who had spent their lives in so working up the tramway industry and bringing legislation to such a condition as to make it possible, and the result of this was now filling the workshops of the manufacturers. To those people the author had been unjust. They were now going in for continuous-current machines, but there were people who would agree with him that the time would yet come when continuous-current machinery would depart from use in traction work, and that three-phase must take its place. If so, it was not yet time to standardise. Mr. Robinson had completely answered the author. He had shown that he had been able to standardise in spite of the electrical engineer, that he had received every assistance from the electrical engineer, and that the reputation of his firm had been such that the engineers had been able to leave the details to him.

Mr. J. E. KINGSBURY disagreed with the previous speaker that the author had been unjust. He (the speaker) considered that the Paper took a very generous view of the respective positions of the engineer and manufacturer. At the same time, he thought that Mr. R. P. Sellon was wrong in trying to arrive at standardisation from demand, whereas in America it was the other way about. It would be a great advantage if there were a little more confidence between engineer and manufacturer.

Mr. R. P. SELLON, in reply, said it was a task of some difficulty to compress within eight or ten minutes a connected reply to the wide amount of ground that had been traversed in this discussion and the many important side issues raised. The essential points might be classed in the following logical order : (1) Whether standardisation was backward in this country relatively to the great trade rival countries who were competing with us. (2) Whether standardisation was desirable. (3) Whether it was practicable, and how. And (4) whether the Institution ought to take any part or action in the matter. What he thought was the fairest interpretation of the word standardisation was : that standardisation meant all such understandings or agreements among buyers as to ends as would enable manufacturers to go in for quantitative production. It was the standardisation of ends with the object of quantitative production. From that point of view he thought that upon the whole the discussion had confirmed the view that standardisation in that sense was further advanced upon the whole in America and on the Continent than here. Mr. Levin, who was well qualified to speak for the people on the Continent, had thrown some doubt as to whether standardisation there was in advance of us here. On the other hand, a number of speakers agreed in the proposition that it was in advance. Gen. Webber had thrown doubt upon the desirability of standardisation on the ground that, judging from America, it was not in the consumers' interests, because there they had those big combinations which practically dictated their terms to the buyer. He ventured to traverse that statement, because he thought that those who knew the facts of the intense competition between the great rival combines in America, and the way in which it had tended to reduce prices, were in a position to state that standardisation, even in America, had been in the consumers' interests. The body of the members who had spoken regarded standardisation as desirable. On behalf of the manufacturers, Messrs. Crompton, Ferranti, Blackburn, and Slater Lewis had spoken; whilst Mr. Hammond and Mr. Addenbrooke represented the consulting engineers, with Mr. Leonard Andrews and Mr. Stewart Russell on behalf of the user. He then passed on to the third heading—viz., Was standardisation practicable ; and if so, in what form ? Several speakers, and prominently among them was Mr. Ferranti, had taken the view that it was too late. On the other hand, Mr. Andrews expressed the opinion that even now central stations were very much in their early stages, and that this was the time to make changes rather than later on, when the loss of capital would be very much greater because the station would have grown very much larger. At any rate, in electric traction and electrical power distribution on a large scale it was by no means too late. The manufacturer had not had the courage to do as the Americans did and as Prof. Ayrton had pointed out, standardise the goods he manufactured and say to the buyer, "You can take it or leave it." The difficulty of the manufacturer in this country to do this had been very much greater than in America, because in America the manufacturer and his interests were largely in a position to dictate to the buyer. At the same time he would frankly state his view that the manufacturer had in the past been in a very considerable measure the cause of the absence of standardisation. If it appeared to

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any of the members that his Paper was in the nature of an unfair criticism upon consulting engineers, it was quite against his intention. His desire was not to bring forward this matter in a sectional interest, either of the manufacturer or the consulting engineer, or of any particular group in the industry, but to endeavour to make a fair and impartial criticism of the causes which in this country were responsible for the absence of standardisation. To say that the responsibility lay at the door of the consulting engineer was to say that which he never intended. Far from this, every manufacturer would gladly own the debt he was under to the many able consulting engineers who had guided the industry in the past. In that connection he need only mention Dr. Hopkinson for them to appreciate at once what a debt not only the manufacturers but the industry as a whole owed him for the guidance he had given to manufacturers. The last point was as to whether the Institution should concern itself with the question of standardisation. In this matter he could only say that he agreed with those who took the view that it was against the spirit of Englishmen to have regulations imposed upon them if they were unwilling to receive them. Just as they could not make people virtuous by an Act of Parliament, so they could not make people standardise by regulations; and he saw no hope for success in the consideration of this matter by a committee of the Institution unless it were approached with a willing mind by both manufacturers and consulting engineers. Such a large majority of those who had spoken seemed to consider that some move towards standardisation should be made, that this made it worth the while of the Institution to see whether some step could be taken in this direction. All were thoroughly alive to the crisis—he ventured to think it was a crisis—through which the whole industry was passing in Great Britain. There were many things responsible for this, such as the great labour problem and the proper organisation of works, but a discussion upon these points would be rather academic. But this question of standardisation was one which they could not merely discuss but take action upon, and it was for this reason that he had brought this Paper before them, not merely for the sake of reading a Paper, but because he was hopeful that this matter could be promptly and effectively dealt with by the Institution to the advantage of the electrical industry at large.

The PRESIDENT (Prof. S. P. Thompson) then proposed a vote of thanks to Mr. Sellon, which was heartily responded to, and the discussion terminated.

PHYSICAL SOCIETY.

At an ordinary meeting, held Feb. 23, 1900, Prof. S. P. Thompson, F.R.S., foreign secretary, in the chair, Prof. R. W. Wood, of the University of Wisconsin, U.S.A., exhibited and described:—

1. "Photographs of Sound Waves and the Kinematographical Demonstration of the Evolutions of Reflected Wave-Fronts."

The sounds were produced by electric sparks and photographed by means of the light emitted by carefully timed subsequent sparks according to the method described in the *Phil. Mag.* for last year. The photographs included: (*a*) The reflection of a spherical wave, as a spherical wave from a plane surface. (*b*) The reflection by an ellipse of circular waves from one focus, and the concentration of the waves as circular waves at the other focus. (*c*) The plane wave-front formed by the reflection of a spherical wave at a parabolic surface. (*d*) The wave-front formed by a spherical wave incident on a spherical surface. (*e*) The wave-front formed by a plane wave incident on a spherical surface. In cases (*d*) and (*e*) the wave fronts are complicated and contain cusps. Prof. Wood pointed out that the paths of the cusps on the wave-fronts traced out the caustic curves.

In the following cases the wave-fronts were drawn for 100 successive positions, and the evolution of the reflected wave was made clear by means of a kinematograph: (*a*) Plane wave on a hemispherical mirror; (*b*) spherical wave on a hemispherical mirror; and (*c*) circular wave inside a complete circular mirror.

2. "A New Scudoscope."

In this instrument the real and inverted images formed by two convex lenses are viewed stereoscopically. The inversion of the object viewed causes the relief to be reversed.

3. "Diffraction Colour Photographs."

Prof. Wood showed some coloured phothographs taken by his diffraction process. The principle of the method is based upon the tri-colour theory. Different colours are produced by gratings so ruled and arranged as to throw upon the eye the particular constituents of the required colours. The arrangement of gratings necessary to produce a coloured picture is obtained by photographing properly spaced gratings through red, green, and blue chromograms of the object. The superposition of one grating upon another which occurs in this process gives rise to an in-and-out-of-step arrangement which produces secondary spectra. These, however, seldom affect the picture to any serious extent.

4. "Artificial Parhelia."

When printing fine gratings upon gelatine, if the film is too thick no point is formed, but the gelatine warps. If such a film is placed in a converging beam the central image is accompanied by four marked concentrations of light situated at the extremities of two diameters at right angles. An examination of one of these plates with a microscope shows that there is a ridge for every third line of the grating, and that the plate is crossed at right angles to these line by irregularly spaced cross ridges.

Prof. Wood also exhibited some photographs taken by zone plates, a silvered copy of a Rowland grating, a photograph of a dynamite explosion, the motion of a ball in its flight, and the anomalous dispersion produced by a cyanine prism.

Mr. BOYS gave some details concerning the photograph of the explosion shown.

Prof. EVERETT expressed his interest in the demonstrations.

Prof. HERSCHEL asked if the photographs of sound waves after reflection had been verified by comparison with waves on mercury.

Mr. WATSON pointed out that this could not be done, as it is impossible to get a solitary wave on the surface of mercury. Owing to the dependence of velocity on wave length, any such solitary wave draws out into a train of waves.

The CHAIRMAN proposed a vote of thanks to Prof. Wood, and announced that by invitation of Prof. Callendar a special meeting will be held at University College on March 2nd.

The meeting then adjourned.

At a special meeting of the Physical Society, held by invitation of Prof. Callendar in the physical laboratory of University College, on Friday last, Prof. G. Carey Foster, F.R.S., vice-president, in the chair, Dr. F. G. Donnan read a Paper on

"The Relative Rates of Effusion of Argon, Helium, and other Gases."

The introduction to this Paper contains a short account of the work which has been done on the effusion of gases. This is followed by a theoretical investigation of the subject, upon the assumption that the ideal gas laws are obeyed and that the back pressure never rises above a certain fraction of the internal pressure. This gives rise to formulæ which are different from the square-root-of-the-density law of Graham. The formula derived from Hugoniot and Reynolds' work gives the ratio of the times of effusion of two gases whose specific heat ratios are 1·408 and 1·67, equal to 1·06 times the square root of the ratio of the densities. The constant derived from Parenty's work is 1·084. The theory therefore indicates that argon should effuse faster than would be calculated from Graham's law. The gases used were oxygen, hydrogen, nitrogen, carbon monoxide, carbon dioxide, cyanogen, argon, and helium, and they effused through small holes pierced in platinum foil. When the holes are large compared with molecular dimensions, the phenomenon is one of efflux on a small scale. In the actual experiments this was the case, although the holes were sufficiently small to cause appreciable viscosity effects. By employing two or more observations in conjunction with the relative viscosities of the gases used, an apparatus constant was determined which allowed these effects to be eliminated. The observations showed that argon effused 3½ per cent. faster than as calculated from the densities alone. This agrees qualitatively with theory, and affords a confirmation of the high specific heat ratio of argon. Hydrogen, oxygen, and carbon monoxide effuse in the manner predicted by the theory for gases having the same or nearly the same specific heat ratios. Carbon dioxide, when compared with oxygen, appears to effuse 1 per cent. faster than as calculated from the densities. This result is not in accordance with the adiabatic theory of the efflux of ideal gases. The results for helium are not uniform, but show that its behaviour is unlike that of argon, a result not foreseen by the theory. If account be taken of the deviation of ordinary gases from the ideal laws, it is possible to obtain an expression for the efflux which contains a correction term involving the constant K of the Joule-Thomson effect. The sign of this correction term shows that a real gas will effuse more rapidly or more slowly than an ideal gas of equal density and specific heat ratio, according as K is positive or negative. The suggestion is made that possibly the anomalous results obtained with carbon dioxide and helium may be thus explained. The deviations of the observed results from the results calculated for an ideal gas are, in the case of carbon dioxide, in qualitative agreement with the theory proposed. In the case of helium they would be so if that gas possesses a negative K.

Lord RAYLEIGH congratulated the author, and pointed out that in the case of very small apertures the gas laws might not be obeyed. The ratio of the dimensions of the aperture to the length of the mean free path determined this, and not the ratio of aperture to molecular dimensions.

Prof. RAMSAY and Prof. EVERETT expressed their interest in the work.

Dr. DONNAN thanked Lord Rayleigh for his correction, and stated that the apertures used were about $\frac{1}{10}$mm. in diameter.

Mr. E. C. C. Baly read a Paper on

"The Distillation of Liquid Air and the Composition of the Gaseous and Liquid Phases."

From the experiments described in this Paper the author has drawn curves showing the relation between the composition of the gas evolved by boiling liquid air and the temperature, and between the composition of the liquid and the temperature, both at constant (atmospheric) pressure. These curves enable the temperature of boiling liquid air to be at once accurately determined by means of

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an analysis either of the liquid or of the gas evolved. The measurements of temperature were made with a Callendar compensated constant-pressure hydrogen thermometer. The correction for the contraction of the glass bulb was determined by measuring directly the linear expansion of glass between—109°C. and 20°C. This was found to be 0·0000073, Regnault's measurement between 0deg. and 10deg. being 0·0000085. The values for the boiling points of oxygen and nitrogen agree fairly well with those given by Olszewski and Estreicher. Boiling nitrogen has a great tendency to superheat. This can be obviated by passing a rapid current through the boiling liquid, or by dropping in pieces of copper. There does not appear to be any connection between the ratio of the vapour pressures and the composition of the gaseous phase in the distillation of oxygen and nitrogen at constant pressure. It is proposed to investigate the distillation at constant temperature.

Prof. RAMSAY drew attention to the uses of liquid air for carrying on researches at low temperatures. It is non-explosive, easy to work with, and is easily kept either by means of a vacuum jacket or by surrounding it with cotton wool.

Prof. CALLENDAR referred to the question of superheating, and stated that the constant pressure thermometer was more accurate than the constant volume one for measuring low temperatures.

A Paper on

"The Reversibility of Galvanic Cells,"

by Mr. T. S. MOORE, was read by Dr. LEHFELDT. In these experiments the reversibility of cells such as the Daniell and the Clark, which are assumed to be reversible, was tested by allowing the cell to send a current and by sending a current through the cell. The E.M.F.s of the cells were determined by means of a Crompton potentiometer, and from the E.M.F.s on open and closed circuits the internal resistances of the cells were calculated.

Prof. S. P. THOMPSON asked if experiments had been made upon Leclanché cells where the products of the action escape.

Dr. LEHFELDT said that experiments were not made upon these cells, because they were known not to be reversible.

A Paper on

"The Damping of Galvanometer Needles,"

by Mr. M. SOLOMON, was postponed until the next meeting.

The Society then adjourned until March 9.

AN EXPERIMENTAL RESEARCH ON SOME STANDARDS OF LIGHT.*

BY J. E. PETAVEL.

The standards of light may be divided into two main divisions—viz., (1) flame standards; (2) incandescent standards. The first class comprises such standards as depend for their constancy on the rate at which chemical combination is going on. Almost all the standards in actual use come under this division. The British candle, the Methven standard,† the Harcourt‡ pentane standard, the Hefner-Alteneck§ amyl acetate lamp, the Carcel lamp, and the acetylene‖ burner are among the best known. Apart from the large number of independent investigators who have carried out researches as to the relative merits of these sources of light, reference may be made to the reports of several committees which have been appointed in this and other countries to investigate the subject.¶ The general conclusions reached may be fairly summed up by saying that the pentane gas standard and the amyl acetate lamp are the lights which, from every point of view, have been found most satisfactory. Of the two, the Hefner-Alteneck lamp is the better known, and has been the subject of the more complete experimental study; it may be taken as fairly representative of its class. The light emitted, as in the case of all the other flame standards, is seriously affected by atmospheric impurities. Liebenthal* has shown that, if x represent the quantity of water vapour in litres per cubic metre of air, the light L sent out will vary according to the formula—

$$L = 1{\cdot}049 - 0{\cdot}0055x.$$

This will cause a variation of about 4 per cent. from one season of the year to another. The variations due to this cause are stated to be still more marked in the Harcourt and Carcel lamps.

Again, if x_1 represent the quantity of carbon dioxide present in the atmosphere, measured in litres per cubic metre, the light will be given by the formula—

$$L = 1{\cdot}012 - 0{\cdot}0072x_1.$$

Variations in the height of the flame are of the greatest importance. If h is the height in mm.—

$$L = 1 + 0{\cdot}025\,(h - 40),$$

or

$$L = 1 - 0{\cdot}030\,(40 - h),$$

according as h is above or below 40mm.† The mean variation is therefore over 2½ per cent. per mm. Owing to the bright halo which surrounds the flame, it is by no means easy to adjust the height correctly.

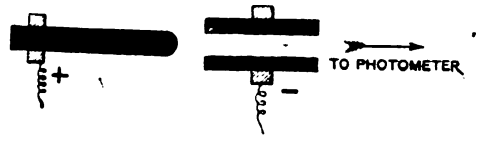
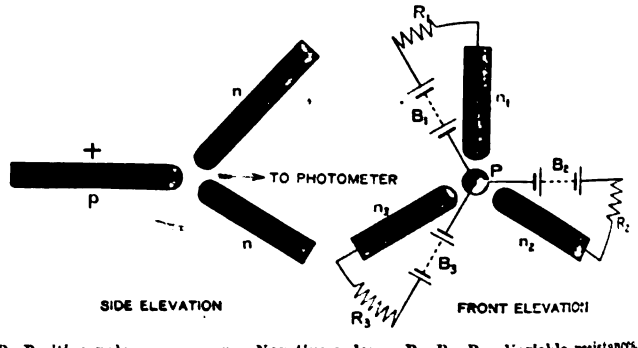


FIG. 1.

Finally, although it was at first stated that the degree of purity of the amyl acetate had no very considerable influence on the light, this has of late been denied, some authorities going so far as to state that sufficiently pure amyl acetate cannot be obtained in France.‡ These facts will suffice to show that the variations are mainly due to causes inherent in this class of standard. Some of the difficulties can be obviated by providing a chemically pure atmosphere, and researches are being carried out in America in this direction, but it is obvious that any such improvement will involve a considerable complication of the apparatus.

Incandescent Standards.

In the case of standards of this class, the constancy of the light depends essentially on the constancy of the temperature at which the radiating body is kept, and on the constancy of the emissivity of the body of that temperature. The temperature may be fixed by some definite physical phenomena, as in the Blondel and Violle standards, or it may be determined in a more or less arbitrary manner, as in the Lummer and Kurlbaum standard. Any solid substance that would not disintegrate at a temperature of about 1,700°C. might, *à priori*, be chosen as a radiator. It has, however, been shown that most of the oxides when maintained at these high temperatures undergo a change in their emissive properties, and cannot therefore be used for the purpose we have in view.§ The choice thus seems restricted in practice either to carbon or to one of the metals of the platinum group.



P—Positive pole. n_1, n_2, n_3—Negative poles. R_1, R_2, R_3—Variable resistances. B_1, B_2, B_3—Batteries.

FIG. 2.

Before passing on to the experimental part of the work, it may be well to recapitulate the necessary qualifications of a standard of light. The requirements may be briefly summed up under three heads:—(1) The standard must remain constant. The slow periodic variations of the amyl acetate lamp which extend over a period of several months are as much to be avoided as the flickerings of the candle or the hourly changes of the Carcel lamp. (2) The standard should be

* Paper read before the Royal Society.

† *Journal of Gas Lighting*, Vol. XL., p. 42, 1882.

‡ See Brit. Assoc. *Proc.*, 1877, p. 51, and 1898, p. 845; also "Report of the Standard of Light Committees," as below.

§ *Elektrotechnische Zeitschrift*, Vol. V., p. 20, 1884; also *Electrical Review*, Vol. XLII, p. 759, 1898.

‖ Proposed by Violle, Ch. Féry and Fessenden (see *Comptes Rendus*, Vol. CXXII., p. 79, 1896; also *Comptes Rendus*, Vol. CXXVI., p. 1192, 1898).

¶ See Blondel's Report to the Congrès International des Electriciens at Geneva, 1896; Report of the Standard of Light Committee's meeting of the Institute of Gas Engineers, May, 1895, *Journal of Gas Lighting*, Vol. LXV., p. 1007, 1895; Report of the Standards of Light Committee to the British Association, 1888, p. 39; Dibden's Report to the Metropolitan Board of Works, 1885; Gas Institute Committee, 1884, and Board of Trade Committee; Preliminary Report of the Sub-Committee of the American Institute of Electrical Engineers, *Transactions*, Vol. XIII., p. 135, 1896; Rapport der Photometrie Com. der Vereeniging van Gasfabrikanten in Nederland. *Journ. fur Gasbeleuchtung und Wasserversorgung*, Vol. XXXVII., p. 613, 1894.

* *Elektrotechnische Zeitschrift*, 1895, Vol. XVI., p. 655.

† *Journ. fur Gasbeleuchtung und Wasserversorgung*, Vol. XXXI., p. 533, 1888; or *Electrotechnische Zeitschrift*, Vol. IX., p. 96, 1888.

‡ "Rapport sur les Unités Photométriques," A. Blondel, Congrès International des Electriciens, Genève, 1896.

§ Nichols and Crehore, *Trans.* Amer. I.E.E., Vol. XIII., p. 190, 1896.

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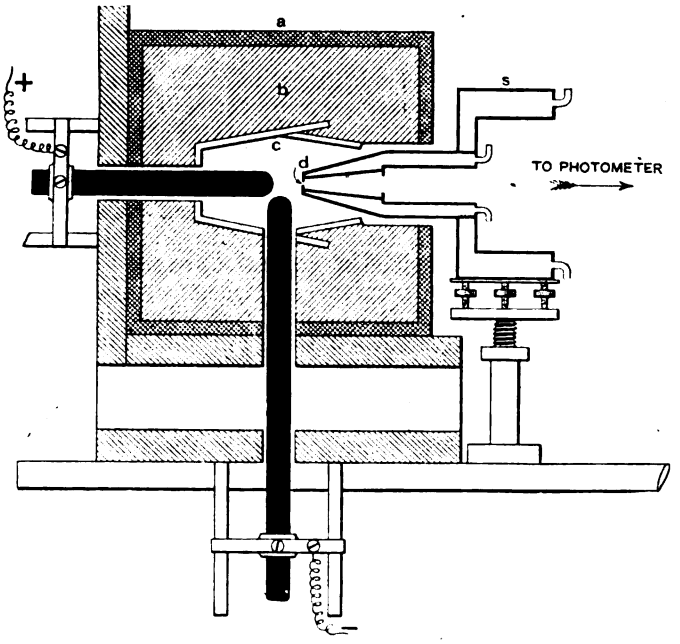
reproducible. This condition is satisfied when the standards reconstituted by independent investigators show no measurable variation between one another. (3) The light emitted should be as nearly as possible of the same spectral composition as that of the chief artificial lights now in common use.*

On the Intrinsic Brilliancy of the Crater of the Arc.

For many years it has been noticed that the area of the crater of an electric arc when burning between carbon poles increased about in proportion to the current; also that the light emitted increased in the same ratio as the area of the crater.†. These and other facts led to the conclusion that the temperature of the crater remained constant. The hypothesis was put forward that this temperature was the boiling point of carbon, this theory being supported by the experiments made in 1892 by J. Violle.‡. In the same year it was proposed simultaneously by Swinburne, S. P. Thompson, and Blondel§ that the crater of the arc should be used as a standard of light, Blondel publishing a series of experiments illustrating the way in which the new standard might be used. In 1894 A. Trotter‖ proved that when the arc is not silent the crater is formed by a point or line of very high intrinsic brilliancy rotating at a speed of from 50 to 450 revs. per sec. The existence of the above-mentioned phenomenon forms a serious objection to the use of the electric arc as a primary standard, but it does not, *per se*, render its use impossible.¶ Finally, the variation of the intrinsic brilliancy of the crater is a question which in itself offers considerable interest.



a—Asbestos box. b—Lining of refractory bricks. c—Graphite crucible. d—Diaphragm. s—Screen.

FIG. 3.

The points on which the present work bears are threefold—(1) What is the average intrinsic brilliancy of a normal (silent) arc? (2) When the conditions are carefully specified, are the variations still too great to allow of the use of this source of light as a standard? (3) What variations can be obtained by the use of excessive currents and current densities, and by surrounding the arc with an enclosure maintained at a very high temperature. To obtain consistent results the observations must be made on a very small area selected from the central portion of the crater. The diaphragm used for this purpose is shown in Fig. 3. The opening, *d*, is 1·47 sq. mm. in cross-section.**

The diaphragm is shaped much like the tuyere of a blast furnace, and being kept cool by a water circulation, it can be placed within a very short distance of the crater of the arc.

The next question involved was the determination of the best relative position of the carbons. In the usual arrangement of the arc the centre of the crater is hidden by the negative carbon. A modification of this arrangement, used by Blondel, which consists in slanting the carbons and placing the positive slightly behind the negatide, was found not to be entirely satisfactory. An attempt was made to take the observations through a hole drilled out of the negative carbon (see Fig. 1), but when the arc was started this hole became filled with mist, and the plan had to be given up. Fig. 2 shows diagrammatically the next arrangement which was tried. The carbons n_1, n_2, n_3 are negative, and form the edges of an equilateral pyramid, the axis of which is in the prolongation of the positive carbon P. The summit of the pyramid is at the point P. The crater formed on the positive carbon by these three arcs is in full view, and good results might have been obtained in this manner. Unfortunately, this disposition had to be abandoned, as it soon became evident that it was impossible for one observer to adjust the currents in the three independent electrical circuits, to feed up the four carbons, and to make all the electrical and photometric readings.

The disposition which was finally adopted is shown in Fig. 3. The diaphragm *d* screws into a screen, *s*. This screen is supported on a system of pivots and levelling screws, so that it can be raised, lowered, or turned round a vertical or horizontal axis. The opening *d* can thus be directed to any portion of the crater. The positive carbon is horizontal, and so placed that its axis coincides with the axis of the photometer. Two distinct series of experiments were carried out—one with the arc placed in a metallic enclosure kept at about 20°C. by a water circulation, the other in the enclosure shown in Fig. 3. The temperature of this enclosure varied from the melting point of silver to near the melting point of platinum, according to the amount of power expended in the arc. Referring to Fig. 3, *c* is a carbon crucible surrounded by a thick layer, *b*, of firebricks and refractory clay. The outer covering *a* is of asbestos. Both the high and low temperature enclosures were provided with a small camera obscura (not shown in the figure), by aid of which the relative positions of the carbons could be adjusted and the length of the arc measured. "Apostle" carbons were used in all the experiments. The size of the positive carbon varied from 6mm. to 25mm. in diameter. To obtain reliable results a sufficient current density must be used to gave a fairly large crater. The arc must also be sufficiently stable for the crater to remain some considerable time without shifting its position. Finally, it is desirable that the arc should be burning in a normal manner, and therefore neither hissing nor roaring. Given these conditions, it is impossible to vary either the current, the electromotive force, or the length of arc within very wide limits.

In the experiments recorded in Table I. the mean intrinsic brilliancy is 147 c.p. per sq. mm.; the variations from the mean amounted to 10 per cent. Table II. gives experiments made under similar conditions, but with the enclosure in which the arc was burning at a temperature of over 900°C. The average intrinsic brilliancy calculated from this table is 143, or about 3 per cent. lower than when the enclosure was at the ordinary temperature. It would, however, be unwise to attach too much importance to this change. The difficulty of obtaining consistent results is considerable, and a 3 per cent. variation is well within the experimental error. The conclusions we have reached may be summed up as follows: (1) The intrinsic brilliancy of the crater of a silent arc is about 147 c.p. per sq. mm. (2) Even when the most favourable conditions are selected, and the intensity of current and the length of the arc are maintained constant, it is difficult to obtain consistent results, variations of over 5 per cent. being by no means unfrequent. The crater of the arc does not, therefore, possess the qualities required of a standard. (3) Variations in the size of the carbons, in the intensity and density of the current, in the length of the arc, and in the total power expended (as long as the arc is kept silent), will not cause the intrinsic brilliancy to vary more than $\frac{1}{10}$ per cent. on either side of the mean. (4) No sensible variation in the intrinsic brilliancy, and therefore in the temperature of the crater, is produced by placing the carbons in an enclosure maintained at over 900°C. With regard to the constancy of the temperature of the crater, these results are not without importance.

Having this question in view, it was necessary to determine what were the effects of extreme variations of current density and power. In Tables III. and IV. will be found the results of observations taken when the arc was hissing.* It will be seen that the current

* Strictly speaking, it is only when two lights are of the same spectral composition that the ratio of their intensities can be expressed by a single figure.

† Prof. S. P. Thompson's Cantor Lectures, 1895; see also "The Electric Arc," by Mrs. Ayrton, *The Electrician*, Vol. XXXIV., p. 399, 1895.

‡ *Journal de Physique*, third series, Vol. II., p. 545, 1893, and *Comptes Rendus*, 1892, p. 1274.

§ See *Proceedings* of the International Congress at Chicago, 1893, pp. 259, 267, 315.

‖ Roy. Soc. *Proc.*, 1894, Vol. LVI., p. 262; see also "Effect of Pressure on the Temperature of the Arc," E. Wilson and C. F. Fitzgerald, Roy. Soc. *Proc.*, Vol. LVIII., p. 174, 1895; Vol. LX., p. 377, 1897; see also the account of the discussion on this subject on Feb. 19, 1897, at the Société Française de Physique.

¶ On this subject see Capt. Abney, *Journal* I.E.E., Vol. XXVIII., p. 443, 1899.

** It has been shown by Prof. S. P. Thompson (see *Phil Mag.*, Vol. XXXVII., p. 120, 1893) that when diaphragms of very small diameter are used the thickness of the plate in which the aperture is pierced introduces a serious error in the measurements. The difficulty was avoided by counter-sinking the opening.

* The word "hissing" is used here as being the generally accepted term. It is only when the current density is small that it is actually descriptive of the sound made; as the current increases, the pitch rises, until with a very short arc and a current density of about 1 ampere per sq. mm., the sound is between a whistle and a scream. The arc then assumes a very peculiar aspect, a pointed blue flame, like the flame of a blow-pipe, being sent out from the crater. This effect was most marked

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Table I.—"*Silent*" *Arcs. Enclosure at about 20°C.*

E.M.F. in volts.	Current in amps.	Power in watts.	Diam. of the positive carbon in mm.	Current density in amp. per sq. mm. of cross-sectional area of positive carbon.	Length of arc in mm.	Intrinsic brilliancy of the crater in candle-power per sq. mm.*
65·0	8·1	526	8	0·161	4 8	136
64·5	7·0	452	8	0·139	...	141
72·0	10·3	742	8	0·205	6·0	143
70·3	7·3	513	6	0·258	...	147
61·7	6·0	370	6	0·212	5·1	154
62·0	9·1	564	6	0·322	6·0	160

Table II.—"*Silent*" *Arcs. Enclosure above 900°C.*

83·0	11·0	913	8	0·219	...	136
57·0	10·9	621	15	0·061	...	142
61·0	8·6	525	8	0·171	6·0	152

Table III.—"*Hissing*" *Arcs. Enclosure at 20°C.*

70·0	15·8	1,106	8	0·314	4·8	136
42·0	21·6	907	8	0·410	1·2	143
53·0	25·8	1,367	8	0·514	2·9	157
44·0	50·0	2,200	15	0 283	...	160

Table IV.—"*Hissing*" *Arcs. Enclosure above 900°C.*

79·0	18·0	1,422	15	0·102	...	119
45·6	42·0	1,915	15	0·238	...	121
60·3	18·6	1,122	25	0·033	...	130
52·0	55·0	2,860	25	0·112	...	133
41·0	43·4	1,779	25	0·088	...	137
50·0	39·3	1,965	15	0·222	...	142

* Each of the figures of this column is the mean of a number of photometric observations.

varied from 6 to 50 amperes, the current density from 0·03 to 0 51 ampere per sq. mm., and the power from 370 to 2,800 watts. The lowest photometric readings gave 119 c.p, and the highest 160 c.p. per sq. mm.

If we assume that the formula†

$$t - 400 = 889 \cdot 6^{c_2}\sqrt{b}$$

(t=temperature in degrees centigrade, b=intrinsic brilliancy in candle-power per sq. cm.) holds good for carbon at these high temperatures, the above change in candle-power corresponds to a variation of temperature of from 3,866°C to 4,018°C. The total alteration in absolute temperature thus works out at 4 per cent. Observations made on silent arcs (Tables I. and II.), reduced in the same manner, give the extreme limits of temperature as 3,935°C. and 4,018°C., or a change of 2 per cent. in the absolute temperature. These variations are somewhat greater than we should meet with in the case of substances boiling at ordinary temperatures. It must, however, be borne in mind that even in the case of a silent arc the crater is the seat of several secondary phenomena, which under certain circumstances may affect the boiling point.‡ The term boiling point is in itself misleading, as it seems possible, if not probable, that at atmospheric pressure carbon does not become liquid, but like carbon dioxide, passes direct from the solid to the gaseous state. It has frequently been stated that impurities cannot affect the temperature of the crater, as all known bodies become gaseous at a lower temperatute. The experimental data to substantiate this are entirely wanting; silica, lime, alumina, magnesia, and other substances are solid at the temperature of melting platinum, and it is difficult to predict at what temperature they volatilise.

Taking everything into consideration, it may therefore be said that the present experiments confirm the theory that the crater of the arc is at the temperature of volatilisation of carbon. The earliest determinations of the intrinsic brilliancy of the crater were made in 1878 at Chatham, under the direction of the Royal Engineers' Committee.* The results varied from 39 c.p. to 442 c.p. per sq. mm., the mean value being 110. With regard to more recent researches, Trotter gives the intrinsic brilliancy as 64 c.p., Weber as 70 c.p., and Blondel as 158 c.p. per sq. mm. With the exception of those of Blondel, all previous results are very much lower than the values I have obtained. The discrepancy may be attributed to the fact that instead of using a diaphragm to select the rays from the centre of the crater, the first-named observers estimated the total area of the crater and compared it with the total amount of light.

(To be continued.)

when the high temperature enclosure was used. With the above current density the entire carbon becomes white hot and burns away with great rapidity; an increase in the intrinsic brilliancy seems also to take place. Unfortunately, it was not found possible under these circumstances to obtain reliable photometric observations.

† *Phil. Trans*, Vol. CXCI., A, p. 515, 1898.

‡ Mrs. Ayrton, "On the Hissing of the Electric Arc," *Journal* I.E.E., Vol. XXVIII., p. 401, 1899; also Dr. J. A. Fleming's remarks during the discussion of Mrs. Ayrton's Paper, p. 439.

CORRESPONDENCE.

ELECTRIC TRACTION CURRENTS AND SUBMARINE CABLE WORKING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In reading your leading article of last week, which very fairly reviews my Paper on this subject, and which also appears in your issue of March 2, I observe that you fall into the very common error of substituting the word *knot* for nautical mile or *naut*.* The former signifies a *rate*, whilst the latter merely indicates a *length*. For example, when we speak of a ship as a 10-knot boat, we mean that her average speed is 10 nauts per hour; whereas, when we desire to indicate the distance which a ship has gone or the length of cable laid between any two places, without any reference whatever to the time taken to do so, we say so many nauts or nautical miles.

Further on (in the second paragraph of the first column of p. 659) I find that you are perfectly correct so far when you say "We may point out, however, that in the former case [meaning the Madras electric tramway disturbances] an earth cable to sea was not laid as he states, but only a parallel underground wire." But you add, "which was found in this particular case to be sufficient. . . ." I ask, Has this proved *absolutely* sufficient up to the present time, under the favourable or unfavourable circumstances, just as you like to consider the matter? I have heard that disturbances are sometimes experienced. With regard to the Coney Island case, I understand that a short sea cable was laid by Messrs. Siemens Bros. and Co., in addition to the underground one one between the cable house and the New York office of the Commercial Cable Co.

Some rather interesting and knotty points (in regard to the precise action of stray currents when passing along the sheathing and their inductive *versus* leakage effects on the receiving signals) were started during the discussion of my Paper at the last meeting of the Institution of Engineers and Shipbuilders in Scotland, which caused me to carry out several experiments. The illustrated description of these experiments and the results obtained will appear in this month's *Transactions* of the above-named Institution. If not conclusive, perhaps you or some of your readers will kindly point out wherein they are deficient or defective?—Yours, &c.,

Glasgow, March 6. ANDREW JAMIESON.

ENCLOSED AND OPEN ARC LAMPS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It is somewhat disappointing to note that at the first meeting of the Glasgow section of the Institution of Electrical Engineers there was no one present to answer the misleading statements advanced by Mr. Sayers. He begins by talking of the comparison as a practical one, and goes on to describe his experiments: these appear to be based on the old shadow test, which is well known to be unpractical as far as results are concerned. He does not even say whether the figures are the mean of readings taken at different angles.

We have ourselves made a number of attempts to arrive at a fair comparison on what we should term the theoretical basis adopted by Mr. Sayers, but found it impossible to arrive at any basis of comparison between the two, after making allowance for the two globes, for the difference of the disposition of the light at different angles, and for the exact voltage which gives the best results with different carbons.

If, however, we are really to come to practical results, we cannot do better than refer to what has happened in America, which is the home of the enclosed arc lamp. There it has been

* *See* ninth line from the foot of the first column on p. 658.

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clearly shown that the enclosed arc has not only replaced the open arc lamp in many important places, but that the fresh orders that have been placed have been almost entirely for enclosed arcs.

We ourselves, who have had to fight the uphill game of introducing the enclosed arc lamp industry into England, have had to make practical demonstrations from time to time to show that the laws of nature in England are the same as they are in America. We have had rooms full of workpeople requiring a good light lit alternately with open arc lamps and enclosed arc lamps, keeping the total watts consumed the same in each case; and it has been left to the users to say which they would have. The result has invariably been the same—viz., that they declared in favour of the enclosed arc lamp, as giving a better light. This we attribute to the fact that the diffusion is much better, also that the colour is different, as no doubt Mr. Sayers noticed when he was trying to make shadow tests.

On these theoretical considerations, however, we can merely throw out a suggestion, for the practical result has been proved over and over again, that to illuminate a given area, more useful light is given by the enclosed arc lamp for the same expenditure of watts than with the open arc lamp; and we shall be very pleased to demonstrate conclusively that Mr. Sayers' figures are not correct.

Is it a fact that Mr. Sayers' results were obtained with a greased paper held on a stick with the lamps (incandescent or arc) hung upon either side?—Yours, &c.,

London, S.W., March 2. DRAKE AND GORHAM.

ELECTRIC TOUCH.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: One cannot but feel interested in reading something that is so entirely new as that on "Electric Touch," by Prof. J. Chunder Bose, the second part of which appears in your current issue. Nor can one entirely disagree with what is said, for there seems no statement that is not based on or borne out by some practical experiment; but still, in my mind, it calls for too great a sacrifice to discard the old idea of electrically-produced cohesion to substitute the entirely new and, I maintain, as yet unproved one of chemical action. I think it may be found in many cases that when any chemical action has taken place, the cause is not so much the Hertz waves as the effect of the current from the local circuit usually employed to detect the cohering action of such waves.

Feeling that my ideas—which have been based upon the ideas of previous experimenters—have been correct, I have been enabled to invent three entirely new types of Hertz detectors, two from theoretical considerations. These two are self-adjusting single-point coherers, one of which is extremely sensitive and is usually worked in connection with a telephone.

The setting up and adjustment of this instrument is somewhat troublesome, the action being seemingly independent of the material of the points, the instrument working quite as well and no better if the points are of iron, platinum, or even of carbon. The third variety of coherer that I have invented is undoubtedly the best. It works with filings, and is entirely self-decohering. I usually use it in connection with a Weston voltmeter. On the coherer being subjected to Hertz waves the pointer of the voltmeter moves up the scale, the final deflection being, so far as I can make out, proportional to the energy of the radiation, and when the waves cease the pointer drops again to zero as swiftly as it rose. Its sensitiveness and regularity of working is considerable, and there seems no end to its rapidity of working.

When I started operating with this instrument I was often troubled with what is known as "fatigue"—that is, after some time of working the pointer of the voltmeter would maintain a certain deflection: it took me a long time to discover the cause. Finally a cure was effected by reducing the current density through the points of contact between the filings. The current round the local circuit was reduced by lowering the voltage to $\frac{3}{4}$ volt, while the current density in the filings was still further diminished by increasing the number of the filings.

If Prof. J. Chunder Bose is interested and would care to see my instrument, I should be pleased to make arrangements so that it could be seen in action.—Yours, &c., S. G. BROWN.

London, March 5.

[Our correspondent is probably unaware that the acceptance of his invitation would involve a journey from Calcutta, at the Presidency College of which city Dr. Bose fills the chair of physical science. We are afraid that our correspondent's success in constructing coherers out of his preconceived ideas cannot, in this case, be regarded as supporting the ideas themselves. We advise our correspondent to wait until Dr. Bose's further researches, embodied in a still later Paper, have been published before he condemns the chemical theory that now seems to him so difficult to believe.—ED. *E.*]

PARLIAMENTARY INTELLIGENCE.

POST OFFICE TELEPHONE SERVICE IN LONDON.

In the House of Commons, last week, Mr. KIMBER asked the Secretary to the Treasury, as representing the Postmaster-General, what progress had been made by the Post Office Department with the expenditure of the two millions of money voted for telephone purposes last session; when the Post Office would be able to supply the public with telephonic communication; whether he would state the terms on which the Post Office proposed to give the public such communication; and whether the telephones of the Post Office would be placed in communication with those of the National Telephone Co.

In reply, Mr. HANBURY said that large contracts had already been made, and others would very shortly be concluded, for plant and underground wires, involving an expenditure of about half a million pounds out of the one and a quarter million pounds which the London exchange would probably cost. Some delay had necessarily been caused by negotiation with the large number of Vestries who controlled the granting of wayleaves, but these having now given their consent, the work would be carried on at once over the whole of the large London area. The Post Office expected to afford telephonic communication in nearly the whole of the City area, the Strand and Charing Cross district, the whole of Westminster, Chelsea, Belgravia, South Kensington and Kensington to Notting Hill, West Kensington, Brompton, Fulham, Wimbledon, Putney, Barnes and Mortlake, Kew, Richmond, Twickenham, Kingston, Norbiton and Surbiton, Hammersmith, Turnham Green, and Chiswick, by the end of the year. In view of the competition with the National Co., it would be obviously unwise to disclose the rates to be charged until it was necessary to canvass for subscribers. There was no power to compel the National Co. to allow intercommunication between their exchanges and that of the Post Office, but in view of the great importance to the public of such intercommunication, all reasonable steps would be taken to effect it, and the co-operation of the London County Council as the chief road authority might be of considerable assistance in bringing about that desirable result.

TELEGRAPH-TELEPHONE FACILITIES.

In the House of Commons yesterday Mr. CHARLES M'ARTHUR asked the Secretary to the Treasury (representing the Postmaster-General) whether he was able to announce if the postal regulations will be so modified that the submarine cable companies might telephone to their clients cablegrams received after business hours, and that the addressees might telephone replies for transmission by submarine cable, without being subjected to the delay involved in sending such messages through the Post Office.

Mr. HANBURY: The Postmaster-General hopes to secure the co-operation of the American cable companies in an experimental arrangement made to expedite the delivery of cable messages at Liverpool. Between the hours of 8 and 9 or 9.30 p.m. such messages will be telephoned direct from the Exchange post office, which immediately adjoins the offices of the four American cable companies, to those addressees who are subscribers to the system of the National Telephone Co., and the subscribers will also be able to telephone their replies direct to the Exchange post office. This arrangement will save the time hitherto occupied in conveying messages by hand between the offices of the cable companies at the exchange and the head post office, and it will be made permanent should the use made of it prove sufficient to justify such a course.

THE TELEGRAM CENSORSHIP.

Mr. JOHN ELLIS asked the Under Secretary of State for War with whom lay the primary responsibility for the system of censorship and suppression now exercised in the South African colonies over telegrams from abroad, under what authority it is exercised, at what date commenced, and by whom the actual duty of inspecting such telegrams is performed.

Mr. GEORGE WYNDHAM: The responsibility for the censorship rests with Her Majesty's Government, several departments of which are concerned. It is exercised under Articles VII. and VIII. of the International Telegraph Convention. It commenced in October last, and is carried out by specially appointed military authorities. It is not desirable to make known particulars with regard to the manner in which the censorship is exercised.

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SOUTH AFRICA CABLE ROUTES.

In the House of Commons on Friday last, on the vote for £10,000, subsidy to the Eastern and South African Telegraph Co.,

Mr. HANBURY said that when the war in South Africa broke out the Eastern Telegraph Co. were laying an additional submarine cable between St. Helena and Cape Town, and in order to obtain the immediate advantage of what was in effect an alternative route to South Africa, the Government arranged with the company that they should send out an extra cable ship to lay the cable between Ascension and St. Helena concurrently with that between St. Helena and Capetown, the undertaking being that the Government should pay whatever the cost might be, up to £15,000, if the cable were laid by Christmas instead of by March 31, as the Company had originally intended. The cable was, in fact, completed by Dec. 15 or 16, and the cost was only £10,000, and thus communication with Capetown was secured by another route.

The vote was agreed to unanimously.

DUBLIN ELECTRIC LIGHTING BILL.

In the House of Commons yesterday, on the motion for the second reading of this bill,

Mr. W. REDMOND said he understood it was agreed to postpone the second reading until the 22nd inst.

Mr. GALLOWAY pointed out the inconvenience of such a postponement, seeing that the President of the Board of Trade had decided to appoint a committee specially to consider all these electric lighting and power bills. The whole object of the appointment of the committee was that these bills should be considered together. As the other bills concerned passed the second reading a week ago, the object would be frustrated by the postponement of the present bill for a fortnight.

The second reading was postponed for a fortnight.

MUNICIPAL TRADING.

On Monday, in the House of Commons, in reply to a question by Mr. Kimber as to whether, pending the appointment of the Municipal Trading committee, the Government would oppose bills or clauses in bills promoted by municipal authorities seeking power to trade or manufacture,

Mr. BALFOUR considered that each particular case must be dealt with on its merits. But undoubtedly the fact that a committee was to be proposed was a factor to be taken into account. The terms of the reference to this committee would be placed on the paper in a day or two.

ELECTRIC POWER BILLS.

In the House of Commons to-day (Friday) Lord Balcarres will move that all private bills by which it is proposed to supply electric power shall be referred to a committee appointed by the Committee of Selection. It is understood that the President of the Board of Trade will assent to the motion, which will ensure that none of the seven members of the committee would have any interest, either personal or in respect of his constituency, in the bill to be considered.

ELECTRIC TRAMWAY BILLS.

The Airdrie and Coatbridge and the South Lancashire tramways bills were read a second time in the House of Commons on Friday last.

LEGAL INTELLIGENCE.

Goldberg and Son v. Liverpool Corporation.

Judgment in this action (fully reported in our last issue) was delivered on Monday by Vice-Chancellor Hall, of the Chancery of Lancashire. Plaintiffs claimed that defendants had unnecessarily erected a tramway pole and fuse box in such manner and in such position as to prejudicially affect access to their premises, and that the Court was entitled to interfere to prevent the nuisance continuing. Plaintiffs had in the first place declined to grant permission to the Corporation engineer to place a rosette on their building, and it had therefore been necessary to erect a post with a fuse box attached at or near that point, and the pole and box had been placed within 2ft. 6in. of plaintiffs' main entrance. Plaintiffs raised a preliminary point that under the Tramways Act, 1870, defendants were restricted to the use of the roadway, but his lordship held that the later Acts clearly comprehended the use of the whole street as being within the powers of the Corporation, the only restriction being reasonable and proper use of these powers. It had been represented during the hearing of the case that the spot selected by defendants was the only practicable one, owing to the complications of gas and water mains and electric wires, &c., in the soil below, whilst plaintiffs contended that this was not so, and that this spot had been selected vindictively and to annoy them for their refusal to allow a rosette to be fixed to their building. As the result of investigations his lordship found that the Corporation was by no means confined to the spot selected, but that the pole and fuse box might have been erected in two other places without inconvenience to the plaintiffs. He held therefore that the borough engineer at the time the spot was selected knew nothing of the state of affairs underground, and that there was no reasonable ground for selecting the front of plaintiffs' premises in the was selected. He therefore held that the engineer's conduct was perverse and vexatious, and not a reasonable exercise of the powers vested in the Corporation for carrying out these works. He decided that plaintiffs were entitled to an injunction, and that defendants should pay the costs of the action.

His LORDSHIP agreed to suspend the operation of the order for a fortnight.

Beaver and Co. v. Allam and Co.

This was an action brought in the Westminster (London) County Court to recover £12. 10s. for electric fittings supplied. Plaintiffs carry on business in Wardour-street, W., and defendants in Hatton-garden, E.C. Plaintiffs are manufacturers and defendants are electric lighting contractors, and were engaged upon an order which included the supply of electroliers, which were ordered from plaintiffs. Some time after delivery it was alleged by defendants that the fittings were damaged, and later it was further alleged that some of the fittings were defective. The amount now disputed was about £10. A revolving electrolier was produced by defendants to prove their contention, but plaintiffs declared that the soft solder on it was not there when turned out from their workshops. The fittings had been wrenched or dropped. Defendants said they at first put the damage down to the railway company, but now thought the workmanship was not good. One of the fittings had to be returned to London from Leicester to be repaired, and the others were afterwards altered and repaired.

Judge LUMLEY SMITH said he was satisfied the fittings were not properly made, and therefore £1. 11s. 6d. for repairs must come off the account. With regard to the revolving electrolier, it was not according to order. Defendants should have refused it, but they put it up and used it, and they must keep it; but it was not properly made, and therefore be valued it at £2.

Judgment for plaintiffs for £2 more than the amount paid into court and costs on £5. 18s. 6d.

Tevenan v Vanderberg.

At Dublin last week Mr. Justice Barton and a special jury heard an action brought against Mr. J. Vanderberg, merchant, 21, Mincing-lane, London, for £113. 13s. 9d., chiefly for work and labour done and services rendered, under an agreement dated May, 1899, and for board and lodging of defendant's alleged agent (Mr. C. Sax). Plaintiff is a "clerk and commission agent," and said defendant agreed that he should act as clerk and agent for him in Ireland, for the purpose of introducing and obtaining orders for the introduction of electric lighting into various towns in that part of the kingdom, at a salary of £6 per week. Under this agreement £155. 3s. 3d. became due. Defendant paid £61. 16s. 6d., leaving £93. 6s. 9d. due. It was further agreed that £3 per week should be allowed for board and lodging for Mr. Sax. Plaintiff provided this from May 9 till Aug. 29, 1899, was entitled to receive £50. 17s., had received £30. 10s., and now sued for £20. 7s. The plaintiff's claim represented 22 weeks' salary at £6 a week, railway fares to Limerick and Derry and back, hotel expenses, &c. Defendant denied he had agreed as alleged, or that plaintiff had acted as his clerk or agent, and said that no salary was earned and no work done by plaintiff as alleged. He further denied that Charles Sax was his agent.

Mr. O'SHAUGHNESSY, for defendant, characterised the case as a dishonest blackmailing action. A syndicate was formed in London, and consisted of five or six gentlemen (Mr. Vanderberg being one), for the purpose of pushing electric lighting in various places, amongst others Dublin. Sax, an electrical engineer, and son-in-law of Vanderberg, was appointed to conduct negotiations for the acquisition of a provisional order and plant of the Dublin Corporation. Sax got from the syndicate £2,500, and drew upon his father-in-law for over £2,000 more, and Mr. O'Shaughnessy alleged that every penny of that had been extracted from the unfortunate Sax in Dublin by a set of most unscrupulous harpies. Counsel said it would be denied that there ever was any agreement to pay the plaintiff £6 a week for twelve months. The only letter he could produce which had the slightest bearing upon this claim was one from Sax, but that only referred to the company which it was proposed to form. That company had never been formed, and in no way therefore did the letter bind Mr. Vanderberg.

Mr. JACOB VANDERBERG said Sax was never his agent in Ireland. He had never entered into any agreement to pay plaintiff any sum at any time. Sax brought plaintiff once to his house and introduced him, but he advised Sax to have nothing to do with him. Subsequently plaintiff desired to get an agreement from the syndicate of which he (defendant) was a director, but he did not get it. The following July defendant gave plaintiff £10, as he said he was very poor and that Sax had owed him some money, which he wanted badly. That cheque was charged to the syndicate. In cross-examination witness said he had not done much in the way of the promotion of companies, and he went into the electric lighting syndicate for the purpose of helping Sax, his son-in-law. It was Sax who started it. He put £250 into it, and it was wound up in May, 1899.

Mr. BUSHE, Q.C. (for plaintiff): Mr. Clancy and your son-in-law, Sax, were trying to work this job in Dublin?—I don't know about Mr. Clancy. Sax always had a lot of hangers-on.

Then why did you not get rid of him?—It is very hard to get rid of your son-in-law. He had authority to act in Ireland for the syndicate when it started. Though the syndicate died in May, he sent money in June to his son-in-law at the offices of the Dublin District and Provincial Electricity Corporation (Ltd.) He knew nothing about the company then, only that the name mentioned was to be the title if the thing came off. He gave Tevenan £10 in July out of charity.

The jury found that defendant had entered into the contract in the first claim, and that the work was done, for which they allowed plaintiff £83. 6s. 9d. On the other claim they found for defendant.

A stay of execution was granted.

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Illegality of Picketing.

The appeal which the defendants in the action "Lyons and Sons *v.* Wilkins and Others" were to have made to the House of Lords has been abandoned. Full particulars of the case were given in our issue of Dec. 23, 1898. Mr. Justice North originally granted an interlocutory injunction, which was affirmed on appeal, and in February, 1898, Mr. Justice Byrne granted a perpetual injunction against the defendants "from watching or besetting plaintiffs' premises with the object of preventing persons from working for the plaintiffs, or for any other purpose than that of obtaining or communicating information." The Court of Appeal affirmed this judgment in November, 1898, so that this judgment may now be taken to represent the law on the important question of picketing, and decides that anything in the nature of intimidation is illegal.

Action for Libel by an "Electro-Metallurgist."

In an action for libel against the *Financial Times*, heard by Mr. Justice Ridley and a special jury on Wednesday and yesterday, the plaintiff, Mr. James Fenwick, was described as formerly an "electro-metallurgist." The *Financial Times*, in discussing plaintiff's connection with a large number of company-promoting schemes, had called plaintiff an incorrigible rogue and pretty nearly everything else in the calendar. It appeared from the plaintiff's examination that he was some years ago managing director of the Electro Metal Co. (amongst others), but that he had never been associated with any company that had succeeded. Having passed under the re examination of Mr. Rufus Isaacs, the plaintiff came to the conclusion that the best thing he could do was to decline to proceed further with the action, especially in the light of various interruptions made by his lordship during the progress of the case. The public has therefore lost an interesting exposure of the lowest type of company-mongering.

Judgment was given for defendants, with costs.

TRADE NOTES AND NOTICES.

[Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.]

NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers, or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London:—

READY.

(Price **12s. 6d.**, by post, 13s. 3d.; Colonies, 14s.; abroad, 14s. 6d. (United States, 15s.)

"The Electrician" Electrical Trades' Directory and Handbook for 1900 (corrected to January 31st, 1900).—In addition to the well-known features of this Directory and Handbook (all of which have been carefully revised and brought quite up to date), a large addition has been made to the Handbook Division, including a Digest of the Law of the Telegraph and Telephone, for the use of municipalities and companies contemplating applying to the Postmaster-General for a Telephone Licence. This section of the book now includes the new model form of Licence issued by the Postmaster-General in January, the Telegraph Acts and Orders passed by Parliament in 1899, and other information in connection with this the latest development of electrical enterprise. The huge sheet tables of Electric Light and Power and Electric Railway and Tramway undertakings of the United Kingdom have been made complete up to the 31st January. These sheets form a most complete record of electrical engineering progress in connection with electricity supply and power and traction applications. The Directory Division has been carefully extended and corrected up to Feb. 2, and is the most reliable list of firms and persons engaged in the electrical and allied industries ever compiled. A number of additional sketches of the careers of well-known electrical experts have been added to the Biographical Division, together with many new portraits. The new volume is, we claim, the most complete and correct book of its kind ever published in any language. An analytical digest of the contents of this volume can be obtained post free.

"Localisation of Faults in Electric Light Mains."—By F. C. Raphael. Price 5s., post free. The book deals with the important subject of localising faults in electric light and power cables; and the various methods of insulation testing are here collected and discussed.

"Wireless Telegraphy: Signalling across Space without Wires by Electric Waves." A Review of the Work of Hertz and his Successors.—By Dr. O. J. Lodge, with a large number of illustrations. New and Enlarged Edition, 5s. nett. *Now ready.*

"Practical Notes for Electrical Students."—By Messrs. A. E. Kennelly and H. D. Wilkinson. Price 6s. 6d., post free. The authors give in a clear and concise manner a good summary of the general principles of electrical science.

"The Incandescent Lamp and its Manufacture."—By Gilbert S. Ram. Price 7s. 6d., post free. The principles underlying the manufacture of the incandescent lamp are carefully and fully dealt with in this volume.

"The Centenary of the Electric Current, 1799-1899."—By Dr. J. A. Fleming. Price, paper covers, 1s. net, post free 1s. 3d.; strong cloth, 2s. 6d., post free.

"Motive Power and Gearing for Electrical Machinery."—By E. Tremlett Carter, C.E., M.I.E.E. Price 12s. 6d., post free. In this comprehensive work an account is given of the scientific principles and modern practice in the use of engines for dynamo driving, not only for isolated power plants, but also for public electric lighting and power stations. The various forms of gearing in the power station and for electric motors are also dealt with; and the book contains, in addition, numerous tables giving exact data of the equipment and working of electric power stations.

"The Manufacture of Carbons for all Electrical Purposes."—by Francis Jehl. 10s. 6d., post free. This is a practical handbook, giving a complete description of the art of making carbons for electric lighting, electrodes, &c., with particulars of the various gas generators and furnaces used in carbonising. The work also contains particulars of the cost, &c. of erecting and working carbon works, and plans of a model factory.

"Electromagnetic Theory."—By Oliver Heaviside. *Vol. I.*, 12s. 6d. *Vol. II.*, 12s. 6d.

"Electric Motive Power," by Albion T. Snell, contains the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. Price 10s. 6d., post free; abroad, 11s.

"Electrical Testing for Telegraph Engineers."—By J. Elton Young, M.I.E.E. The scope of the book aims at furnishing a fuller treatment of the subject, from the standpoint of the Telegraph Engineer, than it has hitherto received, whilst it endeavours to facilitate a thorough comprehension of the theory of testing as applied to electrical lines in general. Demy 8vo, fully illustrated. 10s. 6d., post free.

"Electric Lamps and Electric Lighting," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is handsomely bound, and full of original illustrations, designs, initials, &c. *New and Cheaper Edition now Ready.* 6s., post free.

"Submarine Cable-Laying and Repairing.—By H. D. Wilkinson M.I.E.E., &c., fully illustrated; price 12s. 6d. This work gives a detailed technical summary of modern practice in manufacturing, laying, testing, and repairing submarine telegraph cables.

"The Art of Electrolytic Separation of Metals."—A second issue of Dr. Gore's book is now ready, price 10s. 6d., post free. The author treats fully both the theoretical principles of the art of electrolytic separation of metals and the practical rules and details of technical application on a commercial scale. The work is adapted to the use of the manufacturer as well as the student.

"Drum Armatures and Commutators," by Mr. F. Marten Weymouth, also ready. Price 7s. 6d., post free. Propsectus on application. This is a complete treatise on the theory and construction of drum winding, and of commutators for closed coil-armatures, together with a *résumé* of the principal points involved in their design, and an exposition of armature reactions and sparking.

"Laboratory Notes and Forms."—We have ready a set of 40 Elementary and Advanced Exercises for use with Electrical Engineering classes. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators, and Students. The object of the series is the saving of the time of the Teacher and his Assistants, and to serve as a record of the work done by the Student. Each Form is supplied either singly at 4d., or 3s. 6d. per dozen net; in sets of any three, 1s. net; or the set of Twenty (Elementary or Advanced) Exercises can be obtained, price 5s. 6d. net. The complete set of Twenty Elementary and Twenty Advanced Exercises are price 10s. 6d. net; or in handy portfolio, price 12s. net; or bound in strong cloth case, price 12s. 6d. net. Strong portfolios can be had, price 1s. each.

NOW READY.—The cheaper edition of Dr. J. A. Fleming's "Electrical Laboratory Notes and Forms." These cheaper Forms have been prepared for the use of students and teachers at the Polytechnics and other Science classes throughout the country. The demand for the original set of these Notes and Forms has led to a request for a cheaper set for use at the day and evening classes at many of the technical institutes. These new Forms, which differ only from the higher-priced set in being printed on smaller and cheaper paper, and with less space for tabulated records, are issued at half the price of the original set.

"Electrical Engineering Formulæ," a pocket book, by Messrs. W. Geipel and H. M. Kilgour; price 7s. 6d.; by post, 7s. 9d.; abroad, 8s. *New Edition in the press.*

"The Alternate Current Transformer."—By Prof. J. A. Fleming, M.A., D.Sc., F.R.S. Vol. I.—*New Edition.* Price 12s. 6d., post free, Vol. II., price 12s. 6d., post free, is also ready.

"The Manufacture of Electric Light Carbons."—A Practical Guide to the establishment of a Carbon Manufactory. Fully illustrated price 1s 6d.; post free, 1s. 9d. In this work the author gives useful hints as to the manufacture of electric light carbons, including the preparation of material, firing, saturating, and coring, together with a description and estimate of cost of the plant required.

"Magnetic Induction in Iron and other Metals."—By Prof. J. A. Ewing. Price 10s. 6d., post free. *New Edition nearly ready.*

"Electro-Chemistry."—By Dr. G. Gore. Third Edition. Price 2s., post free.

"The Potentiometer and its Adjuncts": A Universal System of Electrical Measurement.—By W. C. Fisher. Fully illustrated. Price 6s., post free.

"The Students' Guide to Submarine Cable Testing."—A new edition of this book, by Messrs. H. K. C. Fisher and J. C. H. Darby, is now ready, price 6s. net; abroad, 6s. 3d. This work is intended to serve as a guide to operators already in the telegraph service, and to those who desire to enter that service. The great cable companies now insist that their operators and probationers shall pass certain examinations in electrical subjects. The book is very fully illustrated.

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"THE STEAM ENGINE INDICATOR AND INDICATOR DIAGRAMS."—Edited and enlarged by W. Worby Beaumont. Price 3s. 6d., post free. This work is a concise guide to the objects, construction, and use of the steam engine indicator and to the interpretation of indicator diagrams.

"BIBLIOGRAPHY OF X-RAY LITERATURE AND RESEARCH."—A valuable compilation. Being an attempt to classify the data relating to X-Ray work. This work contains a quantity of general as well as special information bearing upon the whole subject of electrical discharge research. Edited by C. E. S. Phillips. Price 5s., post free.

TENDERS INVITED.

Extension of Time.—The *Swansea* Corporation invite tenders for supplying and laying insulated electric mains, conduits, junction boxes, &c. Specifications may be obtained at the Guildhall, Swansea, and further particulars are set out in an advertisement. Specifications may also be inspected (but not obtained) at the offices of the consulting engineers (Messrs. Kincaid, Waller and Manville), 29, Great George-street, Westminster, S.W. *Tenders must be sent to the engineers at the above address, instead of the town clerk (Mr. John Thomas), Guildhall, Swansea, and the time has been extended from the 12th to the 19th inst.*

The *Leeds* Tramways committee invite tenders for one, two, or three steam dynamos. Specifications, &c., can be obtained at the offices of the city engineer (Mr. Thomas Hewson, M.Inst.C.E.), Municipal Buildings, Leeds, or of the consulting engineers (Messrs. Hopkinsons and Talbot), 26, Victoria-st, Westminster, S.W, and 29, Princess-street, Manchester. Further particulars are given in an advertisement, and tenders must be delivered at the town clerk's office, Town Hall, Leeds, by March 21.

The *Barrow-in-Furness* Corporation invite tenders for the supply and erection of (*a*) water-tube boiler and steam and other pipes and sundry ironwork; (*b*) surface condenser, air and circulating pump, cooling tower, pipe connections, valves, and sundry ironwork. Specification may be obtained at the Town Hall, Barrow-in-Furness, or at the office of the consulting engineers (Messrs. Kincaid, Waller and Manville), 29, Great George-street, Westminster. An advertisement gives further particulars and tenders must be sent to the town clerk (Mr. C. F. Preston), Town Hall, Barrow-in-Furness, before March 19.

The *Dartford* District Council require tenders for the supply of generating plant for their proposed electricity supply works. Further particulars of the Council's requirements are given in an advertisement, and copies of specifications, &c., may be obtained at the offices of the clerk (Mr. J. C. Hayward), Sessions House, Dartford. The works will be carried out to the plans and specifications of the consulting engineer (Mr. W. C. C. Hawtayne), 9, Queen-street-place, London, E.C., from whom further information can be obtained after 5th inst. Tenders, addressed to the clerk must be delivered at Sessions House, Dartford, by noon of 27th inst.

The *Dublin* Electric Lighting committee invite tenders for the supply and erection of (*a*) six Lancashire and four water-tube boilers and two economisers, (*b*) two 1,000 kw. and two 500 kw. low-speed polyphase generators. Specifications, &c., may be inspected at the offices of the consulting engineer (Mr. Robert Hammond), 64, Victoria-street, London, S.W., after 15th inst. Further particulars are given in an advertisement. Tenders to the town clerk (Mr. Henry Campbell), City Hall, Dublin, by 4 p.m., April 26.

The *Hull* Electric Lighting committee invite tenders for the supply and erection of two steel Lancashire boilers, &c., for their electric lighting works. An advertisement contains further particulars, and specifications may be obtained at the treasurer's office. Tenders to chairman of committee by noon 22nd inst. Mr. A. S. Barnard is city electrical engineer.

Tenders are invited by the *Walthamstow* District Council for supplying and laying electric cables. Specifications can be obtained (after 13th inst.) at the offices of the consulting engineer (Mr. James Enright), 47, Victoria-street, London, S.W. An advertisement contains further particulars, and tenders must reach the clerk (Mr. E. J. Gowen), Town Hall, Walthamstow, by 5 p.m., 23rd inst.

The *Dundee* Town Council invite tenders for the supply and delivery of feeder mains, joint boxes, and underground conduits for the tramways. Specifications may be obtained from the city electrical engineer (Mr. Walter H. Tittensor), Dudhope-crescent-road, and tenders must be delivered to the town clerk (Sir Thomas Thornton, LL.D.), City Chambers, Dundee, by Wednesday, 21st inst. An advertisement contains further particulars.

The *Fulham* (London) Vestry invite tenders for the supply of 100 5-ampere, 100 10-ampere, and 50 20-ampere electricity meters. Further particulars are given in an advertisement, and tenders must be delivered at the offices of the consulting engineer (Mr. F. H. Medhurst), 13, Victoria-street, S.W., not later than 19th inst.

The *Henley-on-Thames* Corporation require tenders for "free wiring" at an agreed rental per lamp. Tenders to Mr. R. Pratt, borough surveyor, Henley-on-Thames, by 22nd inst. See advertisement.

The Visitors committee of the Lancashire County Asylum, *Rainhill*, invite tenders for the supply and erection of electric lighting plant. Tenders to chairman of committee, by noon of March 22.

The Vestry of *St. Mary, Islington* (London), invite tenders for the supply of electrical stores for one year from March 25. Tenders by noon of 14th inst. to Mr. W. F. Dewey, Vestry Hall, Upper-street, N.

The *Blackpool* Tramways committee invite tenders for the construction of a double line of tramways in Central Drive, the Corporation providing all materials. Tenders to chairman by 12th inst.

The *London* County Council Asylums committee require tenders for electric lighting sundries for their Claybury and Heath asylums. Tenders to 6, Waterloo-place, London, by March 14.

The *Edinburgh* Corporation require tenders for stores, including electric lighting materials and supplies for the burgh engineer's department and for the Powderhall destructor. Tenders by March 14.

The *Plymouth* Corporation invite tenders for wiring the municipal offices, and for twelve months' supply of lubricating oils for the electricity works. Tenders to borough electrical engineer by March 21.

The New Tramways committee of the *Newcastle-upon-Tyne* Corporation require tenders for steel poles. Tenders by 21st inst.

The *Shoreditch* (London) Vestry require tenders for two water-tube boilers. Tenders to clerk, Town Hall, Old-street, London, E.C.

The Visitors committee of the *Lancaster* County Lunatic Asylum require tenders for electrical goods for 12 months. Tenders by the 16th inst.

The *Birkenhead* Corporation invite tenders for overhead line equipment. Tenders to town clerk by March 20.

The Municipal Council of *Campo de Criptana* (Ciudad Real), Spain, require tenders for electric lighting for 20 years. Tenders by March 26.

TENDERS RECEIVED AND ACCEPTED.

The Bedford Town Council have accepted the tender of the Wheeler Condenser and Engineering Co. for supplying and erecting a surface condenser, with air and circulating pumps, and engine for driving same, at £911. The following are the tenders sent in:—

Wheeler Condenser and Engineering Co. (*accepted*)	£911
W. H. Allen, Son and Co.	1,160
Worthington Pumping Engine Co.	1,094
Clay, Henriques and Co.	825

The Crystal Palace District Electric Supply Co. have put in a pair of Hornsby water-tube boilers, the satisfactory working of which has resulted in an order for two further pairs being placed with Messrs. R. Hornsby and Sons.

The Croydon Corporation have accepted the tender of the British Thomson-Houston Co. for two steam dynamos for electric traction work, and that of the Babcock and Wilcox Co. for three water-tube boilers, pipe work, &c. The tender of Messrs. W. H. Allen, Son and Co. has been accepted for a condenser, and that of the Wheeler Condenser and Engineering Co. for a cooling tower at the electric lighting station.

The Shoreditch Vestry have accepted the tender of the General Electric Co. for the supply of arc light carbons for 12 months at schedule prices. Tenders were also submitted by Messrs. Crompton and Co., Messrs. Johnson and Phillips, and the Sloan Electrical Co.

Tenders have been accepted by the Perth Council for the erection of electricity station buildings. The contract has been let in sections, the total being £7,354.

The Dudley Corporation have accepted the tender of Messrs. Babcock and Wilcox for the supply and erection of pumps, feed-water heaters, and pipework for their electricity department.

The Rotherham Corporation have accepted the tender of the Electrical Power Storage Co. for storage batteries for their electricity department at £312 10s., the charge for maintenance being £70 per annum.

The following tenders have been received by the St. Pancras (London) Vestry for condensing plant at the Regent's Park electricity station:—

John Fraser and Son (*accepted*)	£6,309 18 0
Klein Engineering Co.	5,395 0 0
Worthington Pumping Engine Co.	5,374 0 0
G. Wailes and Co.	5,113 16 6
J. Spencer and Co.	4,754 18 4
T. Ledward and Co.	4,594 16 6

The highest tender has been accepted on the advice of the electrical engineer (Mr. S. W. Baynes), who considered the tender of Messrs. Fraser and Son the most advantageous, having regard to all the circumstances.

Derby Council have accepted the tender of Browett, Lindley and Co. for the supply of a 100 H.P. surface condenser at £705.

The Bangor Council have accepted the tender of Meldrum Bros for a refuse destructor at £2,420.

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APPOINTMENTS VACANT AND FILLED.

The Brush Electrical Engineering Co. require an experienced works manager for their Falcon Works, Loughborough. An advertisement contains further particulars, and applications should be addressed to the secretary, 49, Queen Victoria street, London, E.C, by March 15.

An engineer, capable of looking after electric lighting plant, is required for the Islington (London) new infirmary. An advertisement contains further particulars, and applications must reach the clerk (Mr. Edwin Davey), Guardian Offices, St. John's-road, Upper Holloway, N., before 12th inst.

The Plumstead Vestry require an assistant electrical engineer. Further particulars are set out in an advertisement, and applications must be sent to the Vestry clerk (Mr. Edwin Hughes), Vestry Hall, Plumstead, S.E., by 27th inst.

The Whitechapel District Board of Works require a meter inspector and wireman for their electricity department. Applications to engineer (Mr. W. C. P. Tapper), 27, Osborn-street, London, E. See advertisement.

Telegraph linemen are required for the telegraph department of Northern Nigeria, Africa. An advertisement contains further particulars, and applications must be sent to the Crown Agents for the Colonies, Downing-street, London, S.W., before the 19th inst.

The Bray District Council require an assistant electrical engineer. Application to clerk (Mr. P. Macdonnell), Town Hall, Bray, by 10 a.m., 15th inst.

Mr. H. G. Nicholson, A.M.I.E.E., who was for some years with the General Electric Co. and recently with the British Thomson-Houston Co., has been appointed resident engineer to Messrs. Kincaid, Waller and Manville at Southampton to superintend the construction of the electric tramways and the reconstruction of permanent way.

Mr. J. R. J. Bowden has been appointed clerk of works by the Hackney Vestry for the laying of electric lighting mains.

Mr. E. Donoghue, of Sheffield, has been appointed third assistant electrical engineer at Portsmouth.

BUSINESS NOTICE.

Mr. E. C. Wallis, A.I.E.E., asks us to state that his business at Leeds has for the past five years been quite distinct from that of Cuttriss, Wallis and Co. (Ltd.), now in voluntary liquidation.

BANKRUPTCIES, LIQUIDATIONS, &c.

At the London Bankruptcy Court J. H. Douglas-Willan, of 16, St. Helens-place, London, E.C., was examined, the accounts showing total liabilities £12,170, assets £67,305, mainly represented by the debtor's interest in the Bowen and Bowen-Willan electric lamp patents. Debtor stated that in Dec., 1895, he purchased for £450 the inventor's interest in the Stien electric lamp, and parted with a half-share in this interest to another person in consideration of services rendered. A fourth share in the lamp was subsequently sold for £1,000. In Feb., 1896, debtor and his partner combined with the inventor of the Bowen electric lamp, and subsequently endeavoured to develop these patents with a view to disposing of them to a joint stock company, but in 1898, after an expenditure of £3,136. 13s. 4d. on the Stien lamp, it was abandoned in favour of the Bowen lamp. In Feb., 1899, after an expenditure of £2,640 5s. 4d. on the Bowen lamp, his partner withdrew, and debtor took over the liabilities and assets. He claimed that he was not insolvent, but was forced to apply to the court owing to pressure by creditors and inability to immediately realise his interest in the patents referred to. Examination concluded.

The following are the principal trade creditors in the failure of Benjamin Symmons, electrical engineer, 2, North-street, Quadrant, Brighton, and 15, Holland-road, Hove. Total liabilities £1,323. 17s. 10d., assets £761. 8s. 10d.

Veritys (Ltd.)	£183	16	7	Sun Electrical Co.	£25	0	0
Electrical Co.	131	4	0	J. Smith and Co.	17	5	4
G. Braulik and Co.	50	10	10	Foster and Sons	16	3	0
General Electric Co.	28	14	8	W. and J. A. Bailey	10	9	7
Simon, Berry and Co.	28	11	3	Braby and Co.	10	2	0

F. Metcalfe, electrical engineer, 6, Tenter-lane, Swinegate, and 4, Ashcliffe-terrace, Cardigan-road, Leeds, late White Horse-street, Boar-lane, Leeds, has been adjudicated bankrupt. The first meeting of creditors will take place on 14th inst. at 22, Park-row, Leeds, and the public examination on 27th inst., at the County Court, Albion-place, Leeds.

In the bankruptcy of A. R. Earle, electrical engineer, 7, Theatre-street, and Deal Yard, St. Mile's, Norwich, the first meeting of creditors will take place to-day (Friday) at 8, King-street, and the public examination on 21st inst., at the Shirehall, Norwich.

The discharge of Ernest Max Winter, electrical engineer, Amberley House, Norfolk-street, London, W.C., has been suspended for two years.

A meeting of Vril Launches (Ltd.) will be held at 19, Coleman-street, London, E.C., on April 3, to receive an account of the winding up.

It has been resolved to wind up the Gutta Percha Corporation (Ltd.) voluntarily for reconstruction purposes, and to appoint Mr. E. Hayes, 28, Basinghall-street, E.C., liquidator.

The Woodland Electric Co. (Ltd.) is to be wound up voluntarily Mr. F. J. Armstrong, 59, Drury-buildings, Liverpool, is liquidator.

Herbert John Coleman, electrical engineer, trading as H. J. Coleman and Co., Tower-buildings, Bridge-street, Carnarvon, has executed a deed of arrangement. Liabilities £735. 3s. 2d., and assets £451. Mr. J. T. Trotter, 27, Brazennose-street, Manchester, is trustee. The creditors are :—

National Gas Engine Co.	£110	W. T. Glover and Co	£25
Walker and Hodgetts	75	F. G. Jones	12
Perfect Arc Lamp Co.	75		

Plant for Sale.—Messrs. Albright and Wilson (Ltd.), Oldbury, near Birmingham, have a Willans-Crompton steam dynamo for sale. See advertisement.

As announced in an advertisement, the charging station of the London Electrical Cab Co. (Ltd.) (in liquidation), with the machinery, plant, licences, cabs, and premises, are to be sold by tender by order of Mr. Justice Byrne. Tenders to be in by noon of 20th inst. Particulars from the receiver (Mr. Walter Howard, C.A.), 27, Clement's-lane, E.C.; Messrs. Morley, Shirreff and Co., solicitors, 53, Gresham-street, E.C.; and Messrs. Steadman and Van Praagh, solicitors, 23, Old Broad-street, E.C.

Sale by Auction.—Messrs. Farebrother, Ellis, Egerton, Breach, Galsworthy and Co. will sell by auction, at 110, Westminster Bridge-road, Lambeth, London, S.E., on Monday, April 23, and following days, a mass of costly modern engineers' tools, plant, and machinery, the property of Messrs. Maudslay, Sons and Field (Ltd.). The tools, plant, and machinery are by the leading makers, and include some fine examples. Some particulars are given in an advertisement on another page, and catalogues will be obtainable in due course, price 1s. each, of Messrs. Farebrother, Ellis and Co, 29, Fleet-street and 18, Old Broad-street, London, E.C.

Practical Magnetic Testing of Iron and Steel.—An interesting pamphlet is issued by Messrs. Elliott Bros., Century Works, Lewisham, London, describing Prof. Ewing's patented instruments for the practical magnetic testing of iron and steel, including the hysteresis tester, magnetic balance, and permeability bridge. Instructions for using these instruments are also given.

B.T.H. Plant.—Pamphlet No. 42, just issued by the British Thomson-Houston Co., describes and illustrates magnetic blow-outs and controllers as used on the Glasgow, Middlesbrough, Bristol, and Oldham, Ashton and Hyde tramways. Pamphlet No. 55 deals with the GE—800 traction motor.

"Luna" Arc Lamps.—A handy little list, illustrating the different types of Luna arc lamps manufactured by the Electrical Co. (Ltd.), of 122 and 124, Charing Cross-road, London, W.C., is now available. The list is well got up, and can be easily accommodated in the pocket.

"Allen" Compound Engines.—An illustrated sheet showing the two-crank compound engine designed and manufactured by Messrs. W. H. Allen, Son and Co. is just issued. The sheet includes a table of speeds and horse-powers of these engines.

Westinghouse Plant.—Circular No. 1,017, issued by the British Westinghouse Co., deals with alternating current potential regulators, and includes regulating apparatus for both single-phase and polyphase circuits.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Feb. 28 to March 6, with the ports of destination :—

Africa—Cape Town, £67; Durban, £1,182; Port Elizabeth, £1,277 (telegraph material). *Argentina*—Buenos Ayres, £681 (telegraph material). *Australasia*—Melbourne, £3,201 (including £2,961 telegraph wire); Sydney, £857; Wellington, £842 (including £347 telegraph material). *Azores*—£2,134 (telegraph material). *Belgium*—Ghent, £33; Ostend, £107. *Brazil*—Rio Janeiro, £64. *Canada*—Halifax, £111,325 (including £111,300 telegraph cable). *Ceylon*—Colombo, £313. *Chili*—Valparaiso, £172. *China*—Shanghai, £342. *Denmark*—Copenhagen, £295 (including £281 telegraph material). *Germany*—Hamburg, £335 (including £300 telegraph material). *Holland*—Amsterdam, £140; Rotterdam, £300 (telegraph material). *India*—Bombay, £105 (telegraph wire); Calcutta, £603; Karachi, £3,407 (telegraph material); Madras, £105. *Japan*—Yokohama, £560. *Mauritius*—£42. *Norway*—Christiania, £21 (telegraph material). *Straits Settlements*—Singapore, £10. *Sweden*—Gothenburg, £110 (telegraph material). Total £128,630 against £13,647 in the corresponding week last year (March 1 to 7).

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MUNICIPAL, FOREIGN, AND GENERAL NOTES.

Aberdeen.—The electric lighting mains are to be extended to the Rosemount district, at an estimated cost of £284.

Argentina Electrical Imports.—For the year 1899 the following figures relating to electrical imports into Argentina have been published by the *Review of the River Plate* :—

Arc light carbons	139 (tons)	$20,820 gold
Dynamos	658 (tons)	101,141 do.
Electrical apparatus, various	6,211 (cases)	341,034 do.
Fittings, chandeliers, &c.	98 (tons)	143,354 do.
Incandescent lamps	33,704 (dozen)	101,112 do.
Galvanised iron wire	26,240 (tons)	1,692,276 do.
Telegraph material	1,011 (cases)	36,993 do.
Telephone material	416 (cases)	20,143 do.
Wire and cables	1,257 (tons)	511,709 do.

Bedford.—The accounts of the electricity department for the year ended Dec. 31 give the total expenditure at £67,621. 10s. 5d. The revenue from public and private lighting amounted to £8,797. 16s. 4d., and the generation and distribution expenses, salaries, &c., to £4,881. 2s., leaving £3,916. 14s. 4d. Interest amounted to £1 836. 1s. 11d., and sinking fund instalment to £2,369, leaving a net deficit of £288. 7s. 7d. The debit balance on last account was £981. 10s. 1d. The units generated amounted to 702,060 : 189,578 were supplied to public lamps, 90,364 by contract, and 260,204 to private consumers. There were 528 public lamps, and the total maximum supply demanded was 449 kw.

Bolton.—The number of passengers carried by the electric tramway department during February was 728,024, the receipts amounting to £3,033. 8s. 8d. The Electric Tramways committee has reported to the Corporation that the service will be greatly improved when the full number of cars have been received. Some portions of the track in the centre of the town would have to be relaid, as it was in an unsatisfactory condition.

Bootle.—At the Corporation meeting on Wednesday an expenditure of £9,595 was sanctioned for the electrical equipment and conversion of the Derby-road and Rimrose-road tramway routes. The chairman of the Tramways committee (Councillor Regan) said that everything was in readiness for running the electric cars along the Stanley-road in a week's time, and their differences with the Liverpool Corporation would be amicably arranged.

Bradford.—Sanction is being sought to a loan of £70,000 for the erection of refuse destructor works.

Bristol.—Ald. Pearson has acceded to the unanimous request of the Electrical committee, and has resumed his chairmanship of the committee with which he has been so long and closely connected.

Dawson City (B.C.)—A line of Canadian Government telegraphs from Bennett to Dawson City, a distance of 600 miles, which was commenced in April, 1899, was completed in October. The cost of erection is stated to have been £26,000. A branch line, 75 miles in length, from Atlin has also been erected. The rates at present prevailing vary from 18s. to 19s. for a minimum of ten words and from 1s. to 1s. 2d. per additional word.

Death from Electric Shock.—Commenting upon the recent death of an engineer in the employ of the Blackheath and Greenwich District Electric Lighting Co. (Ltd.), Messrs. Veritys Ltd. claim to have developed a system of high-tension switches and fuses which "offer absolute protection and safety under all conditions of working."

Devonport.—The electricity supply station is to be erected at Newport Quay, and sanction to a loan of £74,536 has been applied for.

Dublin.—The Dublin Electric Tramways Co. are extending their Parkgate tramway route so as to make a junction with the Dublin and Lucan railway.

Eastbourne.—Application is to be made for sanction to borrow £800 for electric lighting extensions.

Eccles.—The Council have expended £5,000 on their electricity works beyond the sum for which they have borrowing powers, and sanction is now being sought for this expenditure. An arrangement has been entered into with the Salford Corporation for working the proposed electric tramways in the borough. Salford proposes to lease the existing tramways as well as the new lines which the Eccles Council are to seek statutory powers to construct, for 35 years, subject to a rent equal to 10 per cent. upon actual expenditure. Salford will relay the lines, provide the electrical equipment, and purchase the necessary electric current from Eccles, the latter maintaining the lines and rolling stock.

Electric Lighting in Edinburgh and Glasgow.—At the Edinburgh Corporation meeting last week the convener of the Electric Lighting committee (Bailie Mackenzie) announced that the present year would be a record one in connection with their electric lighting undertaking, as during the year to May 15 the equivalent number of additional 8 c.p. lamps connected would be over 70,000, a result (he said) never heard of in any similar undertaking in any country. Taking into account the additional capital expenditure, the cost per lamp would be £1. 18s. 4d. Last week Bailie Maclay, of Glasgow, stated, in reply to a question as to the relative cost of electric light in Edinburgh and Glasgow, that according to the revised figures of Bailie Mackenzie the capital cost of each lamp in Edinburgh was equal to £1. 18s. 4d., against £1. 15s. 1d. in Glasgow. He regarded a comparison of this sort as unreliable, because in Glasgow particularly, and also in Edinburgh to some extent, they were in a transition state.

Electric Power Plant in Sweden.—In the course of a report to his Government Mr. R. S. S. Bergh, the United States consul at Gothenburg, writes: "As soon as the people of Sweden fully recognise the value of their numerous waterfalls, there will be an immense demand for electric power plant. A large installation of this class of plant will soon be completed at Trollhatten, and electric railways and tramways are being planned for Gothenburg, Lund, Bjerröd, and Jönköping." Mr. Bergh points to the close attention which is being given by German manufacturers to the securing of contracts for the supply of this plant and apparatus, and recommends American manufacturers to appoint active agents to represent them at Gothenburg.

Exeter.—At the Council meeting on Wednesday a communication was read from the Defence committee in connection with the action "Rucker v. London Electric Supply Corporation." The report stated that the action had been dismissed with costs, and no intimation of an appeal had yet been received. The costs of counsel, documents, &c., was £4,548, to which had to be added the solicitors' costs, about £1,000. Calls had already been made to the extent of £2,553, so that £3,015 had to be raised, which would necessitate a call of £5. 8s. for every £1,000 contributing revenue. When the taxed costs were received from plaintiff it was hoped the committee would be in a position to make a proportionate return to the subscribers. The Exeter proportion would now be £19. 9s. 5d, and the total contribution would be £25.

Exhibition.—An exhibition of the products of the State of Rio Grande do Sul (Brazil) is to be held at Porto Alegre, on Nov. 15. The exhibition will include a section on the applications of science to industrial purposes.

Factory Legislation.—An amending bill to the Factory and Workshops Act was introduced in Parliament on Friday last by the Home Secretary. The bill makes owners and occupiers of factory premises as well as employers liable under the act, and prohibits the use of any material or processes that are certified as dangerous. The main object of the bill is to codify the various factory acts and acts which can be regarded as related thereto.

Fermoy (Cork).—A local company is to be formed by English Industrials (Ltd.) for the purpose of erecting electricity supply works.

Frome.—The Electric Lighting committee recommended the Council to erect electricity works.

Glasgow.—The Telephone Service committee anticipate that the municipal telephone exchange will be in operation in about six months. It has practically been resolved that the annual subscription, including an unrestricted number of calls, will be £5. 5s. The toll system rate is not yet fixed, but will probably be fixed at £3 10s. per annum, with a charge of a penny for each call. The charges will apply in Glasgow, the adjacent burghs, and also in the rural districts included in the area which extends from Cambuslang to Clydebank and from Kilsyth to Eaglesham.

Grays (Essex).—A canvass was recently made, at the instigation of the Local Government Board, to ascertain the probable demand for electric current, and at the last Council meeting the consulting engineer (Mr. A. H. Preece) reported that he felt quite safe in saying that there would be an immediate demand for the equivalent of 1,200 8 c.p. lamps for private lighting, which, with an equivalent of 450 lamps for public lighting, would be a fair load to start with.

Holmfirth.—The Council have instructed Messrs. Mitchell and Sons to submit estimates of the cost of erecting electricity works.

Hospital Lighting.—An interesting feature of the large infirmary which was opened in Bethnal Green on Monday last is the electric lighting of the building. The Bethnal Green Board of Guardians, when the new hospital (on which £175,000 was to be spent) was finally decided upon, were determined that it should be replete with all the latest improvements. Contracts were entrusted to Messrs. Owen Lucas and Pyke, who prepared the specification for the whole of the electric lighting scheme; and in due course the tender was awarded to Messrs. Calvert and Co. There are connections for 2,049 8 c.p. lamps, and additional sockets for 392 16 c.p. lamps for use by the doctor on his round through the wards at night. The boiler house contains three 250 H.P. boilers 7ft. 6in. by 30ft., a Worthington pump of 1,000 gallons per hour capacity, and an injector. Two of the boilers are to be employed for heating, laundry, and other purposes. A 40 H.P. motor is used to drive the various laundry utensils. The dynamo house contains two Crompton direct-current 60 kw. generators, supplying current at 100 volts, direct coupled to Willans engines. There is also a battery of 33 K-type E.P.S. cells, having a maximum discharge rate of 300 amperes

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It is intended to shut down the dynamos at 10 p.m., and to light entirely from the cells for the remainder of the night. Mr. G. F. Broadley has been appointed resident engineer, and we are indebted to him for the above information.

Ilkeston.—It has been decided to apply for sanction to borrow £18,271 for electric lighting purposes, and for £62,074 for electric tramway purposes.

Kilmarnock.—The Watching and Lighting committee recommend the Corporation to establish electricity works at an estimated cost of £25,000.

Leeds.—The Tramways committee have been authorised to acquire 1,250 sq. yds. of land adjoining the tramway power station at £4 per yard for extensions.

Legislative Restrictions on Industrial Progress.—At the dinner of the Article Club, on Wednesday, the chairman (Mr. P. A. Muntz, M.P.) referred to the growth of electricity as a motive power, in the use of which foreign countries already outdistanced our own. He did not think the manufactures of this country required any protection. What they did want was a better use of the advantages offered by improved technical and scientific education. Lord Jersey admitted that Parliament, with regard to such matters as telephones, electrical power, and light and heavy railways, had been rather a hindrance than a help, in that it had imposed needless restrictions on the development of the industry. Lord Jersey's view was shared by many subsequent speakers.

Leith.—The Edinburgh and Leith Tramways Co. recently submitted revised terms to the Corporation for leasing the local tramways. The company offer to pay 7 per cent. upon £23,000, the estimated cost of the existing tramways and cabling the lines from Pilrig to foot of Leith-walk, and 5 per cent. upon £54,500, the price of the remainder of the lines within the burgh; also 5 per cent. upon £42,000, the estimated cost of the electric equipment of the whole of the lines within the burgh, excepting the Leith-walk section, which the company propose should wait for five years, while the Corporation are only willing to allow three years. The Tramways sub-committee of the Corporation would accept 7 per cent. for cabling the Leith-walk section, but consider 5 per cent. too low for the rest of the capital required, and that the company should further amend their offer.

Light Railways.—The Board of Trade has confirmed the Isle of Thanet light railway (extension) order in a modified form.

The promoters of the Warrington-Northwich light (electric) railway have decided to proceed with the extension of the railway so as to include Whitley, Little Leigh, Barnton, and Winnington. A supplementary scheme for connecting Winnington with Chester Road is under consideration.

An inquiry has been held into the application of the British Electric Traction Co. for an order to construct an extension of their authorised light (electric) railways in Barnsley and district. Evidence in support of the application was given by Mr. S. Sellon, who said the heaviest gradient was 1 in 13—quite practicable working gradients for electric traction. Power would be obtained from the Barnsley Corporation mains. The cost would be £3,615. 14s., and the period of purchase 28 years. On the suggestion of the Barnsley Council a clause was inserted empowering local authorities to purchase at any time by consent. The Commissioners decided to grant the order.

Liverpool.—The accounts of the electricity department for 1899 have been issued, and show a net profit of £11,206 13s. 8d. It has been resolved to place £6,000 to credit of renewal account, and the balance to reserve. The accounts were passed at Wednesday's Council meeting.

London County Council.—At Tuesday's meeting the dispute between the Council and the Islington Vestry, as to the amount of information to be supplied to the Council when loans for electric lighting purposes are applied for, was considered. The Finance committee in their report urged that the Council, as the sanctioning authority, was the sole judge of the sufficiency or otherwise of the information supplied by London local authorities in making their applications, and that the position taken up by Islington Vestry was untenable. With regard to the loan for £13,200, the Vestry had not satisfied them that the prices making up that sum were fair and reasonable, and accordingly the committee could not recommend the sanctioning of the loan till further information was given; but, following what they understood to be the practice of the Local Government Board, they recommended a loan of £10,000 on account; and a similar course was adopted in regard to the application for a loan of £56,261. The questions at issue referred to the lengths of cable, prices of mains and street work, &c. They had informed the Vestry that they could not take any further steps in the matter of the two loans until the Vestry had supplied these details.

Mr. ELLIOTT said that from personal inquiries he found that all possible information had been supplied to the committee on the authority of the electrical experts employed by the Vestry. If the report of the committee were received as presented, it would mean the complete stoppage of electric lighting works at Islington, because the Council were practically asked to refuse their sanction to the loan. Without that sanction the money could not be raised, and therefore the works must stop. He deplored the fact that such a question had arisen through a difference between the electrical advisers of the Vestry and the Council's officers, and he went into particulars showing the unreasonableness of the position which the Council had taken up.

Mr. HOWELL J. WILLIAMS considered it was merely a difference of opinion between the Council's engineer and the electrical engineers of the Vestry. He argued that the Council's engineers were not electrical engineers, and could not be expected to be able to gauge so accurately and satisfactorily the estimates for such works as the Vestry experts. He pointed out that after all the difference was only one of 5 per cent. between the two sets of figures, and he considered that this was too small to justify preventing electric lighting work in Islington being proceeded with.

Mr. BENSON said Islington Vestry had given the committee more trouble than all the other Vestries put together. The Finance committee were only trying to do the right and fair thing with all those applications which involved the expenditure of large sums of money.

Mr. W. W. BRUCE (chairman of the Finance committee) said the position taken up by the Vestry was that they objected to the practice of the Council in granting them sanction to loans of requiring other than *primâ facie* evidence by the experts employed. That meant that the Council was not to make any inquiry into the statements submitted to them, but that was entirely against the practice of the Local Government Board in such matters. A great boon had been secured by the Council in getting the consent of the Treasury to an extension of loans for electric lighting purposes from 25 to 42 years. Outside London electric lighting loans were only sanctioned for 25 years. This was a distinct advantage, and he urged the Council not to do anything which would in any way imperil that concession.

The report was adopted.

The Highways committee submitted a report on the price charged for current by the Westminster Electric Supply Corporation. On Aug. 1, 1899, the Council consented to the change of the standard pressure of the corporation from 100 to 200 volts between the middle and either of the outers, and from 200 to 400 volts between the outers of the distributing mains. Some customers had complained to the Council that as they were not prepared to accept the increased pressure on the terms offered by the corporation, including the alteration of the service wires and the electric light fittings on their premises, the corporation had raised the price per unit from 4d. to 8d., and had, moreover, required the deposit of a large sum of money. The committee were advised that the corporation could supply at a much cheaper rate, and they recommended that the Council should make a representation to the Board of Trade that it was desirable that the maximum price allowed to be charged should be reduced from 8d. to 5d. per unit. This was agreed to.

Londonderry.—Acting upon the advice of Sir William Preece, whose report on the electric lighting extensions was abstracted in our issue of Feb. 23, the Lighting committee have decided to give a supply of current for private lighting and for power purposes. Further consideration of the report has been adjourned pending the presentation of detailed estimates of the cost of the scheme by the city electrical engineer (Mr. R. V. Macrory).

Madrid.—Up to the 21st inst. the plans for the construction of electric tramways in the city of Madrid, comprising four separate sections, are open for inspection. The *Madrid Gazette* of Feb. 24 contains further particulars.

Marple.—A special meeting of the Council will be held to consider the question of applying for a provisional electric lighting order.

Mexborough.—The Electric Lighting committee have been instructed to obtain tenders for the erection of a dust destructor in conjunction with the electric lighting works.

Motor Vehicle Industry.—At a meeting of the Automobile Club on Tuesday, it was decided to establish a Motor Vehicle Users' Defence Association for the general protection of users of motor vehicles against proceedings or actions at law, and generally to protect the interests of motor vehicle users. The association is open to any user of a motor car on payment of an annual subscription of £2.

Obituary.—The death is announced of Herr Daimler, inventor of the Daimler gas engine, motor car, &c.

Otley.—A committee has been formed to collect information as to the establishment of electricity works.

Paddington (London).—At the Vestry meeting last week the report of the Electric Lighting committee stated that Messrs. Preece and Cardew had reported on a proposal of the Metropolitan Electric Supply Co. to lay extra high pressure mains in Paddington, and they were of opinion that so long as the company complied with the Board of Trade regulations no objection need be raised to the proposal. The committee, however, should stipulate that the mains be laid to the satisfaction of their surveyor, and that the same powers as regards inspection of apparatus, &c., as are given to the Board of Trade be conferred on the Vestry.

Paisley.—The British Electric Traction Co. and Mr. W. M. Murphy have withdrawn their offers for leasing the tramways, and by the casting vote of the chairman it has been decided to drop negotiations with the Glasgow and District Tramways Co., and to introduce a bill next session for the construction of municipal electric tramways.

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Pietermaritzburg (Natal).—The Langdon-Davies Electric Motor Co. recently completed a contract for an experimental consignment of alternating-current electric motors for the Town Council, as they anticipate a large demand for electric motors for industrial uses.

Platinum Supply.—120cwt. 2qr. 16lb. of platinum were obtained from the Ural district of Russia in 1899, an increase of 5cwt. 16lb. over 1898. Owing to the increased demand for this metal and its greatly enhanced market value, extensive operations are being undertaken in the platinum section of this extensive district.

Poplar (London).—The District Board of Works have requested the London County Council to promote legislation to enable metropolitan local authorities to borrow money for wiring consumers' premises and to supply fittings, motors, &c., on hire or on the "easy payment" system. Other metropolitan Vestries have been requested to co-operate with the Board in the matter, and a resolution in support has already been passed by the Newington Vestry.

Portslade.—The Council have withdrawn their opposition to the Brighton Corporation Electric Tramways Bill on condition that nothing in the bill shall interfere with the Council's statutory right to be the electric lighting authority of the district, and that in the event of the Council taking electricity from the Brighton Corporation the minimum price charged to any consumer by the Corporation shall be the minimum charge to the Council, who also ask for a guarantee in the event of the Portslade Council applying for a supply of electric current, in bulk or otherwise, that the Corporation shall undertake to give a supply within a year, this condition being subject to a three years' notice.

Portsmouth.—The negotiations for the transfer of the local tramways to the Corporation have come to a standstill. The question was debated at the Council meeting on Tuesday, when it was decided to take legal proceedings to obtain possession of the lines, after a preliminary consultation with the arbitrator has first been arranged. From April 1 the charge for electric current for public buildings will be reduced from 4½d. to 4d. per unit.

Reigate.—The Council have received sanction to borrow £25,000 for electricity supply, and application has been made to raise the amount by creating Corporation stock.

Salford.—The Corporation have received sanction to borrow £397,408 for erecting a new electricity generating station.

Servia.—The Servian Government, early in 1899, granted an important concession to construct and work a system of six lines of light railways for a period of 90 years, the concession to become operative from May 11, 1899. These lines were for the districts given in the following list:—Belgrade-Obrenovatz-Laïkovatz-Valjevo-Koseyeritz-Pozega. Stalatz-Kroushevatz-Trstenik-Kraljevo-Pozega-Oujitsa. Oujitsa-Kremna-Mokra Gora—Bosnian frontier. Valjevo-Osetchina-Zavlaka-Loznitza—Bosnian frontier. Shabatz-Leshnitza-Loznitza. Kragoujevatz-Gouberovatz-Kraljevo. The concessionnaires were permitted to transfer their rights and privileges to a joint stock company within six months from May 11. 60 kilometres of railway were to be ready for traffic within two and a half years, 200 kilometres within five years, and 400 kilometres within six years. Nine years were allowed for the completion of all the six lines. The Servian Government reserved the right to purchase the railways after the concession had run 40 years, or earlier, with the consent of the concessionnaires; the price to be fixed by a board of assessors to be nominated by the Government and the concessionnaires. In case of disagreement between the parties, and the arbitration board failing to agree, the final appeal lay to the Belgian Government. The privileges and exemption from custom dues provided for by the Railway Law of December, 1898, were granted with the concession, and Article 22 of the Treaty provided that, in the districts traversed by the new railways, the concessionnaires might acquire the right to search for ore deposits and work mines. The concessionnaires did not, however, succeed in forming their company within the six months specified. It is understood that renewal of the concession would be granted if assurances were forthcoming that the required capital had been subscribed. No particular motive power seems to have been specified. Recently a new law has been passed in Servia, authorising a tax collected on the gross profits of commercial firms. In view of the increased trade in plant and apparatus connected with the applications of electricity, it is advisable for foreign manufacturers having business relations with Servia to curtail the period of credit until the effect of this new tax is clearly ascertained.

Sheffield.—Mr. H. S. R. Parton has been appointed manager *pro tem.* of the Corporation Electricity Supply Department.

Shoreditch (London).—The Vestry are inviting tenders for two additional water-tube boilers for the electricity generating station, the estimated cost being £2,100. Representatives have been appointed to attend the conference convened by the Islington Vestry to discuss the procedure of the London County Council in regard to electric lighting loans.

Siam.—The construction of railways and tramways in this country is making sure if somewhat slow progress. Up to the year 1891 no railway or tramway existed. There are now several lines in contemplation, and a large quantity of steam railway material will shortly be required for a line 400 miles in length from Banmayee to Chiengmai and from Ratburi to Petchaburee (near the Burmese frontier). This line will be 118 miles in length. A royal concession to build 70 miles of light railways has recently been granted to Prince Chow Sai, and there is a new railway programme under consideration by the King for constructing lines nearly 500 miles in extent. In 1887 a concession for constructing street railway lines in Bangkok was granted to a syndicate. This line was built for horse traction, and converted to overhead electric trolley in 1892. The line is very successful, and the company working it pays 12 per cent. This line is shortly to be extended, and a new line similar in type is to be constructed. The rolling stock, generating plant, and overhead equipment of the original line are all American, and the permanent way materials are European.

Southampton.—An inquiry was held last week into the application of the Corporation to borrow £55,000 for electric lighting. The town clerk (Mr. R. R. Linthorne) and the consulting engineer (Mr. E. Manville) supported the application, the latter giving technical details. Ald. Bone said that since the electricity undertaking had passed into the hands of the Corporation it had been an unqualified success. During the nine months ended Dec. 31, 1899, the receipts were far in excess of those for the previous twelve months. He felt sure that with the extensions now being made and proposed the undertaking would eventually produce a profit which would go towards the reduction of the rates.

Stockton-on-Tees.—The laying of the electric light cables will shortly be commenced by the Callender Co. Twenty-seven arc lamps are to be erected. The total cost of the gas lamps to be replaced by arcs is £207. 16s. 3d., and the cost of electric lighting will be £562. 16s., but the arc lamps will give 24,000 c.p., against 4,020 c.p. now given by the gas lamps.

Telegrams for Ascension and St. Helena.—Notification is given that telegrams can now be accepted without restriction for Ascension and St. Helena either in code or plain language.

Telegrams for Soldiers.—The Postmaster-General has issued a notification stating that, with the co-operation of the Eastern Telegraph Co., it has been arranged that in telegrams addressed to the troops in South Africa the title of the regiment or battalion (for example, 1st Battalion Princess Louise's Argyll and Sutherland Highlanders) will be counted as one word. Telegrams for officers should give the rank and name in the address, and those for non-commissioned officers and men should give the regimental number and name or rank and name, but both regimental number and rank need not be given. Telegrams should be addressed to Cape Town, whence they will be forwarded to their destination. This arrangement applies only to telegrams ordered "viâ Eastern."

Torquay.—The Local Government Board having sanctioned the borrowing of £2,495—nearly the whole of the balance of the £10,000 applied for recently—for electric lighting extensions, it has now been decided to ask for another £15,000, owing to the continually increasing demand for electric current. The board declined to sanction £164 of the original £10,000, being the amount expended on works rendered useless by the change of site of the station, as well as £200 excess of expenditure over the estimate in the case of the rectifiers. Of the new loan £10,000 will be employed in the purchase of generating plant and £5,000 for extensions to the mains. There are at present 214 customers, representing an equivalent of 11,326 8 c.p. lamps connected, and the capacity of the station is 11,500 lamps.

Trade Marks Law in Japan.—Recently an action was successfully brought in the Japanese law courts against three Japanese for conspiring to counterfeit a British trade mark. In the course of the action it was shown that in prosecutions of this kind it is necessary, according to Japanese law, for the plaintiff to prove knowledge on the defendant's part that the registration of the trade mark has been duly made in Japan. Where it is not feasible for the maker to stamp the words "registered trade mark" in Japanese on his labels or goods, it is important that he should give prominence to the fact of registration in Japan in all advertisements, circulars, and other announcements.

Trowbridge.—The Council have decided to obtain a provisional order, and a special meeting of the Council will shortly be held to consider a report from the surveyor (Mr. Bradshaw) advising the establishment of electricity works of a capacity equivalent to about 4,000 8 c.p. lamps, and estimated to cost from £10,000 to £11,000.

Tunbridge Wells.—The Lighting committee are collecting information as to the construction of a system of electric tramways. A report on the matter will shortly be presented.

Underground Railway Accommodation.—In the House of Commons last week Mr. Ritchie said that the Board of Trade were not in a position to interfere in such a matter as the accommodation on the Waterloo and City Railway. He understood from the manager of the London and South-Western Railway that the number of trains run from Waterloo to the City was as great as

could be run with safety, and that, in consequence of complaints of overcrowding, steps had been taken by the company to regulate the number of persons to be admitted to the platform at any one time.

Whitby.—A Local Government Board inquiry will be held on the 16th inst. into the application of the Council to borrow £26,000 for electric lighting.

Whitechapel (London).—Thirty-five additional arc lamps are to be erected in this district.

Willesden (London).—An inquiry has been held into the application of the Council to borrow, amongst other sums, £3,544 for purchasing land for a generating station. No opposition.

Worcester.—The accounts of the electric lighting department for the year ended Dec. 31 have been issued, and show total capital expenditure of £79,235. 14s. 10d. The receipts amounted to £8,378. 4s. 1d., and generation, distribution, and management expenses, &c., to £4,587. 0s. 9d., leaving £3,791. 3s. 4d. Interest on loans amounted to £1,944. 16s., and sinking fund instalment to £1,755. 15s. 2d. After taking into account the deficit of £460. 1s. 1d. on the previous year's working, there is a credit balance of £90. 12s. 2d. The units generated were 710,416, 109,600 units being supplied to the public lamps, 441,837 to private consumers, and 8,495 used on the works. For public lighting there were 572 500 watt lamps and three 200 watt incandescents. The total maximum supply demanded was 999 kw. The accounts were presented and passed at the meeting of the Corporation on Wednesday.

York.—Ald. Dodsworth, chairman of the Electric Lighting committee, announced at the Corporation meeting on Wednesday that the Council must be prepared for considerable further expenditure on electric lighting. The opening of the electricity works seemed to have brought such a rush of customers for current that it was absolutely essential they should provide for a much larger demand than they had any right to anticipate when the general scheme was drawn up. It was absolutely necessary to take steps to meet next winter's load.

PATENT RECORD.

The following list of Applications for Patents and Specifications published has been compiled for this journal by Messrs. J. C. CHAPMAN and Co., *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs, and Trade Marks may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after the acceptance of the complete Specification. The names within parentheses are those of communicators of inventions. When complete specification accompanies application, an asterisk is affixed.*

February 1, 1900.

2,022. G. E. HEYL-DIA. Manchester. Improvements in the insulation of electric cables.
2,040. B. HOPKINSON. London. Improvements in the system of electrical distribution.
2,050. E. H. TYLER. London. Improvements in controlling electrically-propelled vehicles.
2,062. H. BOURNE. London. Improvements in arc lamps.
2,077. V. CHEVAL and J. LINDEMAN. London. An improved accumulator battery.*
2,079. G. F. MANSBRIDGE. London. Improvements in electrical condensers.
2,085. M. MAYHEW and M. E. CARTHEW-YORSTOUN. London. Improvements in the generating apparatus of searchlights.

February 2, 1900.

2,104. W. F. STAMP. Sunderland. Magnetic electrical surface contact for electrical trams and light railways.
2,109. G. E. HEYL-DIA. Manchester. Improvements in or relating to electric cables.
2,119. L. M. WATERHOUSE and THE SIMPLEX STEEL CONDUIT CO. (LTD.) Liverpool. Improvements in and relating to junction boxes for electric conductors.*
2,120. L. M. WATERHOUSE and THE SIMPLEX STEEL CONDUIT CO. (LTD.) Liverpool. Improvements relating to electric switches.*
2,142. I. ALEXANDER and C. BANNISTER. London. Improved means for controlling and regulating the consumption of electric current on light and power circuits.
2,150. G. DALLAIRE. London. Improvements in telephone transmi ters.*

February 3, 1900.

2,173. F. ARROWSMITH and HOWARD AND BULLOUGH (LTD.). Accrington. Improvements in electric stopping mechanism for drawing or slubbing frames.
2,176. A. ECKSTEIN and A. E. ANGOLD. Manchester. Improvements in regulating mechanism for arc lamps.
2,191. C. W. HILL. London. Improvements in electric brakes.
2,212. W. PERITZ. London. Improvements in electric arc lamps.
2,219. R. ARNO. London. Improvements relating to the measurement of electric power and energy. (Date applied for under Patents, &c., Act, 1883, sec. 103, July 5, 1899, being date of application in Italy.)
2,222. A. WRIGHT and THE REASON MANUFACTURING CO. (LTD.) London. Improvements in electricity meters.

February 5, 1900.

2,260. H. BREMER. Germany. Improvements in electric arc lamps.*
2,271. A. J. BOULT. London. Improvements in or relating to electric ignition devices for explosion engines. (La Société Anonyme des Moteurs et Voitures "Aigle," France.)*
2,282. G. DALÉN and A. HULTQVIST. London. Improvements in dynamo-electric machines. (Date applied for under Patents, &c., Act, 1883, Sec. 103, July 7, 1899, being date of application in Sweden.)*

February 6, 1900.

2,297. D. COOK. London. Method of transforming alternating into direct currents and *vice versâ*.
2,310. J. H. MURRAY. Glasgow. Improvements in the application of electric lamps to dentists' and like mirrors.
2,340. E. DUCRETET. London. Improvements in telephones.*
2,356. SIEMENS BROS. AND CO. (LTD.). London. Improvements in apparatus for regulating the electric lights on theatre stages. (Siemens and Halske Aktien Gesellschaft, Germany.)*
2,357. SIEMENS BROS. AND CO. (LTD.). London. Improved electro-magnetic bell signalling apparatus. (Siemens and Halske Aktien Gesellschaft, Germany.)*
2,366. A. ROUBLEFF. London. Improvements in the production of fi'aments for electric incandescence lamps.
2,370. G. C. DYMOND. Liverpool. Improvements in means for maintaining a constant speed of a driven shaft, electric generator spark generator, or other revoluble part. (H. N. Motsinger, United States.)*
2,384. W. M. MORDEY. London. Improvements in or relating to alternate current distribution.

February 7, 1900.

2,409. H. A. KENT. London. Improvements in electrodes or electrical conductors.
2,473. E. C. MARÇAY. London. Improvements relating to electric arc lamps.

February 8, 1900.

2,518. A. ECKSTEIN and H. J. COATES. Manchester. Apparatus for recording without friction the indications of electrical and other measuring and indicating devices.
2,526. W. J. MARTIN and M. LACHMAN. London. Improvements relating to incandescent electric lamps.
2,543. S. W. MAQUAY. London. Improvements in and connected with primary batteries.
2,544. H. BAKER. London. Improved means of making electrical connections to carbon electrodes.
2,549. J. KUNST. London. Improvements in contacts for electrical alarm bells.
2,557. W. H. COADE. London. Improvements in adjustable blocks for fixing electrotype or other printing plates in "formes" for printing.

February 9, 1900.

2,590. R. D. KIMBALL and A. A. MCKENZIE. Kingston-on-Thames. Improvements in conduits for gas, air, water and like pipes and electric wires.
2,595. A. W. BAXTER and C. BAXTER. St. Leonards-on-Sea. Improvements in electrical storage or secondary batteries.
2,598. E. LAVANCHY. London. Improvements in phonographs.
2,621. A. RUHSTRAT and E. RUHSTRAT. London. A new or improved safety device for electric lamps.*
2,638. J. M. DAVIDSON. London. Improvements in Röntgen-ray apparatus and in interrupters applicable for use in connection therewith or for other purposes.
2,639. G. BLANCK, S. SYMONS, and A. P. B. LOFTUS. London. Improvements in and relating to telephonic apparatus.
2,641. J. J. STEINBACH. London. Improvements in electric traction on the road contact system.

SPECIFICATIONS PUBLISHED.

NOTE.—**All Specifications can now be obtained at the uniform price of 8d. each.**

1899.

934. ALCOCK. Apparatus for electrically transmitting orders, signals, or indications from one place to another.
974. TERREY and PHILLIPS. Prepayment electricity meter for continuous or direct currents, whose action depends on deposition of copper in a balance against silver coins.
1,047. SUTCLIFFE. Construction of straight and curved underground conduits for enclosing electric conductors, haulage cables, and other means of communication, allowing connection of vehicles, sledges, and moving bodies to same and allowing access below.
1,230. ELIESON and NAYLOR. Lighting trains by electricity.
2,273. DAY (O'Neill and Rooney). Electro-therapeutics.
2,627. WENDT and KRAUSSE. Electric time and fire and like alarms.
3,005. LANE. Electrical switches.
3,130. BROWN. Electric lamps.
3,594. BAGGETT. Arc lamps.
3,784. BADGER and PLEWS. Electric safety appliances.
3,999. MILNES. Electric traction for tramcars and the like with accumulators.
4,065. VERITYS LTD. and STEELE. Electrical switches.
4,416. LAMME. Direct-current systems of electrical distribution. (Date applied for under International Convention, Aug. 4, 1898.)
5,548. BRITISH THOMSON-HOUSTON CO. (LTD.) (Steinmetz.) Devices for changing the frequency of alternating currents and systems of electrical distribution.

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5,549. BRITISH THOMSON-HOUSTON Co. (LTD.) (Steinmetz). Systems of electrical distribution.
5,857. BROWN. Apparatus for use in connection with electrical advertising signs and display boards.
8,641 THE BRITISH THOMSON-HOUSTON Co. (LTD.) (Thomson). Apparatus for rectifying alternating electric currents.
8.775. LACHMANN. Electric incandescent lamp fittings.
8,840. THE BRITISH THOMSON-HOUSTON Co. (LTD.) (Davis). Incandescent electric lighting systems.
9,246. THE BRITISH THOMSON-HOUSTON Co. (LTD.) (Fish). Apparatus for measuring electric currents.
13,849. ATHERTON. Electric incandescent lamps.
23,021. SEFTON-JONES. (Kölner Accumulatoren-Werke Gottfried Hagen.) Electric motor road vehicles.
23,047. DUCRETET. Radioconductor tubes or electric coherers.
24,196. HARRISON. (Auto-Protective Appliance Co.) Thermostatic electric switches or pushes.
24,208. LAKE (Williams). Electrically-controlled locking mechanism for collecting and other boxes.
24,337. VAN DEVENTER. Electric incandescent lamp.
24,431. HARRIS. Electric demand indicator.
24,439. BRITISH THOMSON-HOUSTON Co. (LTD.). (General Electric Co.) Systems of electric distribution particularly applicable to electric railway systems.
24,473. MAJERT. Electric accumulator plates.
24,940. LOMBARD-GERIN. Auto-motor trolleys for electrically-driven vehicles.

COMPANIES' MEETINGS AND REPORTS.

Chelsea Electricity Supply Co. (Ltd.).

The ordinary general meeting of this company was held on Wednesday, under the presidency of Mr. J. IRVING COURTENAY.

The SECRETARY (Mr. S. J. Cluer) having read the notice calling the meeting, the report of the directors was taken as read.

The CHAIRMAN then said: The dividend of 6 per cent. on the ordinary shares has been maintained, although the capital was increased at the end of 1898 by a debenture stock issue of £40,000. Owing to the state of the money market last October, it was deemed advisable to make an issue of debenture stock rather than shares, and £50,000 was issued to meet the necessary capital expenditure. The issue was largely over-subscribed. As I intimated on the last occasion of my addressing you, an increase of the dividend on the ordinary shares could hardly be expected this year, owing to capital expenditure in purchases of land under the powers of our Act of Parliament for compulsory purchase of lands, and in making provision for extensive buildings suitable for the growth of the business. In regard to the capital expenditure, I may point out that we are now approaching a period when the expenditure in some directions will be appreciably less, and there will be an increasing return on the capital already expended, while other metropolitan companies are just beginning to provide for their future wants by large capital expenditure on works and buildings. Some of the companies, as you know from the newspapers, have been in serious difficulties recently, owing to their being behindhand in these matters. It is a pleasure to me to say that we have never yet been wanting in our supply, and we may justly be proud that no one can point to any case of failure or refusal to supply or of inefficient supply on the part of the Chelsea Co.

I will now make a few remarks as to the encouraging prospects in the immediate future. First I may draw your attention to the fact that the cost of the unit is decreasing in all its items, the total cost being nearly one halfpenny less than in 1898, and the proportion of costs to revenue being 42½ per cent., as against 48 per cent. for 1898. Another direction in which we may look for improvement is in the increase of custom and the generally increased use of the light by all the consumers, which will be the certain result of the reduction in price by the introduction of the maximum demand system of charging for current supplied. I have before now mentioned the fact that our revenue per lamp is low compared with that of other metropolitan companies, owing to the character of the district; and it is with the view of increasing this that we have, after careful consideration, introduced this system of charging, which has been most successful at Brighton and many other towns. This system has the effect of encouraging the use of the light for long hours by giving the long-hour consumer, though he may have only a few lamps, a distinct advantage in price over the consumer who may use large quantities for a short time only. You will readily see that by this means the plant is employed for longer hours, and thus earns a larger return on capital expenditure. I wish particularly to call your attention to this system. With it the shops, whether large or small, which are open during long hours will find it to their advantage to use electricity in preference to gas, and the smaller private houses in the less fashionable parts of the parish, where the light is used regularly throughout the year, will also gradually discover that the electric light is by no means an expensive luxury. The system was introduced in October last, and we cannot expect to get the benefit of it until it becomes widely known, but we have sent circulars to about 7,000 residents in Chelsea, showing by actual results the benefit obtained by the consumers; and this should within the next twelve or eighteen months bring an increase not only in the number of lamps but in the revenue per lamp. Bearing in mind that our price had hitherto been 6d. per unit, excepting to a few large consumers, our circular shows that many residences and shops by using the light regularly for fairly long hours obtained it at prices ranging from 5d. to 4d.; that public-houses and staircases in flats, where the whole of the light is used for very long hours, obtained it at prices from 4d. to 3½d. We have also published the fact that we are prepared to wire premises on the purchase-hire system. We have to be prepared to meet some disadvantageous elements. There is of course the reduction in price, which will be, however, compensated for in a short time by increased use of the light. We cannot, unfortunately, expect a good London season (which affects Chelsea more than most other districts) this year, owing to the war, and there is also the serious increase in the price of coal.

As mentioned in the report, we have considered it not only prudent but imperative to make some provision for this latter item, and have set aside and placed to reserve £1,096. 8s. 5d. out of profits towards the inevitable expenditure under that head. A sum somewhat in excess of that provided in 1898 has been placed to renewals and depreciation, in view of the increase in capital expenditure. Some shareholders, indeed, would like to see larger amounts provided for depreciation. The necessity for these provisions is so obvious that I should not draw pointed attention to them were it not that certain holders of founders' shares seem to be of opinion that they are being hardly used. As I have pointed out, we may reasonably expect an improvement in revenue in the next 18 months, and any weakness in our financial policy now could not fail to be distinctly injurious to all classes of shareholders in the future, and detract from the benefits we hope and expect to derive from efforts to improve and strengthen the position of the company. We have completed the large generating station at Alpha-place, and are putting in the remainder of the plant. This station will have a capacity for serving a total lamp connection of 150,000. Additions have also been made to the workshops: these are well equipped, and have been of great assistance in carrying out efficiently and with proper economy the necessary constructional and repairing work for the company's stations. A new storage and distributing station has been erected on freehold land at Carlyle-square. This has been equipped and is now at work. One more sub-station is being erected in Milner-street, and this will complete the sub-stations required for serving the district. In this connection I may mention that the capital expenditure on these sub-station buildings, which are of a substantial nature, must necessarily be somewhat heavy, and it is satisfactory to know that the expenditure under this head will cease with the completion of the Milner-street station. The buildings themselves are sufficiently large to contain plant to meet the probable demand for a supply of electricity for many years to come. Important extensions of the mains have been carried out to meet the increasing demand for a supply in various parts of the parish. The number of lamps added during the year was 16,280, which is slightly more than in the previous year. The principal saving effected is in the coal, the figures in connection with which are quite remarkable, for under this head there has been a saving of about ¼d. per unit. This result has been obtained partly in consequence of the very careful supervision which has been maintained to prevent waste of fuel, and partly in consequence of the attention given to rendering more perfect the coal-saving appliances. This saving of fuel is particularly important in view of the abnormal increase which has since taken place in the price of coal, to which I have already alluded.

I have only one or two more words to say. Mr. Emile Garcke has resigned his seat on the board. His financial and technical experience was of great value, and we much regret the necessity for his leaving us. I must also report with extreme regret the death of our late managing engineer, Mr. Frank King. The engineering duties are now carried out efficiently by Mr. Percy Still as chief engineer. There are few large business undertakings which have not temporarily lost the services of some of their employés who have gone to South Africa. In the case of this company several of our men have been called up to join the reserves, and the company is contributing towards the maintenance of the wives and families, feeling sure of the support of the shareholders in that course. I now move the adoption of the report and accounts, and the dividends recommended therein.

Major-General WEBBER, C.B., seconded the motion, and said: The Chelsea Co. has been quietly doing in anticipation what many other companies are now being forced to do—that is, we have spent considerable sums on freehold and leasehold lands, and we have also expended on buildings what would at first sight appear to be rather a heavy charge in order to house the plant which they contain, and which was necessary for the present and immediate future supply of the district.

Mr. MAKINS said he saw their reserve fund amounted to something like £50,000. He attended a meeting on the previous day of the Notting Hill Co., whose reserve fund was £6,000. He asked a question whether this amount was considered sufficient, not only for the present but for a reasonable time to come, and the answer that he received was that it was quite sufficient, and that they did not require a reserve fund at all, the whole of the machinery and upkeep of the works being maintained out of revenue.

Mr. DAWES held that, instead of carrying forward the amounts carried forward in the two previous years, he held that one-third of the amount ought to have been divided among the holders of the founders' shares. He maintained that, while not disputing the right of the directors to carry forward a reasonable amount, one-third of the surplus profits, after a dividend of 6 per cent. had been paid in any year, should go to the founders. He wished to know what the directors intended to do with this fund of £1,096? He moved as an amendment, "That the amount of £1,096. 8s. 5d. be not placed to a coal reserve fund, but be added to the year's net revenue and divided between the holders of the ordinary and founders' shares."

Mr. MAKINS seconded.

Mr. BINGHAM asked how large a reserve fund the directors thought it necessary to put by?

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The CHAIRMAN said: I do not agree with the view expressed at the Notting Hill Co.'s meeting, that £6,000 is a sufficient reserve. I prefer to take the policy, for instance, of the St. James's Co., who have a reserve fund of £50,000. As to the founders' shares, the board wish to divide all that they can as prudent men between the founders and ordinary shareholders. If you have a sinking fund, it must come out of the profits. Things look very favourable now with us, but a day of adversity may come, and what we desire is that the company may be put into a strong position. We have a reserve of £47,000, but if we had not that fund we should have had to have extra capital. That £47,000 consists of the premiums received on shares and debentures after paying the charges connected with their issue. As to the law on the subject of the founders' shares, the directors had been guided by the advice of Mr. Justice Buckley and Mr. Palmer. It is their view that it is the duty of the directors to see that there is a proper reserve kept, and that we ought not to divide the profits up to the hilt every year. I venture to say—and I am sorry to say it—that the Chelsea Co. is putting less to reserve than any other electric lighting company. On the question of the cost of coal, this will unquestionably increase.

Mr. H. H. CUNNINGHAME said it was natural the founders should desire to participate in the profits, and it appeared certain they would do so a little later on. No one would deny, however, that the founders had not only no legal right, but no moral right, to force prematurely a distribution to the detriment of the interests of the shareholders as a whole.

The amendment was then withdrawn, and the original motion was carried unanimously.

The retiring directors (Mr. Courtenay and Major-Gen. Webber) and the auditors (Messrs. Cooper Bros. and Co.) were re-elected, and a vote of thanks to the chairman and directors brought the meeting to a close.

Oldham, Ashton, and Hyde Electric Tramway (Ltd.).

The third ordinary general meeting of this company was held yesterday (Thursday), at the offices, Donington House, Norfolk-street, Strand, under the presidency of Mr. EMILE GARCKE, M.Inst.E.E.

The SECRETARY (Mr. H. S. Hodgson) having read the notice convening the meeting,

The CHAIRMAN proposed the adoption of the report and accounts, and of the recommendations therein contained. He stated that the working of the lines during the first six months had demonstrated that the estimated profits upon which the statements in the prospectus were made had already been fulfilled. It was estimated that when the tramway was in full operation the net profits, after providing for all expenses except depreciation, would be about £10,000 per annum, and that the amount required to pay interest on the debentures when issued and the dividend on the preference shares would not exceed £3,800. This left a sum of £5,200 out of which to provide for depreciation and dividends on ordinary shares. The result of the working for the first six months—it was rather more than that—showed a net profit of £4,419, after paying £390 for debenture interest, making therefore a total net profit of £4,809. Deducting from this the preference dividend for the full half-year, £3,809 (as against the estimated amount of £3,100) was the balance available for depreciation and dividend on the ordinary shares, if the circumstances admitted of the payment of such dividend. The traffic receipts had been £12,397, which was already in excess of the estimates upon which the profits he had referred to were calculated. When he told them that that amount represented the conveyance of over 2,000,000 passengers in the course of the half-year, he thought that the shareholders would appreciate that the company had rendered a very important public service. With reference to the appropriation of the net profit of £4,419, they had first to provide for the cumulative preference dividend from Aug. 15 to Dec. 31 last, that being the period for which the guarantors had not paid this dividend; and in the next place, it was proposed to repay to the guarantors £2,552 in respect of the amounts which the guarantors had paid to the preference shareholders for cumulative dividend up to Aug. 15 last. Under the terms of the prospectus the preference shares were cumulative as to dividend, and they were entitled to dividend as from the date of allotment on the amounts from time to time paid up; and as the company could not make any profit until the lines were open for traffic, it was provided that this dividend should be met by the guarantors. Under the agreements the guarantors were entitled to the repayment of their advances out of the first profits. The board had received some representations from shareholders on the question of whether a dividend should not be paid on the ordinary shares and the repayment of the advances made to meet the preference dividend postponed, but he thought it necessary, on the part of the board, to at once state definitely that such a course would not only be wrong morally but absolutely illegal. The shareholders must therefore wait until the accounts for the current year had been made up before they could receive a dividend, and he did not think that this was very much to ask them to assent to. The directors also proposed to place £500 to depreciation fund, and to carry forward £617. Since the opening of the line for traffic on June 12 the service given, taking it altogether, had been very favourable. He was in the district only the previous night, and he had been very pleased to find that everything was going on very smoothly, and everyone was pleased with the way the undertaking was being carried on. During the past year the directors had issued £40,000 of 4 per cent. mortgage debentures: a certain proportion was placed at a small premium, and the balance was taken by the guarantors at par under the terms of their agreement. The total capital expended up to the end of last year was £121,461. He regretted the unfortunate litigation that was pending with the Corporation of Hyde in regard to the laying of feeder cables under the footway. It had always been considered by tramway promoters that the provisional orders allowed them to do this. The board had been strongly advised by counsel that what had been done in the matter was right, and that they ought not to give up an important principle without having the question dealt with in a court of law. When, therefore, the Hyde Corporation served the company with a writ, no other course was open to the directors but to defend it. Unfortunately, in the court of first instance a decision was given against the company, with damages of £100. Counsel were again consulted, and the board were strongly advised that on appeal the decision would no doubt be reversed. Under these circumstances the directors felt that there was no other alternative but to proceed with the matter. They had thought that there would be no difficulty in making legitimate extensions of their system when the public of the district and the local authorities recognised that a satisfactory service could thus be afforded, but he regretted to say that the application they had made for the extensions indicated on the map was being opposed by the local authorities. He hoped, however, that wiser counsels would eventually prevail in regard to this matter.

Mr. A. R. MONKS seconded the motion.

In the discussion which followed general satisfaction was expressed at the result of the working of the lines so far, but an opinion was expressed by some shareholders that a dividend should be paid on the ordinary shares, and an amendment was proposed and seconded that the accounts be not received.

The CHAIRMAN, in reply, expressed regret that, after the explicit statement he had made in regard to the payment of an ordinary dividend, an amendment should have been brought forward.

On a show of hands the amendment was lost, and the original motion was afterwards adopted.

A vote of thanks to the chairman and directors terminated the proceedings.

The directors' report stated that during the year £40,000 4 per cent. debentures have been issued. The premiums received (£322) have been placed to reserve. In order to cope with the traffic it has been found necessary to obtain eight additional motor cars and 12 trailer cars, and to extend the car depot to provide facilities for storing the extra cars. The total capital expenditure now amounts to £121,461. 13s. 4d. The total revenue from the date of commencing to work (June 12, 1899) to Dec. 31 amounted to £12,606. 0s. 5d., and the expenditure (including debenture interest) to £8,186. 4s. 6d., leaving a net profit of £4,419. 15s, 11d., which the directors propose should be applied as follows: Dividend of 5 per cent. per annum on cumulative preference shares from Aug. 15 to Dec. 31, £750; owing to guarantors, being advances to meet dividends on cumulative preference shares from Jan. 18, 1898, to Aug. 15, £2,552. 3s. 4d.; placed to depreciation, £500; carried forward, £617. 12s. 7d.

The Ashton Corporation have maintained a satisfactory supply of electrical energy for working the lines. The company have appealed against the judgment in the action by the Hyde Corporation for preventing the use of feeder cables which have been laid under the footpaths. The directors have made application under the Light Railways Act for certain extensions of the lines.

Amazon Telegraph Co. (Ltd).

The fifth ordinary general meeting of this company was held on 2nd inst., Mr. D. H. GOODSALL presiding.

The SECRETARY (Mr. R. M. Cunningham) read the notice calling the meeting. The report of the directors was taken as read.

The CHAIRMAN said the result of the year's working was a debit balance of £29,000. This was owing to the difficulties which had been experienced in maintaining the cables. The traffic was there, and if the lines could have been maintained the accounts would have shown a very different appearance. They had an excellent captain at the present time working on the cables, and he had met with considerable success. In three places the cables had been diverted and put partly on land and partly into side waters, and the board hoped that the change would lead to the permanent maintenance of the parts so diverted. The cable would be similarly diverted wherever it was found that it would not last in its present position. The directors believe that by sticking to the enterprise they would ultimately bring the cable into a permanent state of usefulness. They had succeeded in obtaining from the Government of the State of Amazonas a concession for a land line. The Government had nearly completed the road which they undertook to make for this line, and the directors hoped that they would shortly succeed in erecting it. They had already sent out more than one-third of the material required, and the remainder had been ordered. When this land line was up the company would receive, as long as they kept it in working order, a further subsidy of £10,000 a year. Beyond that, the land line would duplicate a part of the system which had so far given the largest amount of trouble. As soon, therefore, as the land line was finished they would have two strings to their bow over the worst part of their system. He concluded by moving the adoption of the report.

Mr. JOHN COPPEN seconded the motion.

In reply to a question,

The CHAIRMAN stated that the terms required by the Wireless Telegraph and Signal Co. for using their system were so excessive that they could not entertain the matter. If they could keep their service at work they would earn £27,000 a year in subsidies, and they had a good traffic as well. Part of the system—unfortunately, it was not a very profitable portion—had remained in working order nearly the whole of the time the company had been at work, and on this part an increase of about 85 per cent. had taken place in the traffic during the four years. This was very satisfactory for a telegraph company.

The report was unanimously adopted, and the retiring directors—Lord Richard H. Browne and Mr. Coppen—were afterwards re-elected, as were also the auditors, Messrs. Deloitte, Dever, Griffiths and Co.

A vote of thanks to the chairman and directors terminated the proceedings

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City of London Electric Lighting Co. (Ltd.)

The report of the directors for the year ended Dec. 31, 1899, states that the capital expenditure during the year amounted to £138,766. 18s. 4d. The total revenue for the year was £187,253. 16s. 7d., from which must be deducted expenses of generation and distribution £69,478. 15s. 11d., rent, rates, taxes, general and special charges £30,451. 2s. 6d., transfer to depreciation fund £21,000, transfer to reserve £2,349. 10s. 7d. (total £123,279. 9s.), leaving a balance of £63,974. 7s. 7d., to which is added £3,381. 13s. 6d. from the previous year, making a total available revenue of £67,356. 1s. 1d. Of this £30,933. 6s. 8d. has been distributed, £19,333. 6s. 8d. as interest on debenture stock and £11,600 as interim dividend on £400,000 6 per cent. preference shares, leaving £36,422. 14s. 5d. for further distribution. The directors now recommend the following dividends for the year, less income tax:—*Preference shares* (Nos. 1 to 40,000), 12s. per share (the full rate of 6 per cent.); *ordinary shares* (Nos. 40,001 to 100,000), 8s. per share (at the rate of 4 per cent. for the year). This will absorb £34,800 and leave £1,622. 14s. 5d. to be carried forward. Dividend warrants will be posted on March 16.

The generation and distribution expenses for the year, including repairs and renewals, were 49·31 per cent. of the gross earning, compared with 36·1 per cent. for 1893, 31·3 per cent. for 1897, 34 per cent. for 1896, 36·87 per cent. for 1895, 46 per cent. for 1894, and 54·2 per cent. for 1893. The increase in the percentage during the past year is due to a largely increased output having been supplied at a greatly reduced rate of charge to the consumer. The following comparative statements show the progress made by the company and at the periods to Dec. 31 in each year:—

Number of Customers and Lamps Connected.

	1892	1893	1894	1895	1896	1897	1898	1899
No. of customers...	242	1,080	2,740	4,230	5,303	6,323	7,414	8,738
Equiv 8 cp. l'mps con.	20,241	65,341	135,460	195,317	247,785	296,012	355,825	429,628

On Feb. 21, 1900, there were 465,712 8 c.p. lamps (equivalent) applied for, out of which 444,361 were connected. Units sold for private lighting during 1899 were 7,446,703, compared with 5,837,317 for 1898. The income for the periods to Dec. 31 in each year was as under:—

	1892	1893	1894	1895	1896	1897	1898	1899
	£	£	£	£	£	£	£	£
Gross rev.	12,450	39,663	68,864	107,000	146,947	175,793	175,608	187,254
Net rev...	500 (est.)	16,941	34,865	59,100	85,701	107,550	97,842	87,324

The statutory provision for depreciation and reserve, in accordance with the City of London Electric Lighting Act, 1833, has been made, of which £23,349. 10s. 7d. have been set aside out of revenue.

A bill is being promoted in Parliament for the compulsory acquisition of certain properties, which interfere with the full development of the site of the Bankside station, and for relieving the company of the statutory obligations as to the provision of depreciation and reserve funds, &c.

The directors have resolved to issue 20,000 ordinary shares of £10 each, being the balance of the additional £400,000 ordinary share capital of the company which will be allotted at par *pro rata* to the holders of preference and ordinary shares.

The approval of the Board of Trade has been received to the company's system of continuous current and to the alteration of standard pressure. The additional buildings and plant are rapidly approaching completion, and the alteration of consumers' fittings to adapt them to the higher pressure is being actively proceeded with.

The directors regret that application by another company for powers to supply electric energy in this company's area has been successful. The expenditure in connection with the opposition to this application (£3,645 19s. 9d.), the balance of suspense account (£4,260. 14s. 3d.), and replacements, &c. (£3,647. 14s. 3d.), have been written off out of the balance of premiums.

Metropolitan Electric Supply Co. (Ltd.).

The report of the directors for the year ended Dec. 31, 1899, states that the capital expenditure, which at the end of 1898 amounted to £993,761. 13s. 9d., has now reached £1,244,254. 1s. 6d., an increase of £250,492. 7s. 9d., and an excess of expenditure over receipts of £18,977. 12s. 7d. The principal item of expenditure was for the new works at Willesden. A portion of this capital expenditure was provided by the issue of £125,000, being half of a new 3½ per cent. mortgage debenture stock which the directors considered it expedient to create. This issue was offered to the shareholders at 97 per cent., and the whole of it placed at that price. The gross revenue for the year amounted to £179,190. 1s. 10d., against £151,605. 12s. 3d. in 1898, an increase of £27,584. 9s. 7d. The cost of generation, which in 1898 was £76,736. 8s. 7d., amounted in 1899 to £90,419. 7s. 1d., an increase of £13,682. 18s. 6d.

During the whole of the period under review the erection of the company's new generating station at Willesden was proceeded with, but owing to delays in the deliveries of constructional and other ironwork, the completion of the works was seriously hindered, with the result that from early in October to Dec. 15, when they commenced to supply current, the resources of the Manchester-square station were unduly taxed, and it was found necessary to temporarily withdraw supply from certain circuits at hours of maximum demand.

The directors have endeavoured to meet the consumers affected in what they regard as a fair and reasonable manner. Since Dec. 15 the Willesden generating station has been working satisfactorily. The construction of the new street from Holborn to the Strand involves the compulsory acquisition by the London County Council of the company's works at Sardinia street, and a clause was inserted in the bill by which the company's interests are fully protected. A protective clause was also inserted in the Central Electric Co.'s bill,

The balance to the credit of revenue account, before providing for depreciation, is £66,392. 17s. The directors have added £13,000 to depreciation and reserve, carrying to the credit of net revenue £53,392. 17s., which, with balance from last account and other receipts, makes a total of £57,728. 10s. After deducting debenture and share interest and other charges, there appears a balance of £25,660. 6s. 3d. An interim dividend of 5s. per share on the ordinary share capital was paid on Aug. 14, 1899, amounting to £19,679. 12s. 8d., and the directors recommend that a further dividend of 5s. per share on such shares be now paid, making a total distribution of 10s. per share for the year, or 5 per cent. on the capital. This will absorb a further £21,250. and leave a balance of £4,410. 6s. 3d. to be carried to next account. The directors consider this to be satisfactory, in view of the exceptional circumstances under which the working has been carried on during the year, and having regard also to the large amount of capital which, while entailing additional charges upon revenue, has been unproductive for practically the whole of the year.

The equivalent number of 8 c.p. lamps supplied by the company increased during the year 1899 from 430,000 to 500,000. The present number of lamps connected is 503,000, and the applications show no signs of decrease. The engineer's report shows that the satisfactory condition of the stations, machinery, and plant has been maintained.

Mr. James Carr Saunders and Mr. Frederick Leverton Harris have been elected on the board, and have appointed Mr. W. Harrison Cripps chairman. The term of Mr. Frank Bailey's appointment as engineering director having expired, he has been elected an ordinary member of the board. Mr. J. Conacher has been appointed general manager of the company.

Brompton and Kensington Electricity Supply Co. (Ltd.).

The annual report of the directors for the year ended Dec. 31, 1899, states that the revenue account shows a credit balance of £18,180. 16s. 6d., which, with £159. 8s. 5d. brought forward and £1,237. 5s. 1d. balance of interest received, makes a total of £19,577. 10s. After deducting £2,250 for debenture interest, £2,100 for interim dividend on the 7 per cent. cumulative preference shares, and £2,457. 12s. 6d. for interim dividend at the rate of 5 per cent. per annum for the half-year to June 30 on the ordinary shares, the directors recommend that the balance (£12,769. 17s. 6d.) be dealt with as follows: Depreciation, £4,500; reduction of renewals suspense account, £2,500; balance of dividend to Dec. 31 on 7 per cent. cumulative preference shares, £2,100; dividend on ordinary shares for half-year to Dec. 31, at 7 per cent. per annum (making 6 per cent. for year), £3,440. 13s. 6d.; balance forward, £229. 4s. The increase during the past year is the largest in the history of the company. The supersedure of plant has proceeded so far that the company's station has now been practically remodelled, the whole of the rope-driven plant having been replaced by high-speed direct-coupled units of the most economical type, and the faulty rubber-covered cable by paper-insulated cable. The result is most satisfactory. The total estimated cost of the plant involved, less receipts from the sale of old material, will not exceed £26,702, of which £23,702 has been incurred to date. To provide for this it is proposed to appropriate £7,000 from depreciation account and £2,500 from net revenue, carrying forward £14,202 to a renewal suspense account, to be written off out of future profits, which the new plant should considerably enhance.

MEMORANDA.—Bank rate 4 per cent. (since Jan. 25, 1900). Price of silver 27⅞d. per oz. (Mar. 8). Consols (2¾ per cent.) 100⅜—100⅝ for money, 100⅝—101 for account; 2½ per cent. 97⅞—98⅛ xd (Mar. 8). Stock Exchange Settling Day: Consols, April 4; Stocks and Shares Continuation Days, Mar. 12 and 27; Ticket Days, Mar. 13 and 28; Pay Days, Mar. 14 and 29; Mining Share Carry-over Days, Mar. 10 and 26.

ALLIANCE ELECTRICAL CO. (LTD.)—A meeting of this company was held yesterday, Mr. George Verity presiding. He congratulated the shareholders on the satisfactory condition in which the company and its affairs now stood. Owing to legal difficulties, it was proposed that, instead of paying a dividend at the rate of 10 per cent. on the ordinary shares from Feb. 1, 1899, a dividend at that rate would be paid only from the end of July, 1899, while for the other period up to that date the ordinary shareholders, the vendors, had agreed to be content with the interest on the purchase money at the rate of 5 per cent., the end of July being taken as if that were the actual date on which the purchase was completed.

BRUSH ELECTRICAL ENGINEERING CO. (LTD.)—The ordinary general meeting of this company will be held on 19th inst.

COUNTY OF LONDON AND BRUSH PROVINCIAL ELECTRIC LIGHTING CO.—The transfer books and register of members will be closed from 13th to 26th inst. inclusive, preparatory to payment of dividend for the year to Dec. 31.

DAVIS AND TIMMINS (LTD.)—The directors' report for the past year recommends the payment of the 6 per cent. interest on the preference shares for the six months to Dec. 31, and a dividend on the ordinary shares at the rate of 8 per cent. per annum.

ISLE OF MAN RAILWAY CO.—Mr. J. Denison-Pender presided at the annual meeting of this company, held on Wednesday, at Douglas, and said that, with regard to the opposition of the electric tramways, the increased receipts of the Isle of Man Railway for last season, compared with other years, showed conclusively that the tramways would not affect them to the extent that had been anticipated by some of the shareholders.

SOUTH LONDON ELECTRIC SUPPLY CORPORATION (LTD.)—The ordinary general meeting will be held at Winchester House, Old Broad-street, London, E.C., on Thursday the 15th inst., at noon. The transfer register is closed from 8th to 22nd inst. inclusive.

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Notting Hill Electric Lighting Co. (Ltd.).

The thirteenth ordinary general meeting of this company was held on Tuesday, Sir WILLIAM CROOKES, F.R.S., presiding.

The SECRETARY (Mr. R. G. Rawkins) having read the notice calling the meeting,

The CHAIRMAN said: Gentlemen, it is with pleasure that I again have this opportunity of presiding at your annual general meeting, and the pleasure is greater because the past twelve months have been what I may term the record year of the company. Previous records have been broken all along the line—the number of new customers and lamps connected up have been more than in any previous year, the increase in profit is considerably in excess of any other twelve months, and the cost of production has been brought still lower. As you will see by the report the additional capital received during the year was £5,000, while the capital expenditure amounted to £9,346. The principal item is, as usual, for new mains, rendered necessary by the demand for electricity in many of the smaller streets in the company's area. The amount spent on new meters is £1,600, and expenditure under this head is always satisfactory, as meters are only purchased for new customers. A sum of £1,250 was spent on land and buildings, as it has been found necessary, for purposes of extension, to take over at the valuation originally agreed on the buildings on the company's freehold premises adjoining the present works which had been let on lease to the original vendor of the property. Turning to the revenue account, on the credit side you will not fail to notice a satisfactory increase in the number of units sold, the total having risen from 455,871 in 1898 to 665,129 last year, being an increase of 209,258 units, or nearly 50 per cent. The expenditure on the debit side naturally shows an increase with so large an addition to the output, but it is gratifying to note that the cost of generating current shows a decrease per unit. Allowing for the difference between our output and the millions of units generated by most of the other companies, I think I may say our sheer cost of production is the lowest in London; and in accordance with the scheme established by the company some years ago, the responsible employés receive bonuses increasing with the economy of production. The increase in the expenses are principally in coal, oil and water, and wages for additional workmen. The cost of renewing and maintaining the accumulators and the engines and boilers amounted to £730, and the whole of this has been taken from the revenue account. The balance shows the profit to be £10,360. 17s. 4d., against £7,251. 13s. 7d. for the previous year, being an increase of over £3,000. In the net revenue account, after paying dividends authorised at the last meeting, the balance has been divided, one half being credited to the founders' shares and the other half to the preference and ordinary shares. After debiting the account with £1,500 for depreciation and renewals, and paying the debenture interest, amounting to £1,183. 6s. 11d., the balance available for distribution amongst the shareholders is £7,626. 14s. 7d. With the £1,500 set aside out of last year's profit, the depreciation, renewal, and reserve fund amounts to £6,000, which we, with all the facts and details before us, consider sufficient. The following table shows clearly the progress of the company from its commencement:—

Year	Houses conn'ct'd	Lamps connected.	Units sold.	Revenue.	Expenses.	Profit or loss.		Div. on ord. shrs.
1891	77	6,056	30,162	£1,623	£2,178	Loss	£554	nil
1892	124	9,436	75,667	3,513	3,301	Profit	112	nil
1893	173	12,153	107,580	4,329	2,848	do.	1,481	nil
1894	234	15,669	130,266	5,123	3,021	do.	2,101	1%
1895	307	20,307	182,327	6,940	3,712	do.	3,227	2%
1896	396	25,715	230,787	8,552	3,816	do.	4,736	4%
1897	571	33,000	354,969	11,625	4,771	do.	6,854	6%
1898	816	46,066	455,871	13,571	6,320	do.	7,251	6%
1899	1,012	59,154	665,129	17,935	7,574	do.	10,360	7%

The bill approved last meeting received the Royal Assent on July 13 last, and, in addition to conferring power on the company, in conjunction with the Kensington and Knightsbridge Electric Lighting Co., to erect and work a joint station, also gives us authority to purchase certain other land which will be required for a distributing station in our own area of supply. The land on which the joint works are to be erected is situated at Wood-lane, Hammersmith, not far from the boundary of our area. The joint committee of management appointed to carry out the provisions of the Act have already placed the contracts for the erection of the necessary buildings and machinery, and the work is now well in hand. It is hoped that the new works will be completed this year, and they then will be an effective addition to the company's source of supply. I may here mention that our present station is quite full of machinery and is being run to its utmost capacity. A short time ago the engineer reported that it would be dangerous to connect further customers, and the directors felt it their duty to pass a resolution instructing the engineer to refuse at present all further applications for a supply of current until we can see clearly when the new works will be available. We have entered into an agreement with the Kensington and Knightsbridge Electric Lighting Co., which provides that both companies are to contribute a share of the expenses and sinking fund of the joint works in proportion to the amount of current taken. It has also been so arranged that by the year 1931, when the local authority has the option of buying up our undertaking, the property will revert to the two companies absolutely free of cost, and will belong to them in proportion to the aggregate amount contributed by each to the sinking fund. We therefore shall be creating gradually a large reserve fund in this way as we proceed, and this ought to more than counteract any possible undervaluation of our property in the event of the local authority exercising their option to purchase. The other site scheduled in the bill is in the northern part of our area, and negotiations are now in progress for the purchase of it. Most of the machinery is on order for this distributing station, and also the plant to be placed on the property adjoining the present works. A distributing station will also be required near the south-western boundary of our area before we can safely connect new customers in that district. Up to the present it has been found impossible to obtain a suitable site, and unless we can we shall not hesitate to apply for an Act of Parliament giving us compulsory powers of purchase. The machinery at these sub-stations will be run by current transmitted at a high pressure through a separate main from the joint works. To complete the whole of these arrangements additional capital will be required, and to give a rough estimate I expect our immediate requirements will amount to nearly £30,000. At present the balance of the authorised capital of the company which remains unissued is only £19,000 debentures, so it will probably be necessary to call you together again during the year to create further capital. With regard to raising the money for the joint works, the mode of doing this has not yet been decided on, and meanwhile the bankers have advanced the capital required on the joint and several guarantees of the two companies. £5,000 have been borrowed in this way to the end of last year. With regard to the dividends recommended in the report, after paying these, there will be a balance carried forward to the credit of the ordinary and preference shares of £64. 14s. 9d., and to the credit of the founders' shares of £19. 14s. 9d. The company is now established on a very firm basis and I think there is every prospect of still higher dividends in future. I now move—

"*That the directors' report and accounts to Dec. 31, 1899, be adopted, and that dividends at the rate of 8 per cent. per annum, less income tax, on the ordinary and ordinary preference shares for the half-year ending Dec. 31, 1899, and a dividend of £1. 16s. per share, less income tax, on the founders' shares, be and are hereby declared payable forthwith.*"

Mr. J. T. JERVIS seconded the motion.

Mr. MAKINS asked if the £6,000 reserve was considered sufficient for some time to come, and in view of the remarks that the chairman has made that no further current could be supplied, could they look for any increase in the business of the company during this year?

Mr. A. E. FRANKLIN: I think I will answer the second question first, because it arises out of the work of the sub-committee of the two joint companies of which I am a member. The directors cannot undertake to develop the business and give further current, at the risk of a breakdown in the supply to the present customers, until we, forming the special committee to which I have referred, can tell them when the new works will be available. This company does not intend to have to put itself in the position of having to ask indulgence of the existing customers. That is all. The committee meet to-morrow, and it may then be possible to obtain further details on the point, but I do not suppose that we shall know for another two months definitely when the new station will be in working order. Until then we shall have to be very cautious, and, in short, we are not doing anything to extend our business until we see our way to do additional work. As regards the question of the reserve fund, in the prospectus we stated that what I may call the wasted money would be covered by the sum received on the founders' shares, and that every single penny subscribed for the ordinary shares, or the subsequent capital, would be represented by visible assets, and we have kept to that. In the first year or year and a half we did not possess our own equipment, and so the work was done by an outside house, but at prime cost. We had an engineer who looked after matters, to whom we paid a certain commission, but so soon as we felt our feet and had got a trained staff together we have done the work here ourselves, so that there has been no middleman's profit. With the exception of a very small amount of the latter portion of our preference shares, we have not issued any shares at a premium, but whatever we have received has gone to reserve or to write off some part of the original expenses. Every penny that we have earned—it is shown in the report, and amounts to about £36,000—has been distributed, except some £6,000, which—I think I am correct, but I am speaking without a reference—has gone to reserve. Then as to the future. As the chairman has said, we have made arrangements in connection with the new works for a sum, which will be £50,000 or £60,000, to come into our coffers as a bonus at a time when we shall run the risk of being bought up by the authorities. I have spoken rather at length, because some newspapers whose opinions are of value have criticised us as I do not think they would have done had the writers taken the trouble to go into the history of the company.

Mr. MAKINS: Have the board taken into consideration the question of doing away with the founders' shares?

Mr. FRANKLIN: We have not considered that matter at all. The founders in this company have no control over the capital, and therefore there is no real reason for cancelling them. There are no disadvantages attaching to their continuing; it is simply a question of pounds, shillings, and pence.

The resolution was then carried unanimously.

Messrs. A. E. Franklin and J. T. Jervis were re-elected as directors, and the auditors were reappointed.

A vote of thanks to the chairman was then passed unanimously.

The CHAIRMAN in reply said: Gentlemen, I am much obliged to you for the proposition. I cannot take much credit to myself. It must be distributed among the board, for without the assistance of my colleagues I could not have done much. The secretary and staff also deserve your thanks. They have worked extremely hard to bring the revenue up to what it now is. I again thank you all for the vote of thanks proposed.

The proceedings then terminated.

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South London Electric Supply Corporation (Ltd.).

The report of the directors for the year ended Dec. 31, 1899, states that the works at Bengeworth-road are, with the exception of one large steam alternator and certain thermal storage arrangements, now complete, and that the various contracts are practically concluded. Mains have been laid in all the compulsory streets, as also in a number of other streets throughout the area of supply. The remaining steam alternator has been delivered and is in course of erection. The thermal storage plant has been somewhat delayed, in order to benefit by experience derived from the use of similar arrangements elsewhere, and to take advantage of improvements in design. The work at the station has been well carried out, and, with some minor exceptions, the machinery is proving satisfactory. When the works were approaching completion in the early autumn of 1899 the directors were able to commence taking over the electrical load, and on Nov. 28, 1899, to terminate the contract under which energy was being obtained from a neighbouring company. The corporation has therefore been relying on its own resources for three months, and the commencement of this year may be regarded as the date from which the real business of the corporation begins. At present electricity is being supplied to the equivalent of 26,688 8 c.p. lamps, and applications have been signed for 3,185 more. Current is also being supplied temporarily to a supply company in an adjoining district. The board have applied to Parliament for powers to supply electricity in Lambeth north of and including the Westminster Bridge-road, which was not included in the Lambeth lighting order of 1892. There appears to be a growing demand for current to be used for motive power. At present there are a number of motors on circuit, and applications are to hand for more, ranging from ½ H.P. to 16 H.P. The dust destructor has been at work some ten weeks, but the full quantity of ash-bin refuse which it is capable of consuming has yet to be supplied under the Lambeth Vestry's contract, which comes into operation at the end of this month. No difficulty has been experienced in destroying all the refuse obtainable. The net revenue account shows a profit of £295. 0s. 6d., which has been carried into the general balance-sheet.

CITY OF BIRMINGHAM TRAMWAYS CO.—At the annual meeting last week the chairman (Mr. James Ross) referred to the negotiations which had been proceeding with the Mayor and Corporation of Birmingham as to the terms upon which the Corporation would be willing to furnish the necessary capital for improving the tramway service in Birmingham, with a view to the company working the lines on lease from the city. Mr. Ross informed the shareholders that he had been unable to meet the views of the Corporation on the subject.

EASTBOURNE ELECTRIC LIGHT CO. (LTD.)—The report of the directors for the year 1899 states that the sale of the company's undertaking and works was duly completed on Jan. 1 last. As a trading concern the company ceased its operations on Dec. 31 last, and the directors are arranging for the prompt realisation and distribution of the assets, with the view of winding up the company as quickly as possible. The accounts show gross profit for 1899 of £6,077. 2s. 2d. The Corporation having agreed to refund all capital outlay made during 1899, it was unnecessary to debit revenue account with depreciation. The net result is that, after providing for interest on debentures and preference shares to Dec. 31 and for the interim dividends paid in 1899, the net profit amounted to £5,094. 1s. 10d., out of which the directors propose that a dividend of 20 per cent. for the half-year ended Dec. 31 (making, with the interim dividend, £12. 10s. per cent. per annum, tax free) be paid on the ordinary shares. The estimated increase in the company's revenue made on the negotiations for the sale of the undertaking to the Corporation has been amply justified. There has already been distributed amongst the shareholders £20 on account of every £10 share fully paid, and £10 on account of each share upon which £5 has been paid, and the directors have in preparation an approximate statement of the ultimate financial position of the company after all assets have been realised and liabilities settled.

GAS, WATER AND GENERAL INVESTMENT TRUST (LTD.)—The chairman (Mr. J. B. Braithwaite) announced at a meeting of the trust on Tuesday that the affairs of the Union Light and Power Co., of Salt Lake City, had been put on a thoroughly sound basis. The final obstacle had now been removed by the complete amalgamation of all interests, and the trust now controlled one of the most complete and most powerful organisations for the supply of electric light and power that was to be found anywhere in the world. The total receipts for 1899 amounted to about £60,000. In 1898 the figure was £48,000. The increase had been obtained with a trifling increase in operating expenses. The bulk of their power was derived from water, and that was a kind of power the working expenses of which did not increase. If they had water that would give them 3,000, 4,000 or 5,000 H.P., as the case might be; it did not cost any more to use it to its full capacity than it did to use it to the extent of only one-fifth. Therefore as their load went up in Salt Lake the increase of the revenue was almost all net profit. The dividend on the preferred stock for the past two half-years had been 2 per cent. It was an 8 per cent. preferred stock, and they hoped this year, with the increased revenue, that something beyond that would be earned and distributed.

HOVE ELECTRIC LIGHTING CO. (LTD.)—The eighth annual general meeting of this company was held on Wednesday, Col. A. J. Filgate, R.E., presiding. Col. Filgate said the directors had met to give a satisfactory account of their stewardship and of the general progress of the business. After dealing with the figures set out in the directors' report (given in full in our last issue), he said they had sold 67,000 more units in 1897 than in 1896, 82,000 more units in 1898 than in 1897, and 94,000 units more in 1899 than in 1898, while the demand for 1900 up to date showed a considerable increase over the corresponding period of last year. The reduction they had made in the price of their product had no doubt helped to swell the consumption, and at the same time had increased their profits. Some 3½ years back, with the consent of the Corporation of Hove, they commenced to supply new customers with current at 220 volts instead of 110 volts, and at the present time they had more customers taking current at the higher voltage than on the lower. With a view of inducing customers to change over, they had agreed to supply on that voltage from Jan. 1 at 7d. per unit for the first hour, instead of 8d. as hitherto. A few of their customers had already changed over, and they hoped that others would follow this example. The directors proposed to pay a final dividend for the half-year at the rate of 9 per cent. per annum, making, with the interim, 7½ per cent. for the year, carrying forward £615. This compared with 6½ per cent. for 1898. In reference to the breakdown of the machinery on the night of Feb. 26, when the town was in darkness for five minutes, he said the repair of the damaged machinery fell upon Messrs. Crompton under their guarantee. The report and accounts were adopted and the dividend approved.

NORTHWICH ELECTRIC SUPPLY CO. (LTD.)—The directors' report for the year 1899 states that there has been a steady and continuous increase in the number of consumers connected to the mains. On Dec. 31, 1899, there were 88 consumers, with an equivalent of 3,885 8 c.p. lamps; and during the past year 64 consumers were added, with a total of 2,301 8 c.p. lamps, bringing the total to 152 consumers and 6,186 lamps. In addition seven motors, with an aggregate of 61 H.P., were connected to the mains during the year. The length of mains laid to the end of the year was as follows: Feeder mains, 5,720 yards; distributing mains, 10,560 yards; public lighting mains, 4,250 yards; service mains, 3,000 yards; a total of 23,500 yards, or over 13½ miles. The principal extensions during the year were for the public and private lighting of Hartford, where the company had been accorded a large amount of support, 1,154 lamps having been connected in the parish since the middle of September. The Parish Council of Hartford have adopted electric lighting, the whole of the roads of the village (about 2½ miles) having been lighted since Nov. 14. The directors claim that this is the first village in the kingdom to adopt public electric lighting throughout. As from June 30 last the maximum demand system of charging has been adopted—viz., 6d. per unit for the first hour's use per day of the maximum current demanded, and 4d. per unit above that amount. This was equivalent to an all-round charge of about 5d. per unit, or a reduction of 15 per cent. With a view to encouraging small consumers, the directors decided to adopt a system of "free" wiring, with prepayment slot meters, which in practice is proving extremely successful, and the directors anticipate a large extension in this department. The system of mains is being extended to Winnington, and it is anticipated that these extensions will be working during the present month. Owing to the rapid and continued increase of business in the supply department of the company, the directors decided in December last to relinquish the wiring department, and have entered into an agreement with Messrs. Woods and Co., of London, for doing all the wiring previously done by the company. In consequence of the continued progress of the company and the extension of the area of supply, it will be necessary to raise further capital, to obtain which the directors will submit a proposal for the issue of debentures. After writing off £59. 9s. 11d. for goodwill of wiring department, the net profit for the year was £529. 18s. 10½d., which, with a balance of £113. 9s. 6½d. from last account, made a total of £643. 8s. 5d., from which, after deducting £28 off preliminary expenses account and setting aside £95 for depreciation, the directors recommend payment of a divided at the rate of 3 per cent. per annum. The meeting was held last week when the report was adopted.

NORWICH ELECTRIC TRAMWAY CO.—At the meeting of this company last week it was announced that the overhead equipment work was proceeding rapidly, and there was every probability that construction work would be completed by April 1. The power station is in an advanced stage, and the first of the steam engines is ready for testing; 20 out of the 40 motor cars have been delivered, and the balance is expected during next month. Capital expenditure amounted to £237,600 and £75,000 was due.

PONTYPOOL ELECTRIC LIGHT AND POWER CO. (LTD.)—The annual report of the directors for 1899 states that during the year the mains were extended to the Town Hall, and the directors had free-wired that building and made further extensions on the premises of existing customers. The directors had also entered into a contract with the District Council to supply and maintain six arc lamps within the compulsory area. After carrying £100 to renewal account, there was a profit of £675.14s. 10d., which, after deducting debenture interest (£214. 14s. 8d.) and adding the balance from last year, left a net profit of £474. 14s. 4d. The directors recommend that £50 be carried to reserve, that £150 be carried to the debenture redemption account, that a dividend of 5 per cent. be paid, and the balance of £12. 13s. 4d. be carried forward. Mr. J. C. Howell having retired from the board, Mrs. Clara A. Pegler has been elected in his place.

WALKERS, PARKER AND CO. (LTD.)—At a meeting of this company on Tuesday the chairman (Mr. W. Newall) stated that the course of the lead market throughout the year was very uncertain and especially difficult to gauge. The lowest price quoted was £13 and the highest £17. 12s. 6d., and for spot lead as much as 12s. 6d. to 20s. per ton over forward quotations had occasionally to be paid by consumers who required supplies. American speculation, which had taken hold of all other metals, began to turn its attention to lead early in the year, and in one day the price was forced up no less than 20s. per ton. Business during the year was exceptionally good, and there had been a largely increasing consumption of lead for electrical purposes.

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CITY NOTES.

BOURNEMOUTH AND POOLE ELECTRICITY SUPPLY CO. (LTD.)—Applications have been invited for £70,000 4½ per cent. debentures at 103 by the Electric and General Investment Co. on behalf of this company. A dividend at the rate of 5 per cent. per annum (less tax) is recommended for the year ended Dec. 31 on the ordinary shares. The transfer books and register of members will be closed from the 9th to the 19th inst. inclusive.

BRITISH INSULATED WIRE CO. (LTD.)—It is stated that both the ordinary and preference shares forming part of the large additional capital of this company have been largely over-applied for.

COMMERCIAL CABLE CO.—A quarterly dividend of 1¾ per cent. has been declared, payable April 14 next, out of the net earnings of this company. The transfer books will be closed from 20th inst. to April 2 inclusive.

ELECTRICAL PROGRESS IN RUSSIA.—A new company, entitled the Russian Electrical Co., has been formed in St. Petersburg, with a capital of 2,000,000 roubles, to acquire and carry on the electrical engineering works of Herr B. Zeitschel. The Schuckert Co. is interested in the new undertaking.

GENERAL ELECTRIC CO. (U.S.A.)—This company has declared a quarterly dividend of 1½ per cent.

NATIONAL TELEPHONE CO. (LTD.)—This company has invited applications for 100,000 ordinary shares of £5 each (part of an authorised issue of 890,000 shares, of which 490,000 have already been issued and paid up in full), and £500,000 4 per cent. debenture stock at 98.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee has appointed 13th inst. a special settling day in the further issue of 8,020 ordinary £5 fully-paid shares of the *St. James' and Pall Mall Electric Light Co. (Ltd.)*, and has ordered the same to be quoted in the official list. Application has also been made to the committee to appoint a special settling day in and to grant a quotation to the further issue of 10,000 ordinary £5 shares of *Callender's Cable and Construction Co. (Ltd.)*, and to allow the further issue of 3,000 £10 fully-paid shares of the *Blackpool and Fleetwood Tramroad Co.*, 10,000 £5 fully-paid shares of the *Hove Electric Lighting Co. (Ltd.)*, and 12,000 ordinary £5 fully-paid shares (Nos. 1 to 12,000), and £50,000 4 per cent. debenture stock of the *Smithfield Markets Electric Supply Co. (Ltd.)*, to be quoted in the official list.

WINDSOR ELECTRICAL INSTALLATION CO. (LTD.)—The annual meeting was held last week. The chairman (Mr. M. Drury Lavin) moved the adoption of the report, which appeared in our issue of the 18th ult. The motion was adopted.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	1900	£	£		£	£
*Birmingham Tramways.	Mar. 3	4,127	+ 386	9	35,224	+ 1,453
Blackpool Corporation...	„ 1	158	+ 8	48	21,883	+ 4,403
Blackpool and Fleetwood	„ 3	177	− 19	9	1,290	− 173
Bradford Corporation...	„ 4	385	+ 120	81	27,018	...
Brisbane Trams	Jan. 17	1,846	+ 484	16	34,319	+ 10,367
*Bristol Trams & Carriage	Mar. 2	2,743	+ 244	9	23,305	+ 966
*Buenos Ayres & Belgrano	Feb. 4	2,304	+ 665	5	11,791	+ 3,491
City & South London Ry.	Mar. 4	1,459	+ 348	9	10,473	+ 402
Dover Corporation	„ 3	139	...	48	9,508	+ 1,027
Dublin United	„ 2	2,989	+ 398	10	25,119	+ 2117
Dublin Southern Dist....	„ 2	640	− 16	9	5,129	
*Glasgow Corporation ...	„ 3	8,268	+ 268	...	...	...
*Liverpool Corporation...	Feb. 24	6,882	+ 1,159	8	52,098	+ 5,980
Liverpool Overhead Rly.	Mar. 4	1,432	+ 147	9	12,932	+ 1,314
*Sheffield Tramways	„ 4	1,866	+ 719	9	16,154	+ 5,012
*South Staffs. Trams.....	...	...	...	...	...	...

* Partly electrical.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	NAME.	Previous Week's Price, Feb. 28.		Price Wednesday, March 7.		Rate per Cent. Yielded. £ s. d.	Dividend Due.	Business Done During Week Ending March 7. Highest	Lowest
			TELEGRAPHS.								
£110,900	100	4%	*African Direct Telegraph 4% Mort. Deb. (red.)	99	103	99	103	3 17 8	January and July.....	...	...
25,000	10	...	Amazon Telegraph.....	3	4	3	4	...	June and December ...	...	...
£125,000	100	5%	Do. 5 per Cent. Debentures	85	90	85	90	5 11 1	...	...	...
£875,520	Stock	28/6	Anglo-American	63	66	63	66	5 11 5	Feb., May, Aug., Nov.	63	...
£3,062,240	Stock	30/0	Do. Preferred	114½	115½	114½	115½	5 3 11	„ „	115½	115
£3,062,240	Stock	27/0	Do. Deferred	14½	15½	14½	14¾	9 3 1	...	14¾	14⅜
$10,000,000	$100	$2½	Commercial Cable Capital Stock	165	175	165	175	4 12 1	Jan., Apr., July, Oct.	...	...
£1,563,078	Stock	4%	* Do. 4 per Cent. Debenture Stock	103	105	103	105	3 16 8	„ „	104½	103½
16,000	10	8/0	Cuba Submarine Ordinary	9	10	9	10	8 0 0	February and August	9⅜	...
6,000	10	10/0	Do. Preference 10 per Cent.	19	20	19	20	5 0 0	„ „	9¾	...
12,931	5	2/0	Direct Spanish Ordinary.....	4	5	4	5	4 0 0	April and October.....	...	...
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference	9	10	9	10	5 0 0	„ „	...	...
£30,000	50	4½%	Do. 4½ per Cent. Debentures	101⅞	105⅞	101⅞	105⅞	4 5 9	January and July.....	...	...
60,710	20	3/0	Direct United States Cable	11½	12	11½	12	5 16 8	Jan., Apr., July, Oct.	11⅝	11⅜
£120,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red.)	99	102	99	102	4 8 3	June and December ...	...	...
£4,000,000	Stock	5%	Eastern Ordinary	155	160	155	160	4 7 6	Jan., Apr., July, Oct.	158	155
£1,795,000	Stock	3½%	Do. 3½ per Cent. Preference Stock	98	101	98	101	3 9 3	„ „	100½	98¾
£1,432,268	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.)	116	121	116	121	3 6 8	May and November ...	116½	...
250,000	10	2/6	Eastern Extension	15½	16	15¾	16¼	4 6 3	Jan., Apr., July, Oct.	16¼	15¾
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	115	120	115	120	3 6 8	February and August	116	...
£6,700	100	5%	* Do. 5% (Austln. Gov. Sub.) Deb.,1900 (reg.) ...	100	103	100	103	4 17 1	January and July.....	...	...
£26,600	100	5%	Do. (Bearer)	100	103	100	103	4 17 1	„ „	...	...
£300,000	100	4%	*Eastern and S. African 4% Mort. Deb., 1909.....	100	103	100	103	3 18 5	February and August	102	...
£200,000	25	4%	Do. 4 per Cent. Mauritius Sub. Debs.(red.)...	101%	104%	101%	104%	3 16 10	May and November ...	...	...
180,227	10	1/9	Globe Telegraph and Trust	11¼	11¾	11½	12	4 7 6	Jan., Apr., July, Oct.	11⅞	11⅛
180,042	10	3/0	Do. 6 per Cent. Preference	15½	16	15½	16	3 15 0	„ „	16	15⅝
150,000	10	5/0	Great Northern of Copenhagen	31	33	31	33	3 15 9	January and July.....	32¼	...
£86,300	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb.(red.) ...	99	102	99	102	4 8 3	...	...	...
17,000	25	12/6	Indo-European.....	49	53	50	54	4 12 7	May and November ...	53	52
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904 xd	107	110	104	107	5 12 2	March and September	...	...
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.)	101	104	101	104	3 16 11	June and December ...	...	...
11,839	8	4/0	Reuter's	7	8	7	8	5 0 0	April and October.....	...	...
3,381	£100 Cert.	6%	Submarine Cables Trust	124	129	126	131	4 13 5	„ „	129	...
15,609	10	...	West African Telegraph	2⅛	3⅛	2⅛	3⅛	4 9 3	December and July ...	...	...
£200,000	100	5%	* Do. 5 per Cent. Debentures (red.) .....xd	98	101	96	99	5 1 0	March and September	...	...
30,008	2½	...	West Coast of America.....	½	1	½	1	...	...	...	...
£150,000	100	4%	* Do. 4 per Cent. Debentures	100	103	100	103	3 17 8	January and July.....	...	...
88,321	10	6d.	West India and Panama	⅞	1⅛	⅞	1⅛	...	May and November ...	1 1/16	...
34,563	10	6/0	Do. 6 per Cent. 1st Preference	9¼	9¾	9¼	9¾	6 3 1	„ „	9 15/16	9 13/16
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	7	8	7	8	7 10 0	„ „	...	...
£80,000	100	5%	* Do. 5 per Cent. Debentures	104	107	104	107	4 13 6	January and July.....	...	...
£389,731	Stock	4%	Western & Brazilian 4 per Cent. Debenture Stock ...	100	104	100	104	3 16 11	June and December ...	...	...
207,930	10	3/0	Western Telegraph (late Brazilian Submarine)	14¾	15¼	14¾	15¼	4 11 10	Mar., June, Oct., Dec.	15⅛	14¾
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1900)	106	109	106	109	4 11 9	June and December ...	...	...
£158,100	100	6%	*Western Union 6 per Cent. Sterling Bonds (red.) xd	98	103	97	102	5 17 8	March and September	...	...
			TELEPHONES.								
44,000	£5	3/0	Chili Telephone (fully paid)	2	3	2	3	6 13 4	August	...	...
224,850	10s.	0/1½	Consolidated Telephone Const. & Manufacturing ...	¼	½	¼	½	4 15 3	July	...	...
72,680	1	2½%	Monte Video Telephone Ordinary	¾	⅞	¾	⅞	5 0 0	November	...	...
86,492	1	1/0	Do. 5 per Cent. Preference	¾	1	¾	1	5 0 0	„ „	...	...
490,000	5	3/0	National .....xd	5⅛	5⅜	5	5¼	5 14 3	February and August	5¼	5 1/16
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Preference xd	14	15	14	15	4 0 0	„ „	...	...
15,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference xd	14	15	14	15	4 0 0	„ „	...	...
250,000	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref. xd	5¼	5½	5¼	5½	4 10 11	„ „	5 7/16	5⅜
2,000,000	Stock	3½%	* Do. Debenture Stock 3½ per Cent. (red.)	77	100	97	100	3 10 0	June and December ...	98⅜	97¼
171,504	1	0/4	Oriental	¾	1	¾	1	5 0 0	April and October.....	...	...
58,000	5	2/6	United River Plate	4¾	5¼	4¾	5¼	7 2 10	July	5 1/16	...
16,639	5	1/4	Do. 5% Cumulative Preference	4¾	5¼	4¾	5¼	4 15 3	June and December ...	...	...
£179,947	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	103	106	103	106	4 14 4	„ „	...	...

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Feb. 28.		Price Wednesday, March 7.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending March 7.	
								£ s. d.		Highest	Lowest
			ELECTRICITY SUPPLY COMPANIES.								
100,000	1	...	Bl'ckb'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.)	⅞	1	⅞	1	...	...	...	...
6,000	10	7/9⅔	Bournemouth and Poole Elec. Supply Ord.	12	13	12	13	3 0 0	...	...	...
6,000	10	4/6	Do. 4½ per Cent. Cumulative Pref.	10	11	10	11	4 1 10	...	...	...
19,661	5	2/6	Brompton & Kensington Electricity Supply Ord.	7	8	7	8	3 15 0	...	...	...
12,000	5	3/6	Do. 7 per Cent. Preference	8½	9½	8½	9½	3 13 8	March and September	...	...
20,000	5	...	Calcutta Elec. Supply Ordinary (fully paid)	6½	7½	6½	7½	...	...	...	...
30,000	5	4/0	Charing Cross & Strand Electricity Supply Corp.	10	11	9½	10½	4 5 9	February and August	...	...
20,000	5	...	Do. (Nos. 30,000 to 50,000)	9½	10½	9	10	...	...	10½	...
20,000	5	2/3	Do. 4½ per Cent. Preference xd	5½	6	5½	6	3 15 0	" "	...	...
34,000	5	2/6	Chelsea Electricity Supply Ordinary	7½	8½	7	8	3 15 0	March	8½	7½
£100,000	Stock	4½%	* Do. 4½ per Cent. Debenture Stock (red.)	110	112	110	112	4 0 11	June and December	111½	111
$1,200,000	$1,000	5%	Chicago Edison 1st Mort. 5% 20 year Gold Bonds (red.)	100	110	100	110	4 10 11	April and October	...	...
60,000	10	7/0	City of London Electric Lighting Ordinary	10	11	9½	10½	3 6 8	February and August	10½	10
40,000	10	6%	Do. 6 per Cent. Cumulative Preference	13	14	13	14	4 5 9	January and July	13½	13⅜
£400,000	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	122	127	122	127	3 18 9	June and December	...	...
40,000	10	...	County of London and Brush Prov. Ordinary	9½	10½	9½	10½	...	...	10½	9⅝
20,000	10	6/0	Do. 6 per Cent. Cumulative Preference	12⅝	13⅝	12⅝	13⅝	4 8 11	March and September	13⅝	13⅜
£200,000	Stock	4½%	Do. 4½% Deb. Stock Certs. (all pd.) (red.)	109	112	109	112	4 0 11	...	110	...
15,000	5	10%	Kensington and Knightsbridge Ordinary	12	13	12	13	4 1 6	...	...	...
10,000	5	6%	Do. 6 per Cent. 1st Preference	7	7½	7	7½	4 0 0	January and July	...	...
110,000	3	...	London Electric Supply Ordinary	1⅜	2⅛	1⅜	2⅛	...	...	2⅛	...
48,050	5	3/0	Do. 6 per Cent. Preference	4⅝	5	4⅝	5	6 0 0	...	5⅛	...
£250,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures	101	103	101	103	3 18 1	Mar., June, Sept., Dec.	...	...
62,500	10	5/0	Metropolitan Elec. Supply Ord. (Nos. 1 to 62,500)	14	15	14	15	3 6 8	April and October	14½	13⅞
22,500	10	3/7½	Do. (Nos. 62,501 to 85,000)	14	15	14	15	3 5 8	...	...	...
£220,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage	114	117	114	117	3 16 11	June and December	...	...
£125,000	Stock	24/8	Do. 3½ per Cent. Mort. Deb. Stock (red.)	95	97	95	97	3 12 3	...	96½	...
6,452	10	6/0	Notting Hill Electric Ordinary	16	17	16	17	3 10 7	March	...	...
10,000	5	5/0	Oxford Electric Ordinary	6⅞	7⅛	6⅞	7⅛	3 9 0	"	...	...
300,000	1	8%	Rand Electric	⅜	½	⅜	½	10 13 4	...	...	...
£130,070	Stock	5%	River Plate El. Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb.	75	85	75	85	5 18 0	...	...	...
150,000	$100	$2	Royal Electric Company of Montreal Shares	150	170	150	170	4 14 2	...	...	...
£123,200	100	4½%	* Do. 4½ per Cent. 1st Mortgage Debentures	104	106	104	106	4 5 6	April and October	...	...
31,980	5	9/6	St. James's and Pall Mall Electric Ordinary	15	16	14½	15½	4 13 7	February and August	15½	15⅛
20,000	5	3/6	Do. 7 per Cent. Preference xd	8½	9½	8½	9½	3 13 8	" "	9½	9⅛
65,000	5	...	South London Electric Supply Ordinary (fully paid)	4	4½	3½	4½	...	...	...	...
79,900	5	8/0	Westminster Electric Supply Ordinary xd	13½	14½	13½	14½	4 9 8	March and September	14½	13⅞
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
125,000	1	7½d.	Aron Electricity Meter 6 per Cent. Cum. Pref.	⅜	½	⅜	½	6 17 2	...	...	...
45,000	1	...	British Electric Works Co. Ordinary	⅛	1/16	⅛	1/16	...	...	...	...
50,000	1	...	Do. 5 per Cent. Cumulative Preference	¾	1	¾	1	...	...	...	...
£50,000	100	4½%	Do. First Mortgage Debentures	99	101	99	101	...	...	...	...
40,000	5	15/0	British Insulated Wire Ordinary ...xd bonus & new	12	13	11	12	4 3 4	...	...	...
27,500	5	3/0	Do. 6 per Cent. Preference x new	6	6½	5⅝	6½	4 16 0	...	...	...
100,000	5	...	British Westinghouse, 6% Preference	...	...	4	5⅛	...	...	4⅛	4
90,050	2	2/0	Brush Electrical Engineering	1⅞	2⅛	1⅞	2⅛	4 14 1	September	2	...
90,000	2	1/2⅝	Do. 6 per Cent. Pref. Non-Cumulative	2⅛	2⅜	2⅛	2⅜	4 16 0	"	2⅜	...
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Deb. Stock xd	108	113	108	113	3 19 8	February and August	...	...
£50,000	Stock	4½%	* Do. 2nd Debenture Stock (red.)	102	105	102	105	4 5 9	June and December	...	...
20,000	5	5/0	Callender's Cable Construction Ordinary	14	15	14	15	5 0 0	" "	14½	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5½	6	5½	6	4 3 4	...	...	...
£90,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb. (red.)	111	115	111	115	3 18 3	November and May	1⅛	...
300,000	1	0/9⅔	Castner-Kellner Alkali Co. (fully paid)	1⅛	1⅜	1⅛	1⅜	5 16 5	...	...	...
60,000	1	0/7½	Chadburn's Ship Telegraph Ordinary	⅜	1⅛	⅜	1⅛	5 6 8	...	...	...
60,000	1	0/7½	Do. 6 per Cent. Cumulative Preference	⅜	1⅛	⅜	1⅛	5 6 8	...	...	...
32,098	3	1/9½	Crompton and Co. (Nos. 1 to 32,098)	3½	4	3½	4	4 10 9	January and July	...	...
£100,000	100	5%	* Do. 5 per Cent. First Mortgage Deb. (red.)	98	101	98	101	4 19 0	" "	...	...
60,000	1	0/3	Davis and Timmins 6 per Cent. Cum. Pref.	¾	1	¾	1	...	...	...	...
99,261	5	1/9⅔	Edison and Swan United ("A" Shares) (£3 paid) xd	2	2⅛	2	2⅛	7 3 9	February and August	...	...
17,139	5	2/9⅔	Do. (£5 paid) xd	3⅛	4⅛	3⅛	4⅛	6 13 4	" "	...	...
£344,023	Stock	4%	Do. 4 per Cent Mortgage Deb. Stock (red.)	93	95	93	95	4 4 3	June and December	...	...
26,100	5	5/11⅓	Edmundson's Electric Corporation Ord. (fully pd.)	4⅛	5⅛	4⅛	5⅛	5 14 3	Half-yearly	...	...
112,100	2	1/2⅝	Electric Construction Co. (Limited)	2⅛	2⅜	2⅛	2⅜	4 16 0	January and July	...	...
25,000	2	2/9⅔	Do. 7 per Cent. Cumulative Preference	2⅞	3⅛	2⅞	3⅛	4 6 2	July	...	...
182,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	104	107	104	107	3 15 2	January and July	...	...
30,000	5	...	Henley's Telegraph Works Ordinary	14	15	14	15	...	February and August	14⅛	14⅛
15,000	5	...	Do. 4½ per Cent. Preference	5⅝	6	5⅝	6	3 15 0	" "	...	...
£50,000	Stock	4½%	Do. 4½ per Cent. Mortgage Deb. Stock (red.) xd	110	114	110	114	3 18 11	" "	...	...
50,000	10	10/0	India Rubber, Gutta Percha, &c., Works	21	22	21	22	4 11 10	" "	21⅛	21⅛
£300,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	100	104	100	104	3 16 11	March and September	...	...
37,350	12	12/0	Telegraph Construction and Maintenance	37	41	37	41	4 7 9	March and July	39⅛	39
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909	102	105	102	105	3 16 2	...	...	...
20,000	5	3/0	Do. Manufacturing Ordinary	9	10	9	10	3 10 0	...	...	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5½	6	5½	6	4 3 4	...	...	...
30,000	5	5/0	Willans and Robinson Ordinary	9½	10½	11	12	3 16 0	April and October	11⅛	10⅛
30,000	5	3/0	Do. 6 per Cent. Cumulative Preference	7½	7¾	7½	7¾	3 17 5	...	...	...
£100,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Debentures	104	106	104	106	4 0 3	May and November	106⅛	...
			ELECTRIC RAILWAYS, TRAMWAYS, &c.								
12,000	10	10/0	Blackpool and Fleetwood Tramways xd	17	18	17	18	4 8 11	...	...	...
£167,900	100	5%	Brisbane Tramway 5 per Cent. Debentures	104	106	104	106	4 14 4	...	...	...
50,000	10	8%	Bristol Tramways and Carriage Ordinary xd	22½	23½	22½	23½	...	February and August	...	...
25,000	10	4%	Do. Cumulative Preference (£6 paid)	6½	6¾	6½	6¾	...	...	...	...
£100,000	Stock	4%	Do. 4 per Cent. Debentures	117	118	117	118	3 7 3	...	...	...
12,000	10	...	British Columbia Electric Railway 5% Pref.	10⅛	10⅜	10⅛	10⅜	...	...	10⅜	10⅛
30,000	10	9/0	British Electric Traction Ordinary (Nos. 1 to 30,000)	16⅛	17⅜	17	18	3 6 8	...	18	17½
£15,000	10	...	Do. (Nos. 60,001 to 75,000)	16	17	16⅛	17⅛	...	...	...	...
30,000	10	6/0	Do. 6% Cum. Pref. (Nos. 30,001 to 60,000)	13½	13¾	13½	13¾	4 7 3	...	13¾	13⅛
£200,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures	125	128	126	129	3 18 0	...	128	...
40,000	5	1/0	Buenos Ayres & Belgrano 6% "A" Cum. Pref.	4⅛	5⅛	4⅛	5⅛	5 17 1	...	...	...
27,500	5	...	Do. "B"	4	4½	4	4½	...	...	4⅝	...
320,000	Stock	5%	Do. 5 per Cent. Debentures	105	108	105	108	4 12 7	...	105	...
213,553	10	3/0	Central London Ordinary	9⅛	10	9¾	10¼	2 18 6	June and December	10¼	10
£855,000	Stock	1½%	City and South London Railway Con. Ordinary	59	62	61	64	2 18 7	January and July	62	61⅛
37,500	10	...	Do. (Nos. 22,501 to 60,000) (£5. 10s. paid)	4	5	4	5	...	...	4⅛	...
£150,000	Stock	5%	Do. 5 per Cent. Perpetual Preference (1891)	140	145	140	145	3 9 0	January and July	...	...
x200,000	Stock	5%	Do. (1896)	132	137	132	137	3 13 0	...	...	...
£187,701	Stock	4%	Do. 4 per Cent. Perpetual Debenture	125	130	125	130	3 1 11	May and November	...	...
20,000	10	7½%	†Imperial Tramways Ordinary	23	24	23	24	...	March and September	...	...
10,000	10	6%	† Do. 6 per Cent. Preference	15	15½	15	15½	3 16 2	" "	...	...
£300,000	Stock	4½%	† Do. 4½ per Cent. Debenture	113	115	113	115	3 17 11	January and July	...	...
30,000	10	1/3	Kidderminster & District E. L. & Tr'ct'n 5% Pref.	10		10		5 0 0	May and November	...	...
37,500	10	2½%	Liverpool Overhead Railway Ordinary xd	9 3/16	9 5/16	9 3/16	9 5/16	4 0 8	February and August	...	...
10,000	10	5%	Do. 5 per Cent. Preference xd	12¼	13	12⅝	13⅜	3 15 7	" "	...	...
125,000	Stock	4%	Do. 4 per Cent. Debenture	105	107	105	107	3 14 11	January and July	...	...
24,000	5	...	New General Traction Ordinary	3½	4	3½	4	...	...	...	...
30,000	5	6/0	Do. 6 per Cent. Cumulative Preference	4½	5½	4½	5½	5 11 8	May	...	...
4,000	10	...	Oldham, Ashton and Hyde Elec. Tramway Ord.	18	19	18	19	...	February and August	...	...
4,000	10	5/0	Do. 5 per Cent. Preference	10½	10⅞	10½	10⅞	4 11 11	" "	...	...
13,334	10	...	Potteries Electric Traction Ordinary	11⅛	12½	11⅛	12½	...	...	...	...
20,000	10	5/0	Do. 5 per Cent. Cumulative Preference	10	11	10	11	4 10 11	...	...	...
£540,000	Stock	3%	Waterloo and City Ordinary	101	104	101	104	2 17 8	June and December	104	...

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.
† The London Stock Exchange Committee refuses to quote these.

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THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,139. [No. 21. Vol. XLIV.] FRIDAY, MARCH 16, 1900. PRICE SIXPENCE (by post, 6½d.), Abroad, 8d., or 16 cents, or 80fr., or 70pf.

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NOTES.

PARLIAMENT is beginning to make a decided move in the direction of establishing on broad and well-defined lines the limitations which are to be imposed on local authorities, with regard to their powers to carry on trading undertakings. The reference to the Joint Committee of the Lords and Commons on Municipal Trading is as follows:—

To consider and report as to the principles which should govern powers given by bills and provisional orders to municipal and other local authorities for industrial enterprise within or without the area of their jurisdiction.

It is to be hoped that the Joint Committee will proceed without delay to make recommendations of a practical and definite nature for meeting the urgent requirements of this important national question. What is needed, perhaps more than anything else, is that an end should promptly be put to the powers of local authorities to oppose useful private enterprise which they themselves are essentially incompetent to imitate.

OUR American contemporary, the *Electrical World and Engineer*, calls attention to the promising field for electrical development in the replacement of mechanical systems of funicular haulage by a revival of what Prof. FLEEMING JENKIN called "telpherage." The telpher system, which had almost its sole exponent in a short length of mineral line at Glynde, was born out of due time; the electrical world was not prepared for its premature arrival, and was unable to grapple successfully with the many technical difficulties it presented. Accordingly, telpherage had its short-lived day, and electric traction engineers turned their attention to the securer paths on *terra firma*.

BUT, as our contemporary rightly observes, the problem of telpherage can be faced to-day with much better prospect of success than was its earlier lot. Technical difficulties which then appeared insurmountable are now non-existent, and to the engineer the task of erecting a workable and reliable telpher line would be, comparatively speaking, child's play. The burden, indeed, is shifted wholly on to the financial side of the question; and the problem is, Will telpherage pay as a rival to mechanical funicular haulage? Naturally, there can be no conclusive answer in general terms; but the capital outlay and working costs of electric telpherage would be reasonably low, so that, in the vast majority of instances, it would be worth while to compare estimates with those for rival systems. Except in the case of very steep grades, or where electrical difficulties of a special nature presented themselves, telpherage would probably be found to have the advantage. We do not, of course, imply that telpherage is necessarily unsuited to steep grade haulage; but for this class of work the system would require modifications which in certain cases undoubtedly might place it at a disadvantage as compared with rope haulage.

IT is natural to inquire to what particular uses telpherage might be applied. The permanent installation of telpher systems for the conveyance of minerals from quarries to railway trucks is one of its most obvious applications, and the one that is most likely to be developed first. But there are a large number of similar applications for which substantial and permanent installations might be erected. For temporary transportation it would also be of service. The spread of electric supply into agricultural districts, which promises to be brought about speedily after the advent of the "electricity-in-bulk" undertakings, will undoubtedly suggest useful applications of telpherage to the collection of agricultural produce from fields and its conveyance to the local electric railway station or siding. By its simplicity the telpher system lends itself readily to this usage, and temporary telpher lines could quickly and expeditiously be erected over a farm, or group of farms, and be removed to another scene of operations after the crops had been gathered. The advantage of carrying all the goods overhead will appeal to the farmer, who would be averse from allowing a surface track to be laid over his fields.

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ELECTRICITY is being applied not only indirectly to assist the physician in diagnosis, as in the testing of muscles and nerves by an induction coil or by continuous currents, and in the employment of X-rays in the earlier stages of pulmonary complaints ,but also directly in stimulating local circulation, the removal of tumors, the curing of lupus, erysipelas, and other skin diseases. These, and many other cases mentioned in Dr. LEWIS JONES' Paper before the Institution of Electrical Engineers last week, sufficiently justify our assertion that what has undoubtedly become of immense importance as an adjunct to the resources of the physician in the curing of disease and the alleviation of pain should be assisted by the advice and experience of those whose daily work is employed in the various branches of electricity. To show that such assistance is really needed, we have only to refer our readers to the Paper itself, which reveals considerable room for improvement in the matter of the instruments and apparatus which the operator is compelled to employ. Mr. MORDEY pointed out that the induction coil, of which Dr. JONES had shown them an example—beautifully lacquered, highly polished, and with plenty of brass mounts—had apparently undergone no change since RUHMKORFF first invented it. He asserted that there were plenty of men in the room who could design a more satisfactory instrument. Then why have they not done so? Is the curing of disease of less importance than the designing of a galvanometer? Much has been heard recently of the necessity for standardisation of electrical apparatus. Here is a notable instance of what the manufacturer can do for himself in the manufacturing of instruments in large quantity of one size and pattern. Our instrument makers are apt to despise the class of instruments required for medical purposes, but if they will only turn their attention seriously to them, they will find that there is a large market ready to hand.

Anglo-French Telegraph Convention.—A bill is before the French Chamber of Deputies approving the Telegraph Convention of Feb. 17th last between Great Britain and France.

A Bachelor of Science?—In an account of Mr. Marconi's recent experiments before the King of the Belgians, *L'Etoile Belge* of the 11th inst. refers to Major Flood Page, chairman of the Wireless Telegraph and Signal Co., as "président de la société Wiveless."

Appointment.—Prof. S. M. Kintner has been appointed to the chair of electrical engineering in the Western Pennsylvania University, in succession to Prof. R. A. Fessenden, who has joined the staff of the United States Weather Bureau at Washington.

Theft of Electrical Energy in Germany.—It will be remembered that on several occasions it had been decided that to steal electrical energy from the supply mains in Germany constituted no criminal offence, as electrical energy could not be considered a material object. A law correcting this anomaly has now been passed by the German Reichstag.

The Postal Telegraph Clerks' Association.—The annual conference of this association was opened yesterday at Newcastle-on-Tyne. The proposals to be discussed include the increase of salaries, 21 days' holiday, appointments in postal departments to be open to telegraphists, compulsory overtime to be limited to six hours weekly, and retirement on two-thirds pay, optional after 50 years of age and compulsory at 60.

New Cable Steamer.—There was launched from the yard of Messrs. Robert Napier and Sons, Govan, Glasgow, on Tuesday, a new twin-screw cable-laying and repairing steamer for the Eastern Telegraph Co. The new vessel has been christened the "John Pender," the ship of that name formerly in the company's fleet having been disposed of. The dimensions of the new vessel are briefly as follows: Length between perpendiculars 305ft., breadth 41ft., depth 26ft. 8in.

Wireless Telegraphy in Belgium.—On Saturday last, Mr. Marconi gave a demonstration of his system of wireless telegraphy before the King of the Belgians. The instruments were placed in rooms about 500ft. apart, and the signals had to traverse thick walls. All the messages, including one written by the King, were most satisfactorily transmitted. A daily contemporary states that his Majesty has promised to support the adoption of the system in Belgium generally and in the Belgian army particularly.

Cable Interruptions and Repairs:—

	Date of Interruption.	Date of Repair.
Latakia—Cyprus	June 21, 1899	—
Cayenne—Pinhieros	Oct. 11, 1899	—
Tangier—Tarifa	Jan. 3, 1900	—
Paramaribo—Cayenne	Feb. 16, 1900	—
Ceara—Maranham	Feb. 20, 1900	—
Para—Maranham	Mar. 2, 1900	—
Hong Kong—Macao	Mar. 6, 1900	Mar. 11, 1900
Môle St. Nicolas—Cap Haitien	Mar. 7, 1900	—
Jeddah—Suakim	Mar. 13, 1900	—

Indo-European Telegraphs.—An announcement has been made in the Russian journals on the subject of the prolongation of the concession of the Indo-European Telegraph Co. This concession expires on March 31, 1905, but has now been prolonged for 20 years beyond that date on the company's agreeing to pay 17½ per cent. in lieu of the existing 10 per cent. on all Indian and Indo-Chinese messages carried over its wires. In the event of any complications arising, upon notification by the Russian Government the company undertakes to place its lines on Russian territory unreservedly at the disposal of that Government.

International Congresses at Paris.—The following is a detailed list, with dates, of the congresses to held in Paris during the present year, which are to be concerned with electrical or allied subjects:—

June.
18—23 Mining and Metallurgy.
25—30 Aeronautics.

July.
9—13 Automobiles.
9—13 Testing of Materials.
16—18 Management of Steam Engines.
19—25 Applied Mechanics.
23—28 Photography.
23—31 Applied Chemistry.
27—Aug. 1 Medical Electricity.

August.
6—11 Chemistry.
6—11 Mathematics.
6 - 11 Physics.
18 - 25 Electricity.

September.
3— 5 Gas.
20 - 29 Railways.

Telephone Statistics in New South Wales.—Telephony in New South Wales is gradually gaining in popularity. During the year 1899, 263 new subscribers were connected to the central exchange in Sydney, 977 to suburban exchanges, and 236 to country exchanges, bringing the total number of subscribers to the Sydney exchanges to 6,694 (of which 3,322 are on the central), and the total of country exchanges to 862—a grand total of 7,556. The number of instruments in use on December 31, 1899, was 10,119, including private telephones and extension instruments. On that date the number of exchanges working was: Central exchange, 1; suburban exchanges, 23; country exchanges, 14: total, 38, against 33 for 1898. There are 71 out-going and 118 in-coming junction wires at the central exchange, 50 junction lines between suburban exchanges, and three long-distance trunk lines from Sydney to Newcastle, Bathurst and Katoomba. All three of the latter were opened in 1899.

The American Pacific Cable.—The United States Senate has just published, as an official document, the argument made by Mr. Herbert Satterlee on behalf of the claims and abilities of American manufacturers to make the proposed Pacific cable, and urging the retention of the "American manufacture" clause in any bill passed for such a cable. If this provision is retained in the Act of Congress providing for the cable, it is expected in America that foreign makers will be forced to go over to America and organise companies. Mr. Satterlee

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estimates $8,000,000 for making the cable and $4,000,000 for laying it. It is understood that Mr. Satterlee was primarily retained by one of the leading wire and cable companies in this country, which has its headquarters in New York, namely, the Safety Insulated Wire and Cable Co. Mr. J. W. Marsh, vice-president and general manager of the Standard Underground Cable Co., also made a statement before the Senate committee, in which he urged the ability and responsibility of that concern to undertake the work.

Telephone Companies in the United States.—The Erie telephone system, the largest Bell system in the United States, has passed into the control of the Telephone, Telegraph and Cable Co. of America. The latter company was organised with a capital stock of $80,000,000, to form a rival system of the Bell, which should extend throughout the country and absorb all the independent telephone companies. The Erie Co. controls five networks operating in various states throughout the country, principally in the west, and employs $22,000,000 of working capital. The combined interests of the Erie Co. on Feb. 15 had 155,000 telephone stations in 2,300 cities and towns, and 250,000 miles of wire, of which 80,000 is long-distance service. The Erie Co. is a Bell licensee, and as such has the legal right to continue to use the Bell patents in all the territory in which it operates. It is one of the few Bell licensee companies, however, the control of which is not held by stock ownership in Bell hands.

Expiration of the Edison American Three Wire Patent.—The *American Electrician* announces that on the 20th of this month patent No. 274,920, issued on March 20, 1883, to Thomas A. Edison, and now owned by the General Electric Co., expires by limitation. This is the fundamental American patent (corresponding to the famous Hopkinson patent in this country) for three, five, or multi-wire systems with any number of conductors, and as a patent has been generally respected throughout its life until within the last few months. It was strongly drawn, the wording showing on the part of the inventor an almost prophetic comprehension of the conditions which would exist during the life of the patent, and the drawings showing several modified arrangements for balancing which have since been either used or proposed. Among these are storage batteries and the use of a third brush on a commutator delivering from its positive and negative ends the full voltage between the outer conductors. The patent claims strongly the use of what is termed a compensating conductor or conductors, and now generally known as a neutral. At the expiration of this patent three, four, or five-wire systems, with almost any means of obtaining a balance, will be open to public use.

Electrical Treatment of Skin Diseases.—Apropos of Dr. Lewis Jones' Paper on "The Application of Electricity in Medical and Surgical Practice," which was read at the last meeting of the Institution of Electrical Engineers, it is interesting to note the extent to which the violet rays proceeding from the arc are being employed both in Denmark and in the United States in the healing of certain skin diseases, such as lupus, erysipelas, &c. This action appears to be due to the ability of the chemical rays to destroy germs and bacteria; and the light from an ordinary arc lamp, which is so intensely rich in all kinds of these rays, is found eminently suitable for this purpose. The method originated with Dr. Finsen, of Copenhagen, and a writer in the *Electrical World* of New York describes the apparatus which has been successfully employed in the United States for this purpose. The radiations must be very intense. The arc, which is rated at 22,000 c.p., and takes 80 amperes at 85 volts, is concentrated by means of a metallic reflector and passed through a tube filled with water and having at the terminal end a system of quartz lenses. The purpose of the water is to cool the radiation, that of the quartz lenses to filter out all but the violet rays. We understand that Dr. Finsen has successfully treated 350 cases by this method, which has been described as unfailing whenever applied.

Will.—The whole of the estate of the late Prof. D. E. Hughes has been valued at £478,084. 9s. 8d., including personalty of the net value of £472,704. 15s. 4d. By his will, dated May 9, 1893, he leaves to his wife a sum of £20,000, together with all his personal effects, medals, papers, and foreign securities, and to his personal relatives and friends a total of £31,000. He left also to the Institution of Electrical Engineers £2,000, to the Société Internationale des Electriciens £2,000, to the Royal Society and to the Académie des Sciences £4,000 each, to be used as a prize fund for discoveries in physics, particularly in electricity and magnetism; and to the Royal Institution a sum of £1,000. The whole of his entire residuary personal estate is to constitute a trust fund, to be called the "David E. Hughes Hospital Trust Fund," of which the first trustees are to be the treasurers of the Middlesex, London, King's College, and Charing Cross Hospitals, who are to retain the capital of this fund in, as far as possible, its present state of investment, and to pay during their lives to his wife £1,000 per annum and to his sister £600 per annum. One half of the remaining income is to be allowed to accumulate during the next 21 years and then added to the principal, and meanwhile the other half, and ulitimately the whole, of the income is to be divided equally between the above four hospitals. Subject to the above annuities, the sum at present available for the Hughes Hospital Fund is estimated at from £300,000 to £350,000.

Obituary.—We regret to announce the death, last Saturday, of Mr. G. J. Symons, at the age of 61. George James Symons, an eminent meteorologist, was perhaps best known as the founder of the British Rainfall Organisation and the publisher of *Symons' Monthly Meteorological Magazine*, but he also devoted much attention to the study of atmospheric electrical phenomena, being appointed a member of the Lightning Rod Committee of the Royal Meteorological Society. In 1878 he was elected a Fellow of the Royal Society, in 1880 he was president of the Royal Meteorological Society, and subsequently performed the duties of secretary to the latter society for several years. He was made Chevalier of the Legion of Honour in 1891, and in 1897 was awarded the Albert medal of the Society of Arts. Mr. Symons was also a member of one of the sub-committees for the National Physical Laboratory.

We deeply regret to announce also the death of Dr. Thomas Preston, F.R.S., which occurred at his residence in Dublin on March 7, at the early age of 39. Dr. Preston had already, in his short life, earned a considerable reputation as a physicist, and in connection with his researches on the Zeeman effect had done more than anyone to advance our knowledge of that subject. He was more generally known, however, as the author of the well-known "Theory of Heat" and "Theory of Light," which since their publication have been the most popular English text-books on these sciences. He was elected a Fellow of the Royal Society in 1898, and held also a Fellowship in the Royal University of Ireland. His career had been one of great promise, and the scientific world will feel deeply the loss it has sustained.

MEETINGS OF SCIENTIFIC AND ENGINEERING SOCIETIES, &c.

SATURDAY, March 17th.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture II. on "Polarised Light," by the Right Hon. Lord Rayleigh, F.R.S.

MONDAY, March 19th.

SOCIETY OF ARTS.

8 p.m. Cantor Lecture III.: "Photography of Colour," by E. Sanger Shepherd.

WEDNESDAY, March 21st.

ROYAL MICROSCOPICAL SOCIETY.

7.30 p.m. Meeting at 20, Hanover-square, W.

ROYAL METEOROLOGICAL SOCIETY.

7.30 p.m. Ordinary Meeting at the Institution of Civil Engineers, 25, Great George-street, Westminster, S.W.

THURSDAY, March 22nd.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary General Meeting. Paper to be read: "Storage Battery Problems," by E. J. Wade.

FRIDAY, March 23rd.

PHYSICAL SOCIETY.

5 p.m. Meeting in the rooms of the Chemical Society, Burlington House. Agenda: (1) An Electromagnetic Experiment, by Prof. S. P. Thompson, F.R.S.; (2) Some Experiments illustrating Syntony, by P. E. Shaw; (3) An Electrical Micrometer, by P. E. Shaw.

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CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

Discharge through Argon and Helium.—The difference of potential between the surface of the cathode and the outside of the negative glow is a constant, independent of the current and the pressure, provided there is no chemical action on the cathode and the glow does not cover the whole of the cathode. This constant potential difference is known as the cathode-fall of potential. R. J. Strutt has measured it in helium and argon. In ordinary gases it is 300 volts. In helium it is 226, while in argon it is 167 volts. The case of argon presents peculiar difficulties, inasmuch as the positive column insists on curling round the cathode, a phenomenon which does not seem to have been observed in any other gas. The difficulty was finally overcome by giving the cathode the shape of a disc which nearly filled up the cross section of the tube. An interesting investigation was that of the conductivity of helium under the influence of Röntgen rays. Experiments in which the conductivity of air and helium respectively was brought to a maximum by strong X-ray ionisation showed that the rate at which ions are produced in helium is about half that at which they are produced in air. The expenditure of energy in this process is also less. The ions of all monatomic gases are probably split up into something smaller.

[R. J. Strutt, *Phil. Mag.*, March, 1900.]

New Thermo-Couple.—In the course of a determination of some of the physical properties possessed by various new alloys of iron prepared by Hadfield, of Sheffield, W. F. Barrett came across one which possesses remarkable properties. It consists of 68·8 per cent. iron, 25 per cent. nickel, 5 per cent. manganese, and 1·2 per cent. carbon. Its temperature coefficient is very small, but its resistivity is no less than 97·52 microhms per cubic cm. Coupled with pure iron, the new alloy shows a pretty steady increase of E.M.F. up to about 250deg. After that it becomes stationary until white heat is reached, and there is even a slight dip in the curve in the region of red heat. The stationary value of the E.M.F. is very high, being nearly 4,000 microvolts. No corresponding anomaly is shown at lower temperatures, the ordinary behaviour of thermo-couples being exhibited down to – 80 deg. A small thermo-electric battery formed of 25 strips of pure iron and of the new alloy gives an E.M.F. of 0·1 volt when heated over any flame. The author also describes a peculiar hysteresis effect obtained with copper-steel couples, in which the temperature of the neutral point is not the same during heating as during cooling. This is generally the case when iron is one of the elements.

[W. F. Barrett, *Phil. Mag.*, March, 1900.]

Electrolytic Convection in Vacuum Tubes.—J. J. Thomson has described a case of apparent electrolytic convection of chlorine through hydrogen. A small quantity of chlorine is introduced into a capillary tube filled with hydrogen at a low pressure, and a discharge from an induction coil is sent through the tube. On examining the tube with a spectroscope, the chlorine is seen only at the anode, and on reversing the current the chlorine appears at the new anode, and so on as often as the current is reversed. The most obvious explanation lies in electrolytic convection, but it is not at all certain that the chlorine does not pervade the whole tube, and is only discovered at the anode on account of the high temperature which exists there. H. Morris-Airey has therefore made a crucial experiment to decide between the two views. He attached two vacuum tubes to each other, end to end, and first used the anode of the one and the cathode of the other as electrodes, neglecting the two electrodes in the middle. If the electrolytic convection hypothesis were correct, a spectroscopic examination should reveal the existence of chlorine only in that tube whose extreme electrode was used as an anode. On separating the two tubes, however, the author found that the chlorine lines had the same intensity in both.

[H. Morris-Airey, *Phil. Mag.*, March, 1900.]

Electrical Treatment of Tuberculosis.—A continued application of d'Arsonval's high-frequency current method to the treatment of pulmonary tuberculosis has, according to E. Doumer, a very happy effect in the earlier stages of the disease. The treatment consists in the application of the high-frequency brush discharge to the surface of the skin just above the diseased tissue for about five minutes per day. The author takes no precautions to avoid sparks, which are not painful in this case. The various symptoms of the disease in its first stage do not disappear at the same time. Night fever and perspiration disappear almost at once, and do not return after treatment. The appetite is much improved, and the weight rapidly increases. The coughing fits are at first increased, but after about a month of the treatment the coughing becomes less persistent and less painful. Expectoration is much reduced, and the number of bacilli diminishes, subject, however, to occasional relapses. The last symptoms to disappear are the stethoscopic sounds, which are not usually arrested till after six or eight months of treatment. Seventeen cases in all were treated, all successfully. Two of them were in the initial stage, while a few showed advanced signs of softened tissues. No relapses have occurred so far.

[E. Doumer, *Comptes Rendus*, Feb. 26, 1900.]

Theory of Stratified Discharges.—Considering the case of a one-dimensional discharge between two parallel and infinite plates, Thomson arrived at a differential equation connecting y, the semi-square of the electric intensity at a point, with x, a co-ordinate measured along the line of discharge. It is impossible to solve this equation in finite terms, but Thomson has drawn a graph giving an approximate value of y for every value of x, this graph satisfying the differential equation at every point and also the terminal conditions at the electrodes. The graph is convex to the axis of x at every point, and therein lies its fundamental difference from the graphs derived from experiment, which are concave to the axis of x wherever the discharge is luminous. J. H. Jeans shows that Thomson's equation, based as it is upon the ionisation hypothesis, represents an ideally steady discharge, which is, however, unstable under actual conditions, just as a jet of water becomes unstable at a certain point and breaks up into drops. He gives an alternative solution of the differential equation, which shows that the intermediate portion of the curve may be broken up into a series of arches. These arches represent the luminosity produced at all points where the number of ions recombined exceeds the number of those which are being dissociated.

[J. H. Jeans, *Phil. Mag.*, March, 1900.]

Theory of Atmospheric Electricity.—According to Exner, atmospheric electrification is chiefly due to the fact that large bodies of water, in evaporating, lose the charge they possess and communicate it to the atmosphere. This was denied by G. Schwalbe, who found that hot water evaporating from a metallic dish did not carry off any perceptible portion of the charge of that dish. This, again, was controverted by H. Pellat, who discovered 5 per cent. or 10 per cent. of a difference in the gradual loss of the charge of the vessel accordingly as it was filled with water or not. Schwalbe has therefore repeated his own and Pellat's experiments, using the higher voltages employed by the latter, and testing both for positive and negative charges. The differences produced by evaporation were again very slight, and did not exceed the experimental errors. This is all the more remarkable, as vessels filled with fine silica and electrified lose their charge when the silica is blown off. The author attributes Pellat's positive result to small dust or metallic particles, which are torn off as soon as the dish is charged. That there is no transfer of electric charge from a liquid to its nascent vapour is a fact of high theoretical interest, the full investigation of which must shed some light on the constitution of liquids.

[G. Schwalbe, *Ann. d. Physik*, No. 2, 1900.]

"Electrical Phenomena."—On Saturday, March 17, at 8 p.m., Prof. Carey Foster, F.R.S., will deliver his presidential address on this subject before the Morley College Faraday Society, Waterloo-road, London, S.E.

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THE METROPOLITAN ELECTRIC SUPPLY CO.'S NEW WORKS.

(*Concluded from page 697.*)

Step-up Transformers and High-Pressure Switching Gear.—From the engine room, cables run in a subway to the transformer house, where the extra high-pressure switching apparatus has also been installed. The cables pass through cut-outs (Nalder Bros. and Thompson's pattern) in the basement, and then to switches placed above the transformers in the high-pressure switch room. Fig. 22 is a view of one side of this room, showing the step-up transformers, and Fig. 20 shows the extra high-pressure fuses placed on the opposite wall.

One end of the extra high-pressure winding is earthed, but there are no earth shields or Cardew earthing devices. Every transformer has been subjected to the following tests: 15,000 volts for half-an-hour across the primary coil, one pole being connected to the secondary winding and frame of the transformer; and a pressure of 2,000 volts between secondary and case for half-an-hour. An unusual feature in transformers of such a large size and for such high pressures is that they are not in cases, and to this arrangement and the thorough ventilation provided not only in the iron but also in the winding, the remarkably cool running is due. A temperature test, the makers inform us, shows the rise after a 12-hours run on full-load to be only 40°C. This is attained without the use of air blast, oil, or any device other than the free circulation of air. The specified efficiency is 98 per cent. at full load. The transformation ratio is 21 : 1—*i.e.*, primary coil 528 volts and 497 amperes, secondary coil 11,000 volts and 28 amperes.

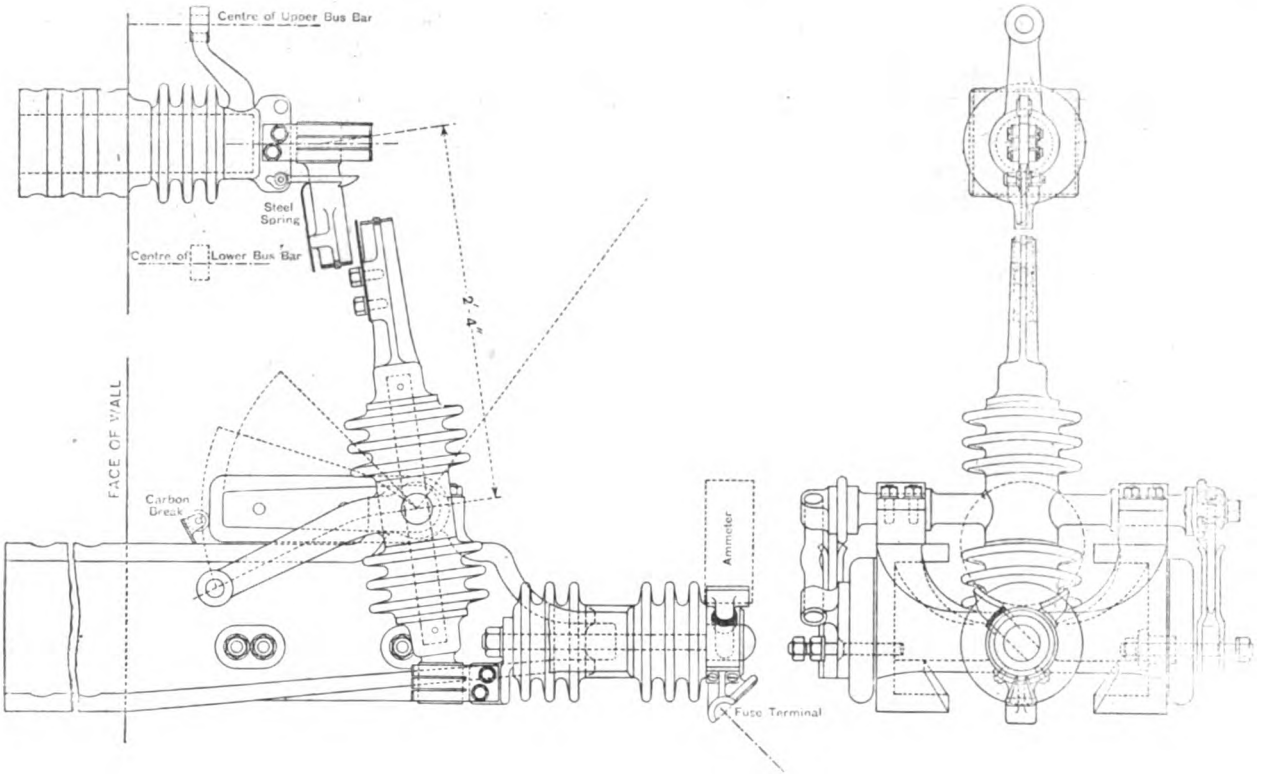

FIG. 12.—DETAIL OF EXTRA HIGH PRESSURE MAIN SWITCH. Scale, one-eighth.

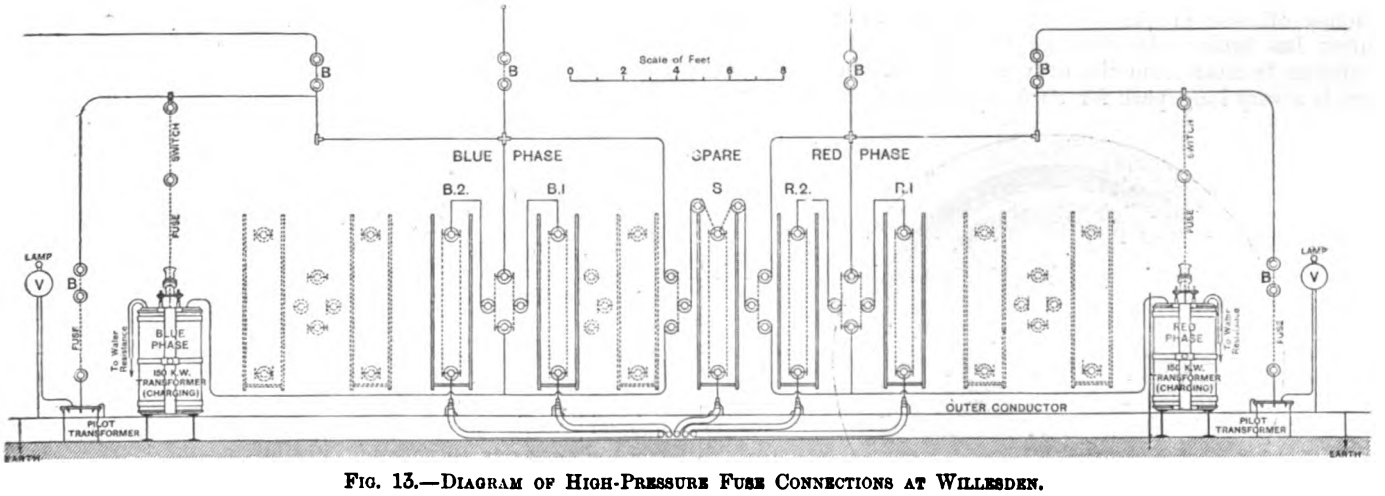

FIG. 13.—DIAGRAM OF HIGH-PRESSURE FUSE CONNECTIONS AT WILLESDEN.

The transformers have been made by the British Electric Transformer Manufacturing Co., and are of the Berry type. When the last one or two have been put in there will be 14, each of 250 kw. capacity, equivalent to seven two-phase 500 kw. sets, as the transformers for the two phases are independent of one another. Each transformer is 2ft. 9in. in diameter by 6ft. 8in. high, and weighs about 4 tons. Substantial under-carriages of steel joists with massive rollers are fitted to all the transformers, so that they can be moved with facility. For transport purposes, a pair of steel joists are attached to each transformer, and to these trunnions are fixed. The transformer is then handled in the same way as a big gun.

Above the transformers is placed the high-pressure switch-gear. All the high-pressure gear has been designed by Mr. G. W. Partridge, of the London Electric Supply Corporation,

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and manufactured by the Indiarubber, Gutta-Percha and Telegraph Works Co., of Silvertown. The details have been most carefully worked out by Mr. Partridge, and the gear is undoubtedly one of the most interesting features of the whole system. Each of the high-pressure switches is worked from a lever on the floor, and the primary and secondary circuit switches are in each case combined. Fig. 12 shows one of these switches in detail. It is mounted on a U-shaped casting, and the two parts of the switch are insulated

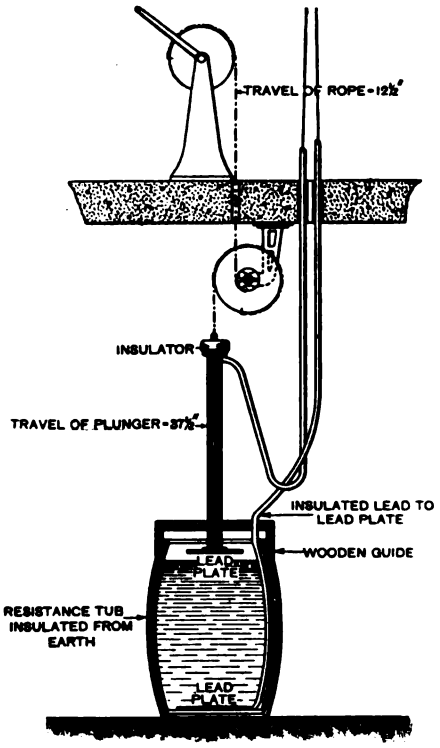

FIG. 14.—ARRANGEMENT OF WATER RESISTANCE AND LEVER FOR "MAIN DISCHARGER."

from one another by corrugated collars of ebonite A long steel spring, attached to the extra high tension brass lever, catches in a clip as the switch is being switched off, and breaks contact some time after the main contact has broken, thus taking the spark. The system of insulation is clear from the drawing. It will be seen that there is a very long path for surface leakage from the extra

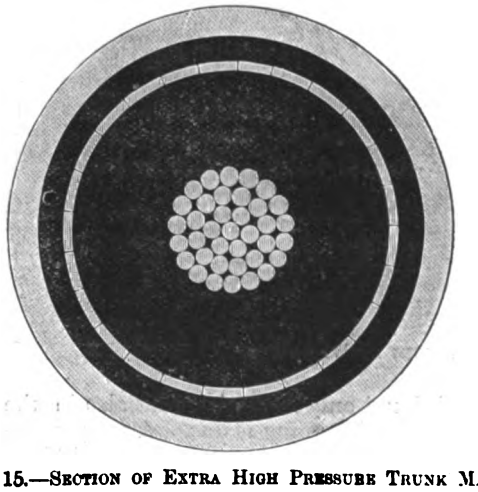

FIG. 15.—SECTION OF EXTRA HIGH PRESSURE TRUNK MAIN.

high-tension metal parts. A notable point is the way the ammeter is connected. This is on the extra high pressure side, and contact is made to it by means of a pin passing through an ebonite collar. The ammeter is what Mr. Evershed would call "standing on its terminals." In this case, Mr. Evershed notwithstanding, it is difficult to see any objection, as an excellent screwed contact is made. But even if this added slight difficulties in the construction of the ammeter, such matters may well be subordinated to the necessities of the switchgear in extra high tension work. It may be added that in the actual switch the ammeter is situated rather higher than shown in the drawing, the lugs to which it is attached projecting upwards slightly. This switch is used for switching in the low-tension side of the transformer and for switching off both the high-tension and low tension sides, but the switching on of the high tension is done at the fuses, a diagram of which is given in Fig. 13.

The two phases are separated, one being brought to each side, and distinguished as the blue phase and red phase respectively. In addition, the spare cable is brought to the middle of the board, so that it can be used on either phase. All the outers of the concentrics are connected together by a copper bar and earthed, the other conductors going straight to the lower fuse terminals. Two fuses in parallel are used in each case. At light loads one of these only is used; as the load gets heavier, the second one is put in. The reason of this is that if a fault developed in the main at light loads, and both fuses were in, a tremendous amount of energy would be expended at the fault itself before the fuse blew, and the damage might be considerable. The construction of the fuses is clearly seen

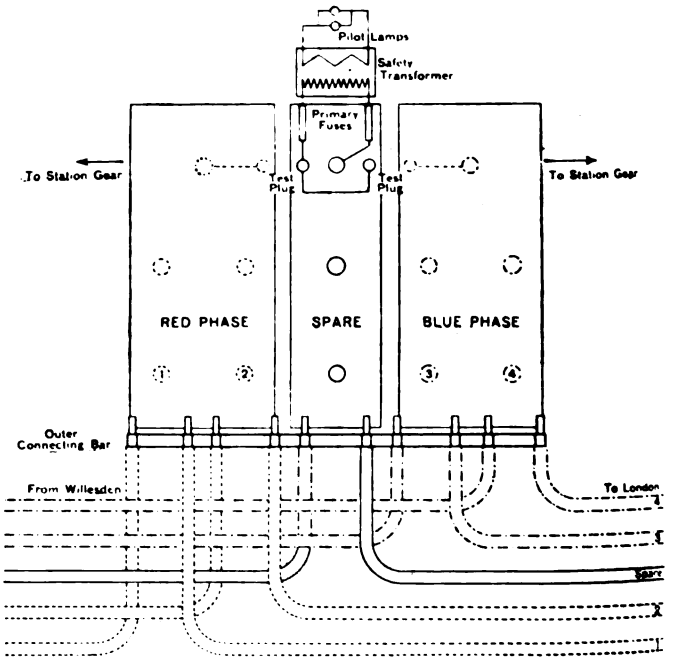

FIG. 16.—DIAGRAM OF TERMINAL BOARD AT SUB-STATION.

in the general view (Fig. 20). They consist of stoneware tubes 4ft. 6in. long, covered with a specially high insulation tape, and divided in the middle by a short length of toughened glass tube, which serves as a window. The lower part is partially filled with sand, and in the upper part are ventilating holes. The fuse itself consists of several tinned copper wires connected in parallel. The man who puts these fuses in stands on a little platform, clearly seen in Fig. 20, which is covered by a rubber mat 1in. thick and mounted on fairly high corrugated porcelain insulators.

In describing the method of switching in, it is necessary to refer to the "main discharger," which was introduced by Mr. Partridge at Deptford as long ago as 1893. Instead of switching the main directly to the transformer terminal, it is first switched on through the primary of a charging transformer. The secondary of this is connected to a water resistance (shown in Fig. 14), which is adjustable by means of a lever in the middle of the room in front of the fuses. There are two of these charging transformers, one for each phase, two water resistances, and two levers which can be interlocked. The secondary of the charging transformer being first on open circuit, this apparatus interposes a considerable amount of self-induction, and the current to charge the main is gradually increased by lowering the upper lead plate of the water resist-

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ance. When this reaches a low enough position, the main fuse is put in and the charging transformer switched out. The reason for this precaution is that, owing to capacity effect, if the main were switched on directly instead of gradually, the rise in pressure might be very great, and it would at any rate cause a fluctuation in the consumers' pressure, even if it did not damage the main or the step-down transformer at the other end. In switching off, the reverse operation takes place.

The connections of this spare main are so contrived that it is impossible by any error of the attendant to switch it on to both fuses at once. This is the reason for what at first sight would appear to be an excessive number of plug connections.

tow-path the ducts are filled with pitch around the cables, but those in London are merely filled up with sawdust to prevent the accumulation of gas. Fig. 18 is a view taken of the canal bank while the mains were being laid. All the work on the tow-path was carried out by the British Insulated Wire Co., who also made the joints in the London sections of the trunk cable.

Fig. 17 is a disconnection box for extra high pressure, designed by Mr. G. W. Partridge. An ebonite plate half-way up the box divides it into an upper and lower portion, and through it the terminals from the cable project for the attachment of the links. The inner conductor is not in immediate contact with this ebonite plate, as it is seen that an ebonite

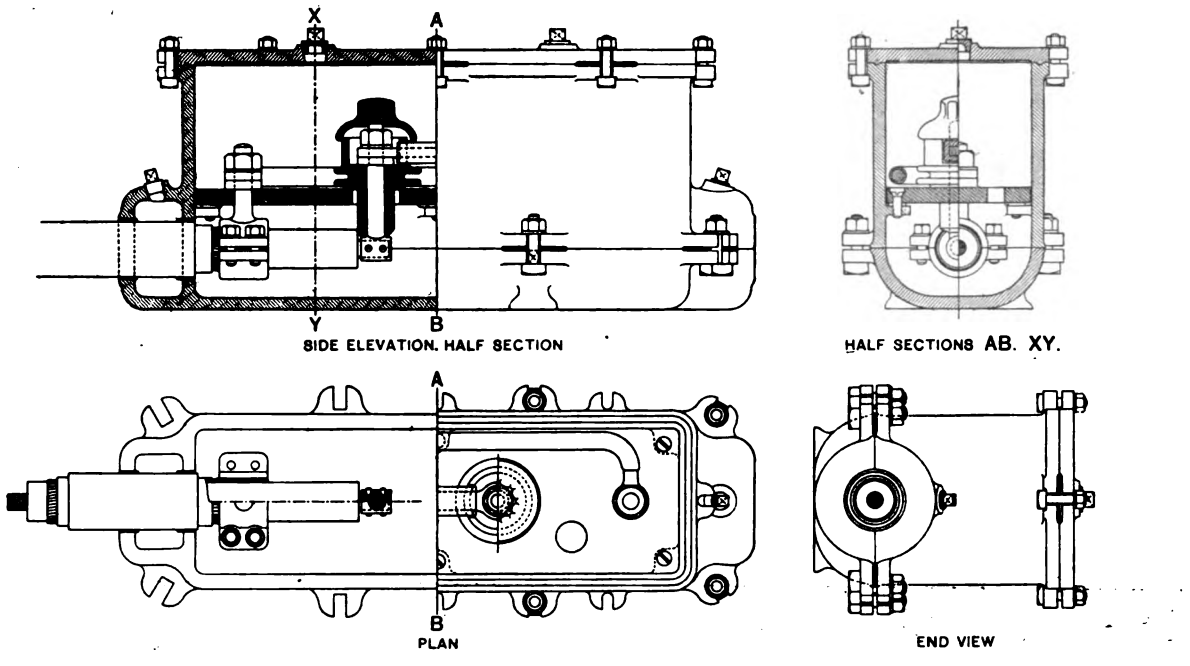

Fig. 17.—Disconnecting Box for 10,000 Volt Concentric Cable. Scale, one-eighth.

All regulation is done at the sub-stations by means of regulating turns on the step-down transformers. A small telephone exchange in the high-pressure room at Willesden enables the works to communicate with the sub-stations.

Trunk Mains.—From Willesden to Paddington the extra high pressure trunk mains are laid in the tow-path of the Grand Junction Canal, and the remaining portions to the various sub-stations are laid in the roadways, following the routes shown in the map published in our last issue. The cable is of the British Insulated Wire Co.'s manufacture. As already explained, there is one concentric cable for each phase. The cable is duplicated, and the fifth cable is as a reserve in case of breakdown. They are of the British Insulated Co.'s usual paper-insulated type, with flat wires for the outer conductor. As this conductor is earthed at the Willesden end, the insulation between it and the lead is not very thick. From Willesden to the Amberley-road station the section of each conductor is 0·25 sq. in.; from Amberley-road to Burwood-mews, 0·19 sq. in.; from Burwood-mews to Manchester-square and thence to Rathbone-place, 0·09 sq. in. A section of the 0·20 sq. in. cable is shown in Fig. 15. Joints in the cable are made "solid," the insulation employed for them being cotton tape, boiled in resin oil, alternating with layers of mica. The lead sleeve, which is drawn over the cable ends before the joint is made, is of exceptionally large diameter, and is filled up with insulation after the joint is completed and the ends of the sleeve have been soldered. The cable is laid in flat cast-iron ducts 15½in. wide, 5½in. deep and in 6ft. lengths, not including the socket. The ducts are five-way, and the depth is sufficient to take a second cable in each way when required. The four partitions have a thickness of ½in. at bottom and ⅜in. at top. Cast-iron covers ¼in. thick are merely laid on the trough without jointing. Special sections of duct, without partitions, are employed to contain the joints in the cable. On the canal

collar passes over the brass rod leading from it. The upper part of this collar is corrugated, and it is surmounte by and ebonite cap which screws on to the top of the terminal screw. Thus the length of the path for surface leakage is very great, and no danger of gradual leakage need be anticipated. The lower part of the box is filled with oil. The box is split, and the cables are led in on either side through compound glands.

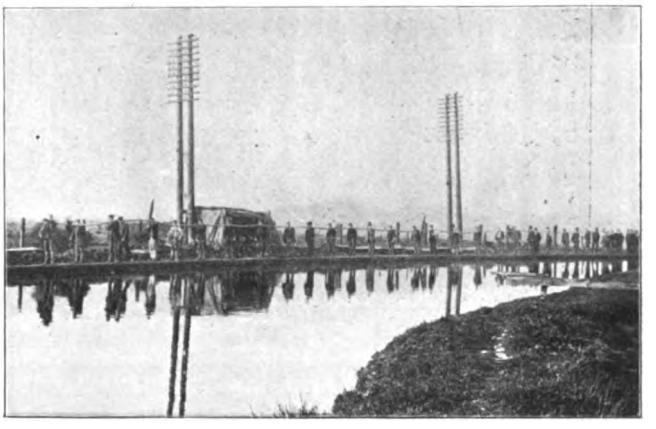

Fig. 18.—Laying Mains on Tow-Path of Canal.

Sub-Stations.—The step-down transformers are of 100 kw. capacity each, and reduce the pressure to 1,000 volts. They are 2ft. 2in. in diameter by 4ft. in height, and weigh about 25 cwt. Each is mounted on an under-carriage similar to the step-up transformers at Willesden. The middle of the secondaries is earthed, and no earth shields or Cardew devices are used. Some of the windings of the secondary

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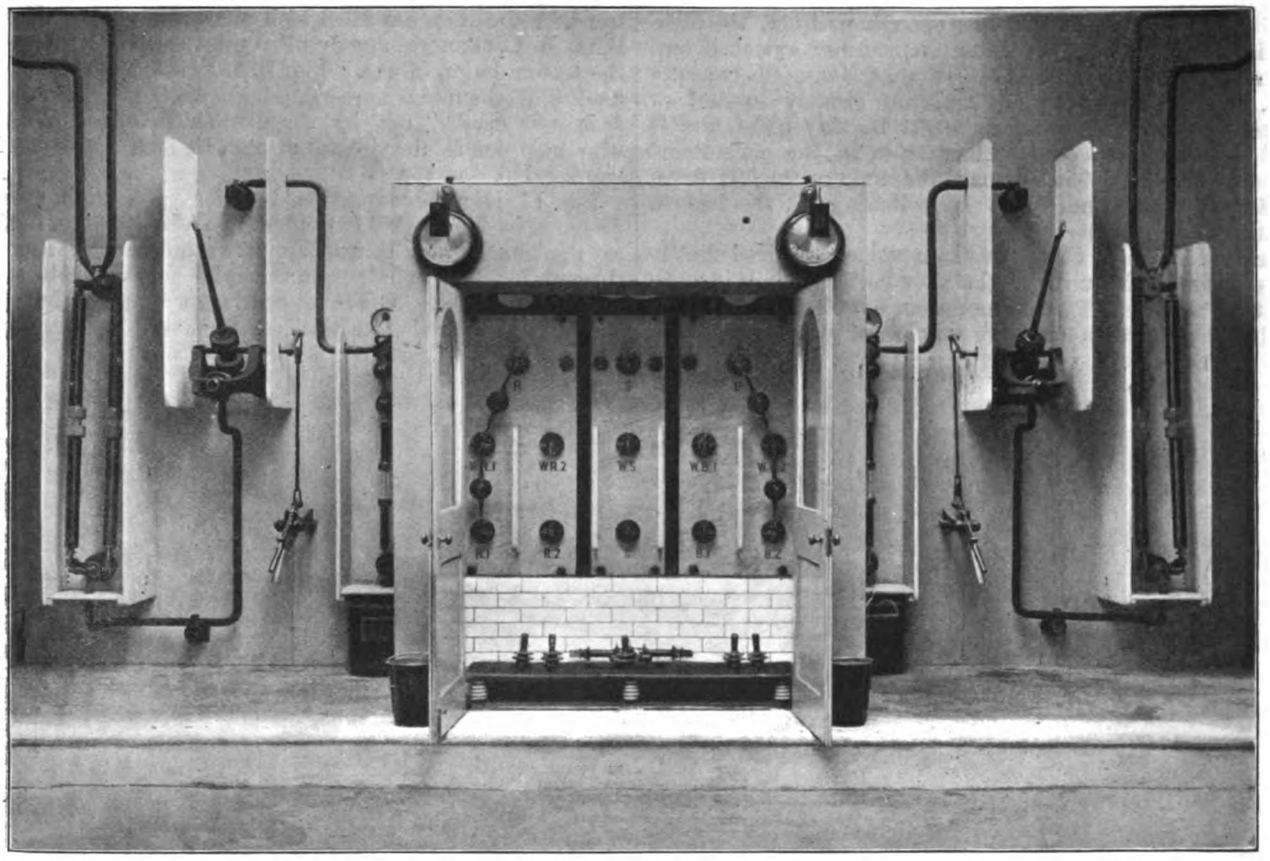
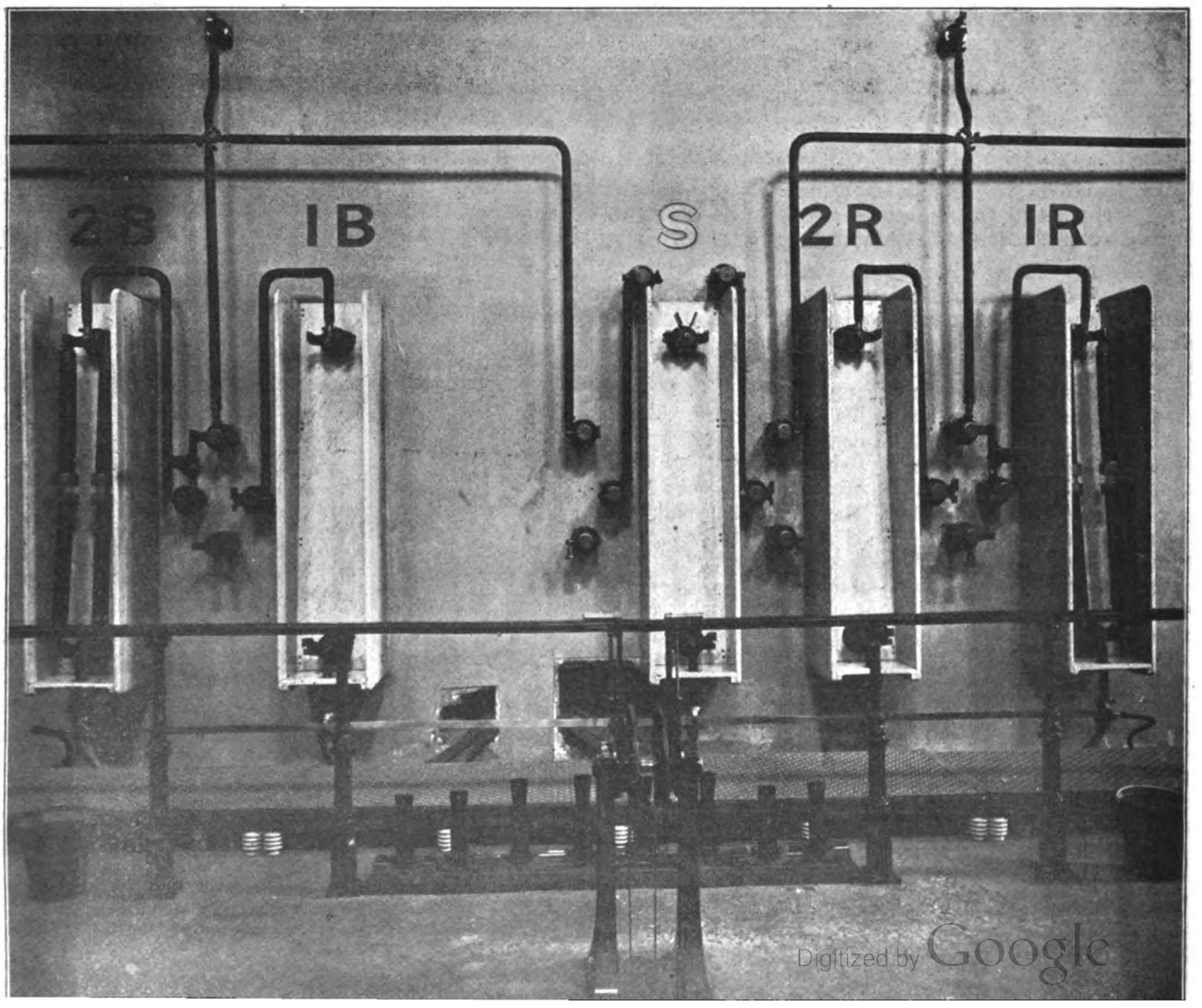


FIG. 19.—VIEW OF SUB-STATION SHOWING TERMINAL BOARD.



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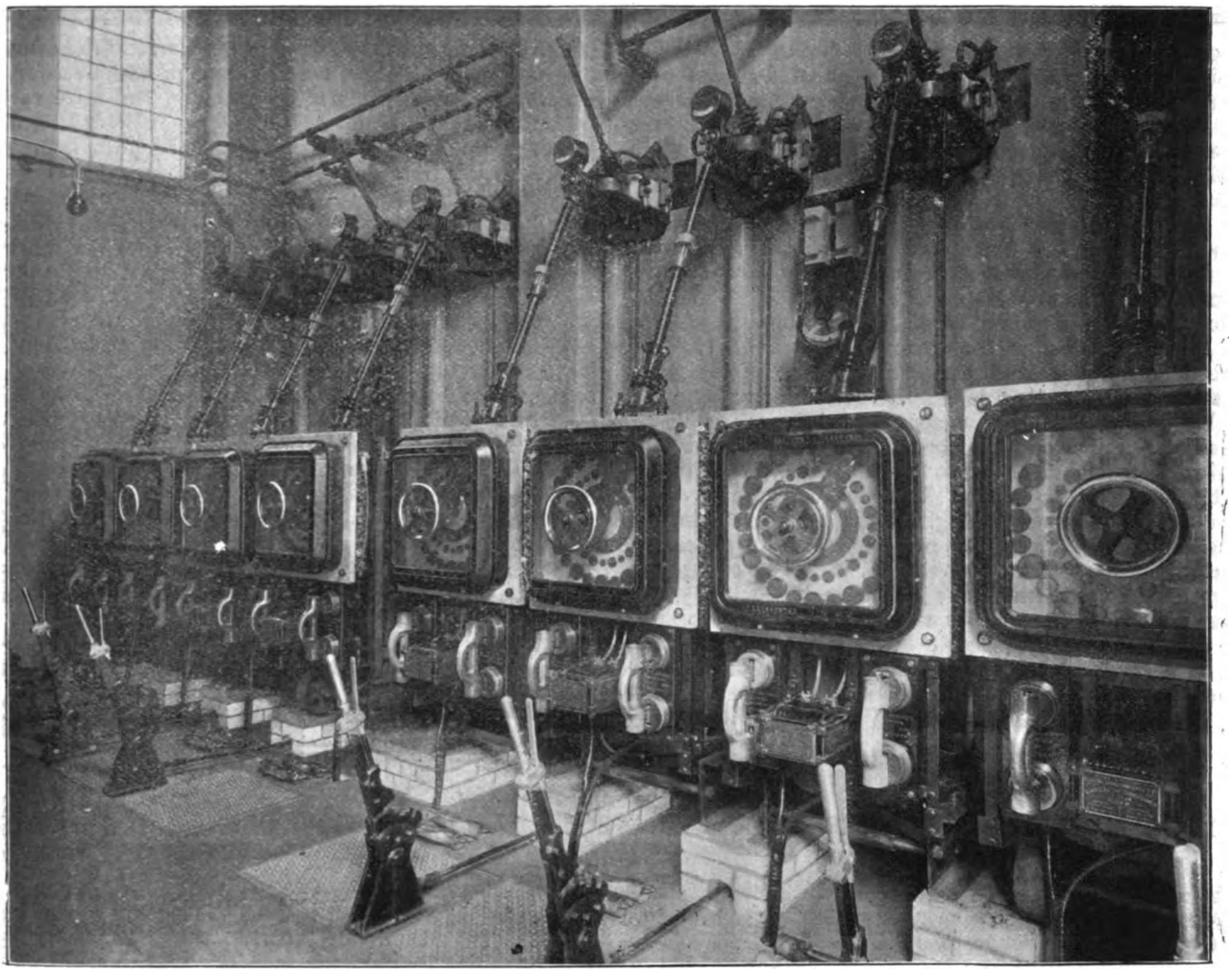
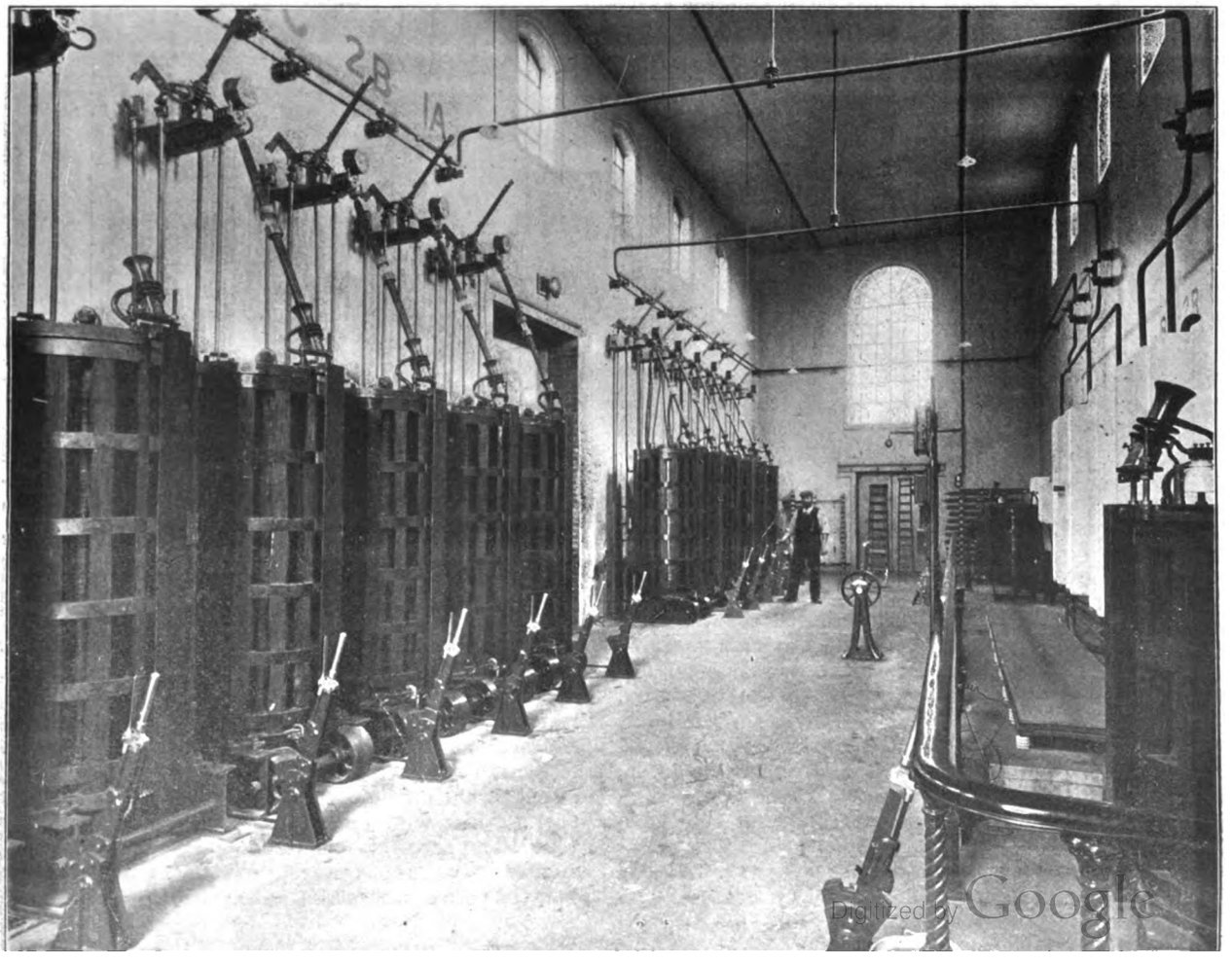


FIG. 21.—VIEW OF SUB-STATION SHOWING TRANSFORMERS, SWITCHING AND REGULATING GEAR.



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are connected to a regulating switch so as to give a range of adjustment of 120 volts in 12 steps of 10 volts each. Intermediate points between the steps are connected through choking coils, to avoid short-circuiting the transformer coils, just in the same way as in an accumulator switch except that choking coils are employed instead of resistances.

In general the switchgear at the sub-stations is similar to that at Willesden, but some modifications are necessary to meet the different requirements of the case. In each sub-station the extra high pressure cables are led in and out again, and are brought to a terminal board, shown diagramatically in Fig. 16 and in the photographic view in Fig. 19. The numbers on the plug holes correspond to those of the cables, and the board is single-pole, all the outers being connected together below. The connections for the spare cable are interesting. Provision has to be made to avoid the possibility of this main being connected to the red-phase at one end and the blue-phase at the other. This arrangement is clearly understood by reference to Fig. 16. If, as an example, it is desired to employ the spare main of the blue-phase, the attendant in the London sub-station, before he connects up this main, must ascertain that Willesden has actually made the connection to the blue-phase. To do this he inserts a plug to connect the spare cable to the primary of the safety transformer, and a test plug between the two smaller holes to connect the blue-phase at the sub-station to the other terminal of the primary of this transformer. If the connection has been made correctly at Willesden, the transformer is merely short-circuited; but if, in error, the spare cable has been connected to the red-phase at Willesden, a current passes through the transformer and the pilot lamp in the secondary will light.

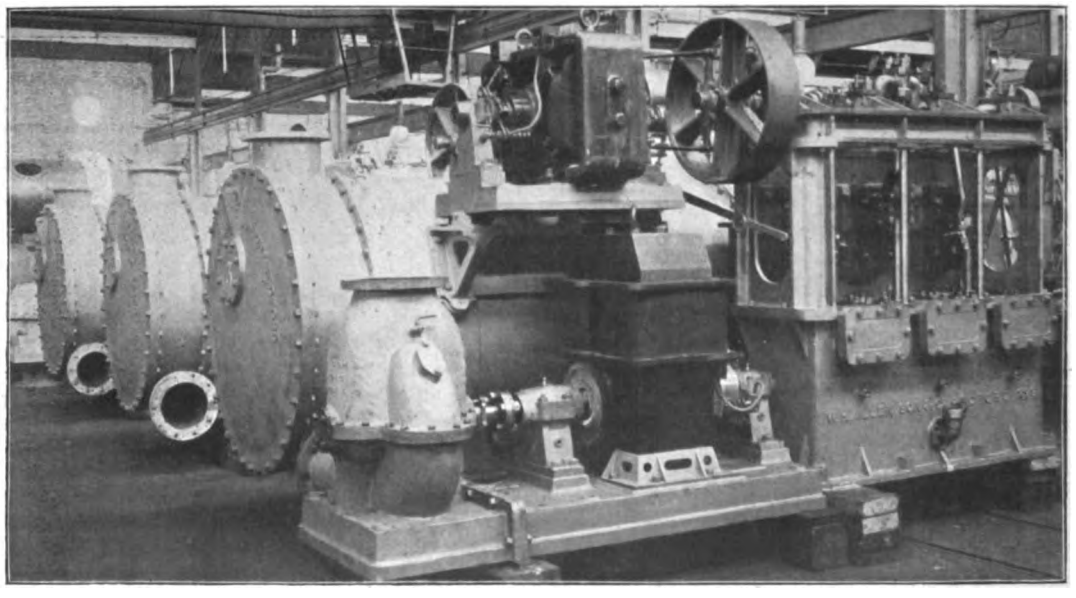
Another important point to be observed in the switching gear is that the transformer must not be switched on to take full load at once, without first magnetising the iron with a small current. This is simply effected by arranging the combined switch so that the secondary is switched on first and the primary afterwards.

From the terminal board connection is made through the large single-pole switches on either side (Fig. 19) to the 'bus-bars over the transformers on the opposite wall of the sub-station (Fig. 21). The low-pressure (1,000 volt) part of the switches is clearly seen in the latter figure.

In concluding this article we must express our thanks to the Metropolitan Electric Supply Co., who have afforded us every facility during its preparation. Mr. Bailey, Mr. Todd, and Mr. Holbrow have spared no pains in showing us all that was to be shown, and explaining all matters in connection with the new works; and Mr. Partridge was kind enough personally to go through with us all the details of his ingenious switch-gear. Some of the contractors have also given us interesting information as to the plant and material manufactured by them.

ELECTRICALLY DRIVEN SURFACE CONDENSING PLANT FOR GLASGOW ELECTRICITY WORKS.

The accompanying illustration shows the group of electrically driven surface condensing plants recently erected at the new Corporation electricity works at Glasgow by Messrs. W. H. Allen, Son and Co. As this plant embodies several improvements in the type of condensing plant usually manufactured by this company, some particulars of it may interest our readers. There are three independent or self-contained sets, each capable of dealing with 27,000lbs. of steam per hour. The elements of each set consist of the surface condenser, a three-throw Edwards air pump and a centrifugal circulating pump, the pumps being driven by electric motors. Within the cylindrical cast-iron casing of the condenser there is a cooling surface of 2,550 sq. ft., composed of longitudinal brass tubes and brass tube plates. The air pumps are designed to run at 160 revs. per min., and are geared by Hollick's gear to the motors, while the "Conqueror" centrifugal circulating pumps are direct-coupled to their motors and run at a higher speed. The air pumps have an effective displacement of 2·36 cubic feet per revolution, obtained by cylinders of 12in. diameter and a 12in. piston stroke. The circulating pumps are provided with suction and discharge pipes 11in. in diameter, the diameter of the impeller being 17in. Our illustration shows the entire plant erected in the manufacturers' shops, and from the view given it will be seen that the plant is very compact. The motors driving the pumps are supported on brackets cast on to the condensing casing. When dealing with full load the air pump motors require about 10 amperes at 520 volts and the circulating pumps 85 amperes at the same voltage. We understand that the plant has given perfect satisfaction as to efficiency and good running.



CONDENSING PLANT FOR THE NEW ELECTRIC SUPPLY WORKS OF THE GLASGOW CORPORATION.

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ELECTRIC HAULAGE IN MINES.*

Within the last ten years great strides have been made with the electric motor for hauling coal along the main roads of mines. While there have been failures in the use of this power, they have generally been due to the fact that persons who tried to apply it did not understand the requirements of the mine; to-day electric motors are as much a success in mines as they are along the streets of a city. The first thing to be decided, upon the introduction of electric haulage, is the weight of the motor needed, as this is one of the most important points. This the mining engineer and mine manager can estimate from a knowledge, as approximately as possible, of the maximum grade he expects to maintain in his mine.

After deciding the maximum grade, the distance the coal must be hauled, and the amount to be hauled, by comparing these figures with some other motor in use a fair judgment can be formed as to the weight of motor required. A 10-ton motor, travelling at the rate of six or eight miles per hour, can haul 18 loaded cars weighing 1,300lb. each, with 4,000lb. of coal, up a 2 per cent. gradient, if the cars are in fair condition, with 16in. wheel, and kept well oiled. After deciding on the weight of the motor, the next thing will be the size of rail needed. A 25lb. rail for 7½-ton and 30lb. rail for a 10-ton motor will make good tracks. The tracks should be kept as dry as possible. When it is very difficult to keep them dry and where the bottom is soft, it may be expected that there will be much trouble with the track, and it would probably not be a desirable system under these circumstances. Curves should be made of as small curvatures as possible, although it is surprising on what sharp curves they can be worked. The track is an important thing, and care should be taken in laying it; on sharp curves, and also opposite the frogs, guard rails should be used. Efforts should be made not to have a curve exceeding 25ft. radius. A good rule is to lay a straight-edge 10ft. long against the inner side of the top of the outer rail, then measure from the 5ft. mark of the straight-edge to the inner side of the rail. This distance should not exceed 6in. The height of outer rail should be measured with the 10ft. straight-edge, as given in the above rule, and one-third of the distance to the rail makes a good height for the outer rail. Either stub or point switches can be used with equal success. A motor for a 42in. gauge track should be built 41½in. inside of flanges, which will give a wider wearing surface to the tyre and a much longer use.

If the mine is a drift, the work of wiring will be simple. If a shaft, use insulated wire to the bottom; usually the air shaft is used. If the shaft is wet, run the wires through a pipe hung in the shaft. If the wire is to be carried down a drill hole or the shaft be deep, much more care should be taken, using wire that is well insulated and has a lead covering. Along the hauling road some means of supporting the hangers must be used. A good way when the roof is suitable is to drill two holes about 2in. in diameter, 10in. deep and 1ft. apart, crosswise over one of the rails; then drive wooden plugs in the holes. As it is important to have the hangers of uniform height above the rails, the plugs should be long enough to allow them to be sawed off at the proper height above the rails; then nail a piece of wood 1½in. × 4in. × 14in. on to the ends of the plugs. This gives a good support for the hangers, and will give no trouble afterward. Where the roof will not admit of this, use cross-bars across the entry. Plugs driven in the sides and extending out over the rail is another plan, but is not so good and will give more or less trouble. The hangers should be about 30ft. apart, except on curves. In stretching the wire one end should be fastened to an insulated turnbuckle. As the wire should be stretched very taut, the writer has found a pair of chain blocks to be the best for this purpose. Two or three men can pull the wire tight enough, and the blocks will hold without any difficulty. The wire should be pounded with pieces of wood in order to get all kinks out; then another pull made of the chain blocks; then after closing the ears, the blocks are moved on about 100 or more feet and the same thing repeated.

Some mines bond the rails when required by using a No. 5 wire and winding it around the bolts before the fish plate is put on. Cross bonds should be used every 100ft. or so. When naked lights are used there is no danger, where a 250 volt supply is made use of, in using electric power in mines giving off any fire damp. How much higher voltage can be used with safety the author could not say.

Some places use three tracks at their inside or gathering switches; unless very long trains are used this is not needed. By a little practice, running switches can be made that would surprise anyone not acquainted with the system. This leaves the motor ready to start out with loaded trip by the time the empties have run in on the siding. If the motor has any spare time, it should be used at the shaft bottom or at the hoppers to block down trains, thereby saving labour. Longer sidings are required than with horses. At the hoppers if a drift mine, or at the bottom, if a shaft, three tracks should be used, as it would be too much risk and a loss of time to dumpers or cagers to make running switches. It should be arranged so that the motor will come as near the hopper or shaft bottom as possible. This can be done by having a track passing the side of the shaft and a track leading back off to one side. By this plan coal can be hauled with the same motor from both sides of the shaft, and by so doing much labour will be saved.

The writer stated that he had opportunities of observing steam locomotive haulage, rope haulage, and electric haulage, and preferred the latter on the grounds of health of employés, adaptability, and least care.

* Abstract of Paper by D. C. Thomas, read before the Ohio Institute of Mining Engineers.

PHYSICAL SOCIETY.

At an ordinary meeting, held on March 9, 1900, Prof. EVERETT, F.R.S., vice-president, in the chair, a Paper on

"The Damping of Galvanometer Needles"

was read by Mr. M. SOLOMON. The solution of the equation of motion for a magnetic needle, swinging in a uniform magnetic field, points to the conclusion that the ratio of the period to the logarithmic decrement is independent of either the moment of the needle or the strength of the controlling field, and is simply a function of the damping coefficient and the moment of inertia of the moving system. This ratio should therefore be constant if these latter quantities are constant. Experiments to test the constancy of period to logarithmic decrement have been conducted at the Central Technical College at various times since 1891, and they have invariably pointed to a variation in the value of the ratio. The object of the present Paper is to discover the cause of this variation. It may be due to an alteration in the moment of inertia, or to an alteration in the damping coefficient. If the control magnets are either directly above or directly below the needle there is no chance of any change in moment of inertia. The damping coefficient depends on three things: (1) viscosity of the air, (2) viscosity of the suspension, and (3) eddy currents. The author has carried out experiments with a galvanometer on open circuit, and finds a constant value for the ratio. The viscosity of the air and suspension therefore cause no variation. Upon closing the circuit and repeating the experiments the value of period over logarithmic decrements alters. The variation is therefore due to eddy currents. The damping factor due to eddy currents may vary owing to three causes: (1) change in moment of needle due to change in field strength, (2) effects of self-induction, (3) effects of rise of temperature on the resistance of the coils. The author points out that the two latter causes would tend to alter the ratio in the wrong direction and he therefore concludes that the variation is due to an alteration in the strength of the swinging needle produced by altering the strength of the controlling field.

Mr. BLAKESLEY said it was interesting to note the fact that the ratio of period to decrement was independent of the controlling field. In the case of a condenser discharging this ratio is independent of the capacity, in the case of a tuning fork of the rigidity, and in the case of water oscillating up and down in a U tube of the acceleration due to gravity.

Mr. ROSENBAUM said that the ratio considered was constant in the case of a Nalder-D'Arsonval galvanometer.

Mr. SOLOMON said that his arguments did not apply to a galvanometer of this description, because the swinging system was not a magnetic needle, but simply a coil.

A Paper on

"The Distribution of a Gas in an Electric Field."

was read by Mr. G. W. WALKER. The author has considered a gas as consisting of a number of molecules each containing two atoms of equal mass, one positively and the other negatively charged with electricity. When under the action of electrical forces some of the molecules split up, and we arrive eventually at a steady state, in which there is a definite number of undissociated molecules and of free positive and free negative atoms. Treating the problem as one-dimensional, the potential at any point is expressed in general by elliptic functions, and is therefore periodic. Applying the results to the case of a vacuum tube, it is found that there is superimposed upon the gradual fall of potential along the tube minor periodic variations which it is suggested are connected with the striæ of discharge. Both the matter density and the electric density are periodic along the tube. If the places of maximum matter density coincide with the places of minimum electrical action, then, whether luminosity is due to collisions or recombinations, there will be maximum luminosity at these points. In general these points do not coincide, and thus the positions of maximum luminosity are not clearly defined. The analysis leads to the conclusion that the distance between the striæ is inversely proportional to the density of the gas and to the current strength, and these facts have been experimentally verified.

Mr. C. E. S. PHILLIPS exhibited a

"Surface Tension Lecture Experiment."

The effects of surface tensions were exhibited by placing water between two pieces of microscope cover glass. When the glasses are circular they set in any position, and one can be made to rotate upon the other. If the plates are square or elliptical they set in a definite

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position, to which if displaced they immediately return. Mr. Phillips pointed out how two circular discs with liquid between could be used, from which to suspend the moving system of a galvanometer.

Mr. COFFIN suggested the use of some liquid which would evaporate less slowly than water.

Mr. BLAKESLEY asked what accuracy could be obtained with such an arrangement, and what weight it would be possible to support without squeezing out the water?

The meeting then adjourned until March 23.

ELECTRICITY WORKS ACCOUNTS.

Kensington and Knightsbridge Electric Lighting Co. (Ltd.)

Although the figures contained in our table dealing with the 1899 accounts of the Kensington and Knightsbridge undertaking indicate that in all essential respects good progress attended the year's operations, yet we must say that we cannot unreservedly commend all the results attained.

In the matter of increased lamp connections, and also as regards output, the record is very encouraging as compared with the corresponding increases noted last year. The lamp connections rose in 1898 some 18 per cent. and the output only about 9·6 per cent. Last year the increases in these quantities were respectively 17·5 per cent. and 18·4 per cent. Upon the output of 2,463,950 units sold an average revenue of 4·94d. per unit was secured. An additional 0·16d. from meters and 0·08d. from other sources raised the total average revenue to 5·17d. per unit.

Passing on to a consideration of the costs, it is necessary at the outset to note that the load factor which obtained was about 12·2 per cent., a figure which, although lower than that which characterised the 1897 and 1898 load on the station, is yet considerably above the average.

It is highly satisfactory to find that in every item of cost except one—viz., "repairs and renewals of mains"—a reduction has been made. The already very fair figure of 0·76d. which obtained for fuel in 1898 has been reduced to 0·64d. Precisely the same thing might be said of station wages, while "oil, waste, water, and stores" has likewise diminished from what was even originally a low value.

What surprises us are, however, the repairs items. Last year we had occasion to remark in connection with these that they had been somewhat unfairly saddled (for comparative purposes) with charges amounting to 0·35d. per unit in the aggregate. In that portion coming under generating charges there has certainly been a slight reduction last year, but even now this item is more than double what we should have expected it to be. The other department of repairs and renewals—that of mains—shows the considerable increase of from 0·064d. to 0·246d. per unit. After making allowance for the unrepresentative charges which entered into the 1898 accounts, the generating, works, and total costs of that year were exceedingly satisfactory, but in 1899, in spite of the excellent economies which have been effected in other items, the repairs, maintenance, and renewal charges have been potent to introduce a virtual increase in the totals influenced, and while these totals (viz., generating, works, and total costs) show results quite up to the average, they appear to us to take a second place to the corresponding figures of 1898. Management and property charges, though they have improved, are still somewhat high, though of course included in the item of salaries there is a charge of £1,000 in respect of directors' remuneration.

Appended are a few particulars of interest regarding the growth of this undertaking:—

Year.	No. of consumers.	No. of lamps connected. 8 c.p.	Output. Units sold.	Total costs per unit.	Ordinary dividend. %
1890	291	25,535	...	...	...
1891	436	38,408	385,051	...	2
1892	550	47,441	535,343	...	4
1893	734	64,529	724,308	...	5
1894	908	80,678	977,789	...	5
1895	1,109	94,780	1,228,734	2·63d.	6
1896	1,325	119,955	1,614,729	3·03d.	7
1897	1,620	137,953	1,898,362	2·65d.	10
1898	1,851	156,158	2,081,074	3·04d.	10
1899	2,110	183,462	2,463,950	2·81d.	11

Notting Hill Electric Lighting Co. (Ltd.).

We must congratulate this company on the excellent results of its operations during 1899—not only in the new business secured and the largely increased output, but also in the marked and general reduction which has been effected in the costs of supply. As affording an interesting comparison, the following figures concerning the undertaking since the commencement of supply are repeated:—

Year.	No. of consumers.	Equiv. 8 c.p. lamp connections.	Output. Units sold.	Total revenue.	Gross or working profit.	Total costs per unit sold.	Ord. div. %
1891	77	6,056	30,162	£1,623	− £555	17·34d.	nil
1892	124	9,438	75,667	3,513	+ 112	10·78d.	nil
1893	173	12,153	107,580	4,329	+ 1,481	6·36d.	nil
1894	234	15,669	130,266	5,123	+ 2,102	5·57d.	1
1895	307	20,307	182,327	6,940	+ 3,228	4·89d.	2
1896	396	25,716	230,767	8,552	+ 4,736	3·97d.	4
1897	571	33,000	354,969	11,626	+ 6,854	3·22d.	6
1898	788	46,065	455,871	13,418	+ 7,252	3·25d.	6
1899	1,012	59,154	665,129	17,674	+10,361	2·64d.	7

During last year 224 new consumers with the equivalent of 18,088 8 c.p. lamps were connected to the mains, thus raising the total lamp connections about 28 per cent. A still greater advance is indicated in the output, which has increased about 50 per cent.—the year's output exceeding 665,000 units sold. An average price of 5·93d. per unit was received for supply, while other items, including 0·24d. per unit from meters, raised the total revenue to 6·38d. per unit.

Looking down the costs column, it will be noticed that all the chief items, except "rent, rates, taxes," have been reduced.

Among the generating costs the fuel item is slightly below the average under similar conditions of output and load factor. "Oil, waste, water, stores" and "wages at station" show most excellent figures, but we should like to see the repairs and maintenance bill still lower. Management and property charges at 1·24d. per unit are also too high to be allowed to rest. Their still somewhat abnormal value is, however, largely due to the very considerable increase in rent, rates, and taxes. Compared with the £7,752 of 1898, the working profit of £10,361, representing 7·8 per cent. of the mean expended capital, marks very gratifying progress. The joint contribution to the reserve and depreciation funds was £1,559, while the interest charges absorbed £1,188. The balance available for distribution was therefore £7,627, out of which an ordinary dividend of 7 per cent. was paid.

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

Aberdeen (Municipal)	Jan. 12, 1900	Kingston-on-Thames (Mun.)	April 21, 1899
Ayr (Municipal)	Sept. 22, 1899	Lancaster (Municipal)	Jan. 19, 1900
Bath (Municipal)	Feb. 9, 1900	Leeds (Municipal)	Dec. 1, 1899
Bedford (Municipal)	May 19, 1899	Leicester (Municipal)	Jan. 26, 1900
Belfast (Municipal)	Sept. 15, ,,	Leyton (Municipal)	Sept. 8, 1899
Birmingham (Company)	Sept. 15, ,,	Liverpool (Municipal)	June 9, ,,
Blackburn (Municipal)	Jan. 19, 1900	Londonderry (Municipal)	Feb. 16, 1900
Blackpool (Municipal)	Sept. 29, 1899	Manchester (Municipal)	Aug. 11, 1899
Bournemouth (Company)	April 28, ,,	Newcastle and District (Co.)	Oct. 6, ,,
Bolton (Municipal)	Nov. 24, ,,	Newcastle-upon-Tyne (Co.)	April 14, ,,
Bradford (Municipal)	April 14, ,,	Newport (Mon.) (Municipal)	Dec. 15, ,,
Brighton (Municipal)	May 12, ,,	Northampton (Company)	Oct. 20, ,,
Bristol (Municipal)	July 14, ,,	Norwich (Company)	Nov. 17, ,,
Burnley (Municipal)	Aug. 25, ,,	Notting Hill (Company)	Mar. 17, ,,
Burton-upon-Trent (Mun.)	April 21, ,,	Nottingham (Municipal)	July 21, ,,
Bury (Municipal)	Sept. 22, ,,	Oldham (Municipal)	Dec. 1, ,,
Cambridge (Company)	Mar. 10, ,,	Oxford (Company)	May 19, ,,
Cardiff (Municipal)	Dec. 15, ,,	Pontypool (Company)	May 5, ,,
Charing Cross (Municipal)	Mar. 9, 1900	Portsmouth (Municipal)	July 14, ,,
Chelsea (Company)	Mar. 31, 1899	Prescot (Company)	Dec. 8, ,,
Cheltenham (Municipal)	Nov. 10, ,,	Preston (Company)	Sept. 29, ,,
Chester (Municipal)	June 22, ,,	Reading (Company)	Oct. 13, ,,
City of London (Company)	May 12, ,,	Richmond (Company)	Oct. 13, ,,
Clerkenwell (Company)	Aug. 18, ,,	Salford (Municipal)	Feb. 23, 1900
Coventry (Municipal)	Feb. 23, 1900	Scarborough (Company)	Nov. 3, 1899
Croydon (Municipal)	Feb. 9, ,,	St. Helens (Municipal)	Dec. 8, ,,
Derby (Municipal)	Jan. 26, ,,	St. James' & Pall Mall (Co.)	Feb. 16, 1900
Dewsbury (Municipal)	Nov. 24, 1899	St. Pancras (Vestry)	May 26, 1899
Dover (Company)	June 2, ,,	Sheffield (Municipal)	Dec. 29, ,,
Dundee (Municipal)	Jan. 12, 1900	Shoreditch (Vestry)	Oct. 27, ,,
Eastbourne (Company)	Feb. 2, ,,	Southampton (Municipal)	Nov. 10, ,,
Edinburgh (Municipal)	Nov. 17, 1899	Southport (Municipal)	July 7, ,,
Exeter (Municipal)	Aug. 5, 1898	South Shields (Municipal)	July 7, ,,
Glasgow (Municipal)	Sept. 1, 1899	Stafford (Municipal)	Dec. 29, ,,
Guildford (Company)	May 5, ,,	Sunderland (Municipal)	July 28, ,,
Halifax (Municipal)	July 21, ,,	Taunton (Municipal)	June 16, ,,
Hammersmith (Vestry)	May 26, ,,	Tunbridge Wells (Mun.)	Sept. 1, ,,
Hampstead (Vestry)	Aug. 25, ,,	Wakefield (Municipal)	Dec. 1, ,,
Hanley (Municipal)	April 28, ,,	Walsall (Municipal)	June 23, ,,
Harrogate (Municipal)	Oct. 20, ,,	Wandsworth (Company)	Aug. 12, ,,
Harrow (Company)	June 16, ,,	Westminster (Municipal)	Mar. 9, 1900
Hast'gs & St. Leonards (Co.)	Feb. 2, 1900	Whitehaven (Municipal)	July 28, 1899
H'use-to-H'useCo. (K'ns'gt'n)	Mar. 31, 1899	Windsor (Company)	Dec. 22, ,,
Hove (Company)	Mar. 10, ,,	Woking (Company)	Dec. 22, ,,
Huddersfield (Municipal)	Oct. 6, ,,	Wolverhampton (Municipal)	June 30, ,,
Islington (Vestry)	Oct. 27, ,,	Woolwich (Company)	Jan. 13, ,,
Kens'gton & Knightsbr' (Co.)	Mar. 8, ,,	Worcester (Municipal)	April 7, ,,
Kingston-upon-Hull (Mun.)	June 9, ,,	Yarmouth (Municipal)	Nov. 8, ,,

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	KENSINGTON & KNIGHTSBRIDGE		NOTTING HILL.	
Undertaking Worked by	The Kensington and Knightsbridge Electric Lighting Co. (Limited).		Notting Hill Electric Lighting Co. (Limited).	
Date of Commencement of Supply	January, 1887.		May, 1891.	
System of Supply	Three-wire continuous-current, with batteries.		Continuous-current three-wire, with batteries.	
Chief Engineer	H. W. Miller.		George Schultz.	
YEAR ENDED	DEC. 31, **1898.**	DEC. 31, **1899.**	DEC. 31, **1898.**	DEC. 31, **1899.**
QUANTITIES—				
Units generated	—	2,781,579	479,371	695,878
„ SOLD (TOTAL)	2,081,074	2,463,950	455,871	665,129
„ sold to consumers	2,081,074	2,463,950	455,871	665,129
„ sold for public lighting, &c.	—	—	—	—
„ used on works	—	120,658	9,700	16,251
UNITS SOLD PER 8 C.P. LAMP CAPACITY	34·1	33·5	18·2	33·2
Maximum supply demanded	1,880 kilowatts	2,301 kilowatts	460 kilowatts	620 kilowatts
Number of public lamps	—	—	nil	nil
Number of consumers	1,851	2,110	788	1,012
Connections to mains in 8-c.p. lamps	156,158	183,462	46,066	59,154
CAPACITY OF PLANT IN 8-C.P. LAMPS	61,000	73,500	25,000	20,000
CAPACITY OF PLANT IN KILOWATTS	1,950	2,350	800	640
CAPITAL—	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.
AUTHORISED (TOTAL)	£508,435 / £261	£508,435 / £216	£150,000 / £187·5	£150,000 / £234
Share	350,000 / 179	350,000 / 149	100,000 / 125	100,000 / 156
Loan (including Debenture charges)	158,435 / 81·3	158,435 / 67·4	50,000 / 62·5	50,000 / 78·2
RECEIVED (TOTAL)	248,435 / 127	248,435 / 106	126,000 / 157·4	131,000 / 205
Share	158,435 / 81·3	158,435 / 67·4	100,000 / 125	100,000 / 156
Loan (including Debenture charges)	90,000 / 46·1	90,000 / 38·3	26,000 / 32·5	31,000 / 48·5
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	260,000 / 133	260,000 / 111	24,000 / 30·0	19,000 / 29·7
Share (unissued)	191,565 / 98·3	191,565 / 83·5	— / —	nil / —
Share (uncalled)	— / —	— / —	— / —	nil / —
Loan (including Debentures)	68,435 / 35·1	68,435 / 29·1	24,000 / 30·0	19,000 / 29·7
REPAID (TOTAL)	— / —	— / —	— / —	— / —
RESERVE OR SINKING FUND	25,615[a] / 13·1	30,380[a] / 12·9	} 4,500 / 5·63	6,000 / 9·38
DEPRECIATION FUND	1,783 / 0·914	2,145 / 0·913		
EXPENDED (TOTAL)	263,481[b] / 135	273,814 / 117	128,004 / 160	137,351 / 215
Lands and buildings	52,851 / 27·1	52,990 / 22·5	22,306 / 27·9	23,559 / 36·8
Plant	106,368[c] / 54·6	111,408 / 47·4	30,841[a] / 38·5	32,734 / 51·1
Mains	85,733 / 43·9	90,943 / 38·7	69,984 / 87·5	76,196 / 119
Miscellaneous	18,529[b] / 9·50	18,472 / 7·86	4,873 / 6·09	4,861 / 7·60
BALANCE OF CAPITAL ACCOUNT	−15,046[d] / −7·72	−25,379[d] / −10·8	−2,004[b] / −2·51	−6,351[b] / −9·92
REVENUE—	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.
TOTAL	£46,332 / 5·342d.	£53,055 / 5·166d.	£13,418 / 7·065d.	£17,674 / 6·380d.
Revenue from supply	44,067 / 5·083d.	50,655 / 4·935d.	12,239 / 6·445d.	16,423 / 5·930d.
„ meters, &c.	1,463 / 0·169d.	1,596 / 0·155d.	487 / 0·256d.	654 / 0·236d.
„ public lighting	— / —	— / —	nil / —	nil / —
„ sale of lamps, &c.	44 / 0·005d.	15 / 0·002d.	412 / 0·217d.	313 / 0·113d.
„ miscellaneous sources	756 / 0·087d.	790 / 0·077d.	281 / 0·148d.	284 / 0·103d.
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	£26,383 / 3·043d.	£28,799 / 2·806d.	£6,167 / 3·247d.	£7,313 / 2·639d.
WORKS COSTS	18,051 / 2·083d.	19,921 / 1·941d.	3,123 / 1·644d.	3,891 / 1·401d.
Generation of electricity	*16,517 / 1·906d.*	*16,830 / 1·640d.*	*3,078 / 1·620d.*	*3,689 / 1·329d.*
Fuel (including cartage, &c.)	6,587 / 0·760d.	6,558 / 0·639d.	1,472 / 0·775d.	1,902 / 0·687d.
Oil, waste, water, stores	807 / 0·093d.	807 / 0·078d.	241 / 0·127d.	255 / 0·092d.
Wages at station	3,186 / 0·368d.	3,120 / 0·304d.	532 / 0·280d.	646 / 0·233d.
Repairs and maintenance at station	5,937[e] / 0·685d.	6,246 / 0·609d.	832 / 0·438d.	877 / 0·317d.
Distribution of electricity	*1,534 / 0·177d.*	*3,091 / 0·301d.*	*45 / 0·024d.*	*201 / 0·073d.*
Wages, &c.	983 / 0·113d.	568 / 0·055d.	} 45 / 0·024d.	201 / 0·073d.
Repairs, renewals of mains, &c.	551 / 0·064d.	2,523 / 0·246d.		
Public lighting	— / —	— / —	*nil* / —	*nil* / —
Attendance	— / —	— / —	— / —	— / —
Renewals	— / —	— / —	— / —	— / —
MANAGEMENT AND PROPERTY CHARGES	8,330 / 0·961d.	8,878 / 0·864d.	3,044 / 1·603d.	3,432 / 1·240d.
Royalties	— / —	— / —	*nil* / —	*nil* / —
Rent, rates, taxes	*3,874 / 0·447d.*	*4,096 / 0·399d.*	*222 / 0·117d.*	*650 / 0·235d.*
Management	*4,456 / 0·514d.*	*4,782 / 0·467d.*	*2,822 / 1·485d.*	*2,782 / 1·007d.*
Salaries	2,717 / 0·314d.	3,103 / 0·302d.	2,298[c] / 1·210d.	2,336 / 0·843d.
Stationery, &c.	318 / 0·037d.	280 / 0·027d.	76 / 0·040d.	} 223 / 0·081d.
Establishment charges	377 / 0·044d.	333 / 0·032d.	140 / 0·078d.	
Law charges, &c.	1,044[f] / 0·120d.	1,066[h] / 0·104d.	308[d] / 0·162d.	223[f] / 0·081d.
FINANCIAL RESULTS—	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded
WORKING PROFIT FOR YEAR	£19,949 / 7·74%	£24,256 / 9·03%	£7,252 / 6·01%	£10,361 / 7·80%
Sum carried to Depreciation Fund	} 5,408 / 2·10%	5,054 / 1·88%	875[e] / 0·726%	1,550[e] / 1·17%
Sum carried to Reserve or Sinking Fund				
Net interest on loans (incl. Debenture charges)	3,292 / 1·28%	3,438 / 1·28%	717 / 0·595%	1,183 / 0·89%
BALANCE FROM LAST ACCOUNT	7,264 / 2·82%	1,226 / 0·456%	14 / 0·012%	nil / —
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	12,715 / 4·93%	16,990 / 6·33%	5,673 / 4·70%	7,627 / 5·75%
Deficit	— / —	— / —	— / —	— / —
ORDINARY DIVIDEND PAID	10% / —	11% / —	6% / —	7% / —
PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE	57%	54·3%	46%	41·4%
Expenditure per kilowatt capacity	£13. 10s. 7d.	£12. 5s. 0d.	£7. 14s. 2d.	£11. 8s. 5d.
REVENUE PER KILOWATT CAPACITY	£23. 14s. 10d.	£22. 11s. 2d.	£16. 15s. 7d.	£27. 12s. 0d.
Expenditure per 8-c. lamp capacity	8s. 8d.	7s. 10d.	4s. 11¼d.	7s. 3¾d.
REVENUE PER 8-C.P. LAMP CAPACITY	15s. 2d.	14s. 5¼d.	10s. 9d.	17s. 8d.
REVENUE PER 8-C.P. LAMP CONNECTED	5s. 11d.	5s. 9½d.	5s. 10d.	5s. 11¾d.
Price charged for lighting, per unit	6d. to 5d.[g]	6d. to 5d.[g]	6d.	6d.
Price charged for power, per unit	4d.	4d.	4d.	6d.[g]
Price charged for public lighting	—	—	—	—

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The Electrician.

The Oldest Electrical Journal (established as a weekly Journal 1861—1878

Published every Friday, Price Sixpence; Post Free, Sixpence-Halfpenny.
Editorial Publishing and Printing Offices,

1, 2 & 3, SALISBURY COURT, FLEET ST., LONDON.

Telephone: 949 Holborn. *Telegrams:* "ELECTRICIAN NEWSPAPER LONDON."

All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher "THE ELECTRICIAN," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN" *Printing and Publishing Company, Limited, and be crossed* "*Coutts and Co.*"

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"THE ELECTRICIAN" *is published every Friday morning, in time for the morning mails. It is on sale at the railway bookstalls throughout the Kingdom on Friday morning, and can be obtained of all Booksellers and Newsvendors; or direct from the Publishing Offices, as above*

Subscription Rates.—The Rates for Subscriptions to "THE ELECTRICIAN" are as under:—

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LIGHT AND POWER CABLE SPECIFICATIONS.

By tacit consent the greater part of the recent discussion on standardisation at the Institution of Electrical Engineers was devoted to the plant required for electric lighting, but cable specifications were not once referred to during the two evenings set aside for Mr. SELLON'S Paper. This omission, the more remarkable as cables represent roughly about a third of the total capital expenditure of electricity supply works, was undoubtedly due to the fact that the question of standardising cables is not so important to the manufacturer as that of machinery. No castings are required in cable manufacture, except those for junction boxes, which even at the worst would be standardised over each particular job, and the drawing office expenses are but a minute fraction of the cost of the cable and its accessories. From the buyer's point of view, however, the cable specification is a matter of considerable interest. Not only are the specifications frequently worded loosely, but the acceptance tests of cable, when carried out at all, are often performed in a slipshod and perfunctory manner, and the user of the cable, who may have been very particular about 1 per cent. more or less in the efficiency of his engines and dynamos, may not know within 5 per cent. the resistance, and therefore the efficiency, of the various parts of his cable network. Not only this, but there are still, we believe, makers of electric light cables who have not the means in their testing room of measuring with sufficient accuracy the conductor resistance of a short length of cable of large sectional area.

It is especially to the copper core of the cable that more attention should be directed. So much has been said recently with regard to the definition or choice of Matthiessen's standard, that we need do no more than point out that there is a difference of 2 per cent. between his standards for soft annealed and hard-drawn copper wire. Again, owing to the spiral lay of stranded cable, the actual area of stranded wires at any cross section exceeds that of the same number of straight wires. If the wires could be assumed to be in perfect contact with one another, this actual area would be employed in calculating the resistance of the wire, while if it be assumed that the contact resistance is great, the "equivalent area" must be taken as a certain percentage less than the sectional area of the same number of straight wires. Thus there is occasionally a decided uncertainty how the specification of area is to be read, and as the increase in

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weight due to stranding is in the order of 1 per cent., there is an added uncertainty of 2 per cent. Yet consulting engineers, instead of asking for a cable of fixed resistance per mile, are apt to specify a certain percentage conductivity accorded to Matthiessen's standard, and a certain sectional area of conductor. If, therefore, a manufacturer is able to take advantage of inexactitude in both definitions, the user of the cable will be increasing his copper losses by 4 per cent. In order that it may not be thought that we are setting up a bugbear, a comparison of actual figures may be made. Taking as a starting point the definitions recently decided upon by an association of manufacturers of india-rubber covered cable, the resistance per mile of a solid copper conductor of a 0·4 sq. in. sectional area would be 0·1058 of a standard (international) ohm; and employing the convention for equivalent sectional area of stranded cable adopted by the same association, we arrive at 61/·092 in. (61/18 S.W.G.) as the size of cable to fulfil the condition. The equivalent area of 61/18 S.W.G. cable, according to the same standards, is 0·401 sq. in., and its resistance per mile 0·1056. Yet the manufacturers and, we have reason to believe, at least one of the signatories to the report, continue to sell 61/090in. cable as "0·4 sq. in." Sixty-one times the sectional area of 0·090in. diameter wire is 0·388 sq. in., or about 3· per cent. below 0·4; and allowing for loss in lay as specified in the report, the "equivalent area" of 61/·090in. would be 0·383 sq. in., or more than 4 per cent. less. This size of cable is listed by another maker as having 0 112 ohms per mile at 60°F., a temperature also adopted as standard in the above figures.

In insulation, on the other hand, it would be difficult to improve on the present state of affairs. The Board of Trade regulations impose a certain minimum radial thickness, as also do the wiring rules of the Institution of Electrical Engineers. British cable manufacturers, although frequently working right down to these limits, have been most successful in making thoroughly reliable cable. The 10,000 volt cable, described in another column of this issue, between Willesden and London, was manufactured, laid, and tested without the least hitch; and indeed cables have for many years past withstood this pressure between Deptford and London. It is probable also that there would be no difficulty in making cables for higher pressures, whether or no the same relation as that stipulated by the Board of Trade between voltage and radial thickness be retained as the pressure is increased further. The results are especially significant when compared with the trouble experienced abroad with underground high-pressure mains, and there is little doubt that, besides the excellence of the cable, the precautions adopted in the switching arrangements have contributed largely to the success. A word of caution may here be added as to the employment of too high pressures for testing purposes. A factor of safety of from 2 to 3 has usually been deemed sufficient, and this should not be exceeded, for although cables will frequently withstand even ten times the voltage for which they are designed, the application of this may occasion an injurious strain in the dielectric. The term "non-hygroscopic" is freely used and abused with reference to lead-covered cables. Few, if any, lead-covered paper and fibre cables now on the market are absolutely impervious to water for an indefinite time when the lead is removed, and, in consequence, if their insulation is exposed to the air, there is little doubt that it would absorb moisture in due course. It is almost safe to say that all such cables are hygroscopic; but of course there is a degree in hygroscopy as in most other things. Instead of specifying "non-hygroscopic insulation," the consultant should clearly describe a time test in water to which a sample of the cable, deprived of its lead covering, must be submitted.

The last but by no means least important omission in many specifications is a statement of the thicknesses of lead and iron sheathing. The durability of a lead-covered cable depends almost entirely on the thickness of the lead, just as immunity from mechanical injury depends on the thickness of the armouring, and neither should on any account be overlooked.

REVIEWS.

Copies of any of the undermentioned works can be had from *The Electrician* office post free, on receipt of published price.)

La Traction Electrique sur Voies Ferrées. Par ANDRÉ BLONDEL et F. PAUL-DUBOIS. Two volumes. Libraire Polytechnique Baudry et Cie., Paris. Price 50 francs.

This work is a most exhaustive and admirable compendium of almost everything that refers to the rolling stock of electric tramways and electric railways. It also contains a considerable amount of information concerning street railway road-beds and their laying, though this section is not so comprehensive as that dealing with the rolling stock. Of overhead construction and generating station plant it does not profess to treat. Of the dimensions of the work some estimate may be formed when it is stated that it consists of two volumes, each of some 850 pages, most profusely enriched with illustrations, sectional and other drawings, and diagrams. The book represents a vast amount of labour in the mere collection of examples of traction plants of all kinds now in use, not only in France, but also in America, Germany, England, and other countries. Indeed, the references to French practice are comparatively rare, and Mons. Potier, in his preface to the work, laments that this is but just, seeing that France has done so little for the development of electric traction. It must not of course be imagined that in all cases the fullest particulars of the apparatus described are given, and doubtless the reader who seeks in these volumes for some detail of any particular motor or controller or other device will find that everything seems to be described except that which he most wants; yet the work must be judged as a whole, and considering the great and very natural difficulty of obtaining detailed information from manufacturers we cannot but congratulate the authors on the result of their labours.

At the commencement of the first volume we have about 30 pages of historical matter, which will prove sufficient for most readers. It is our opinion that in many practical treatises on technical subjects too much time and space is spent upon what can have but little interest to the majority of those for whom the books are intended. After the historical section comes a somewhat inadequate dissertation upon road-beds, rails, and bonding; and next a very exhaustive discussion of the motors used in traction work, together with descriptions and illustrations of motors of the best-known makers, including those of the General Electric, Westinghouse, Thomson-Houston, Allgemeine, and Siemens and Halske companies. After this we have a rather scanty section on alternating motors, both single-phase and polyphase, sections on trucks, on accumulator cars, on the lighting and heating of cars, and finally a chapter of considerable length on motors for electric railway as opposed to tramway work, and on mine and workshop locomotives. This ends the first volume, to which, however, there are annexed several appendices upon the cost of installation of electric tramway systems, upon the design of traction motors, &c., and a very complete series of regulations affecting the working of electric lines, including those of our Board of Trade and of sundry French, German, and American authorities.

In the second volume we have a description of various single-rail systems and of cog and mountain railways. This ends one of the natural divisions of the book, and the authors then proceed to an enunciation of the fundamental principles upon which the design of traction motors is based, followed by a description of the various means of regulating speed and

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torque, with concrete examples of the controllers, resistances, and brakes manufactured by the great engineering firms. The remainder of Vol. II. is mainly taken up with a development of the previous section in the first volume on alternating current working, and with calculations upon the adhesion of rails, the energy consumed by an electric car or locomotive at different portions of its journey, and so forth. Last of all, there is an exceedingly good bibliography, and—no small matter—a first-rate index. No reference is made to road motor cars or motor cycles.

The work thus covers a considerable amount of ground, and on the whole does it very effectually; though of course, with such a wide range of subjects, we here and there find information lacking that we should very much like to have, and even in some cases erroneous impressions conveyed. For instance, the question of the heating of traction motors requires treating in a more practical manner, and the authors give us no curves or figures showing the relation between rise of temperature and length of run for different powers developed, though of course this matter is of great importance and has a vital effect upon motor design. A railway motor has a rating far in excess of the power it could give on a continuous run of say six hours, which is the period generally specified in the case of shunt motors for stationary work; and, again, the motion of the car through the air has a great cooling effect upon the motor, and will permit of a dissipation of energy per unit of cooling surface much greater than that of the transformer which is cited as a parallel case on page 165 of the first volume. The curve there given simply shows the relation of temperature rise to the square centimetres of cooling surface per watt dissipated, and the time taken to attain this temperature is not even mentioned. As a matter of fact, we find in practice that railway motors are generally rated according to the horse-power they will develop when attaining to a certain temperature rise, say 75°C., after a given time, generally one hour. This whole question should have received full and careful treatment. Further, too much stress is laid upon the current density in the conductors of a motor, seeing that the density is a matter of minor importance and must depend upon the relative values of the various losses which cause the heating of the motor as a whole.

But it is easy to find fault, and to do so is ungracious in the case of a work containing such a vast amount of information so carefully compiled and systematised as the one under review. F. W.

Lockwood's Builder's and Contractor's Price Book for 1900. Edited by FRANCIS T. H. MILLER. (London: Crosby, Lockwood and Son. 1900.)

Very little has been added to the electrical sections of this useful reference book, but the prices have in all cases been brought up to date. In the preface it is stated that on the whole the high prices ruling in the building trade at the commencement of the year have been maintained. While some classes of material have gone down in price, it is stated that others, notably iron and lead, have risen to a higher value than ever before. No general advance in wages has taken place, but yet the editor finds that labour is dearer than it was, owing to the fact that "workmen do undoubtedly less work for their money than they used."

Annuaire pour l'An 1900, publié par le Bureau des Longitudes. (Paris: Gauthier-Villars.) 1fr. 50c.

Among the additions to this useful annual publication are an article by M. A. Cornu on electrical generators, which is well written but rather of too elementary and historical a character for a book of this class; an excellent little article by M. G. Lippmann on the new gases of the atmosphere; and a short section by M. J. Janssen giving an account of the work done during 1899 in the Mont Blanc Observatory. The last-mentioned item is mainly a description of some interesting experiments, made by MM. Lespieau and Cauro, in which it is shown that a bare telegraph wire, laid on the ice of a glacier without supports, has a sufficiently high insulation resistance for practical purposes.

INAUGURAL ADDRESS OF DR. EDWARD HOPKINSON TO THE MANCHESTER SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.*

I suppose there are in England alone at least a score of societies whose proceedings are more or less of interest to electrical engineers and whose members are annually addressed from the chair; in fact, taking account of the various sub-sections of such societies, I apprehend there are no fewer than 50 presidential addresses yearly. Surely the time has come when these might be curtailed both in number and length, and the time more usefully spent in other directions; for how is it possible, except for the very few in the vanguard of science to say aught that is new, and that which is old it is vain to repeat?

English electrical engineering has been and is passing through a momentous epoch of its history. Before recovering from a strike of unprecedented length and extent, a period of extraordinary expansion in the general trade of the country, and quite sudden realisation by the public of the advantages of electric lighting, electric traction, electric transmission and distribution of power, and many other applications of electric energy, has led to great demands on both manufacturers and undertakers, for which it cannot be said they have by any means been fully prepared, with the result that large orders for electrical plant have been placed abroad. Patriotic English newspapers are full of lament and recrimination against those who are responsible for placing such orders; unpatriotic papers, of gibes against the backwardness of English manufacturers and the decadence of English manufacture; and the foreign Press indulges in more jubilation over an order for a locomotive or a dynamo secured from England than over ninety-and-nine which the development of their own country requires. It is not our business to join either chorus, but it quite naturally concerns us to seriously inquire into the causes of these events. Let us take it for granted for a moment only—for the sake of argument, and we will return to the assumption later—that the conditions in England are generally as favourable for manufacture as they are in other countries; then it is obvious that undertakers, including under the term more particularly municipalities and public bodies who are undertakers in the Parliamentary sense of the word, ought not to deprive their own ratepayers and constituents of work and order abroad, except by reason of inability of otherwise obtaining delivery in reasonable time or of serious difference in price. Primarily dependent, as they are, for their own prosperity upon the full employment of the working classes of this country, they cannot regard with indifference the passing of any work out of the country which can be done in it; nor can they throw the odium of unpreparedness entirely upon the manufacturers, as it is, I venture to think, as much their business and their interest to so forecast the future as to take such steps for increase of their plant to afford ample time for properly digested plans of extensions and for the execution of the work, as it is the business of the manufacturer to provide the appliances for construction. Would the nation relieve the Admiralty or War Office of responsibility if they suddenly found that they wanted ships and guns with such rapidity and in such quantity that they had to buy in Germany? Would it not rather hold that the departments had shown lack of foresight and due preparation?

I asked you a moment ago to grant for the sake of argument that the conditions in England are generally as favourable as in other countries. Are they? A large question, with many answers. In one respect it must be admitted they are. English manufacturers find no inducement either in price or in quality to buy their coal, iron, or steel, except in relatively infinitesimal quantities, from abroad. But are our conditions of labour and our capabilities of design and management equal to those of foreign competitors? I cannot refer to the first without apprehension, lest I should step on forbidden ground, knowing that opinions are various and feelings strong; yet for this very reason I think the problem cannot be too freely or openly discussed. Let us compare some of the conditions of labour which obtain with us and those which obtain in the United States. Given a particular piece of work, done in a particular way and with given appliances, I have never seen any evidence to prove that the work is done more cheaply in America. The American workman has higher wages, and probably accomplishes somewhat more in a given time, so that the net result is probably about the same. That the output of an American workman is somewhat greater than that of his English brother is partly due no doubt to mere physical causes, a more bracing climate during the greater part of the year, and the fact that American workshops are, as a rule, better lighted, heated, and ventilated than most British shops, and that more attention generally is paid to hygienic conditions; partly to the greater stress which characterises American life generally and has grown to be inherent in the national character; but chiefly due to the fact, in my opinion, that American workmen are in general very much better educated than English workmen—not in the sense of more technical knowledge of their work, but are

* Abstract.

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generally more cultured and have a wider mental horizon. I believe it to be a quite general law of human effort that the better educated a man is, the harder he will work at whatever his hands find to do, and that, apart from the question of skill of handicraft, an educated man will produce more in a given time than the uneducated. The cultured man has more to look forward, when his work is accomplished, and values his earnings and his leisure more highly, and so has greater incentive; and, accustomed during his years of early training to constant effort, it becomes a mental and moral habit to work to the utmost of his capacity. An utterly uneducated Russian weaver can mind but a single loom, and is content to work 72 hours a week, for what value is leisure to him? The better educated English weaver will mind four looms and do the work better. If these considerations be true, we may anticipate the future will bring a gradual increase in the rate of work, as our educational systems become more developed and extended, as indeed has no doubt been the case during the last 50 years; but this tendency will bring and has brought us face to face with another problem—viz., the time of working. Concurrently with increase in the rate of work there has been a steady diminution in the hours of work, and probably we have not yet reached the limit. Here, again, I tread on debateable ground; but I may say at least that, whatever solution of the problem we may arrive at, it is at least capable of exact enunciation. The efficiency of a particular manufacturing plant is measured by the ratio of the difference between the market value of the production and its cost to the capital employed. There are various fixed losses or charges, rent, rates, management, and so on, which I need not enumerate; there are other charges which are a function of the time during which the plant is worked—for example, cost of power, lighting, &c.; and finally there is the cost of labour, which again is a function of the hours of labour. Maximum efficiency is therefore determined by a linear differential equation. The problem has its counterpart in the determination of the proper size of a conductor for the transmission of electric energy, the solution of which is expressed by Lord Kelvin's rule; or it is perhaps still more analogous to the problem, When is a dynamo working at maximum efficiency? the answer to which is, as you know, when the C^2R losses in the armature are equal to the sum of all other losses. Unfortunately, dynamos never do work at their point of maximum efficiency, as long before then injurious sparking takes place and the armatures are overheated. Possibly similar phenomena would occur in our workshops if you endeavoured to apply too vigorously the solution I have indicated. The solution depends primarily on the function you choose to represent the dependence of the cost of labour in the hours of work. I shall not venture to discuss it here; probably personal equation may largely influence it; but if any of you are inclined to work out the problem for yourselves on the lines I have suggested, I would commend to your notice the very excellent and truly scientific investigation recently made by Mr. Crompton into a corresponding and just as difficult a problem—the proper length of crank in a bicycle, pointing out in passing that in general a long crank corresponds to short hours.

But to return: we assumed, for the argument in comparing English and American labour, that the appliances were the same—an assumption at the present time certainly not generally justified by the facts. American electrical industry at any rate is so much more concentrated into comparatively few shops on a larger scale than most of our English shops, that there has been far greater possibility of standardisation in every detail, and repetition of types, and consequent inducement to the introduction of automatic machine tools; but our workshops are changing in this respect, and any ground we may have relatively lost may be regained and certainly will be recovered if those responsible for the laying out of our electrical undertakings realise that machinery of standard size and manufacture is not only cheaper but intrinsically better and more accurate in workmanship than machinery built to suit their own particular idiosyncrasies. A cotton mill is laid out and designed for the accommodation of the makers' standard frames and mules, and a weaving shed for standard looms running at well-ascertained speeds; and who would think of asking a Lancashire boiler maker for a boiler 29ft. by 7ft. 9in. instead of 30ft. by 8ft., because he wanted 5,800lb. of steam per hour instead of 6,000lb.? But too often is the builder of electrical plant forced to design his plant to fit the station and to meet all manner of conditions which ought to have been subservient to the plant.

No doubt the introduction of automatic machine tools in England has been and is attended by many difficulties with the workpeople, but I am optimistic enough to believe that, as our workpeople become better educated and more intelligently alive to their own interests, these difficulties will rapidly disappear. This is not by any means necessarily coincident with the larger adoption of piecework, and will not, I think, be solved by this means. Piece-work is open to many objections and often breaks down. Rightly or wrongly it is always regarded with suspicion by the English working man, and is often unsatisfactory to the employer. Though in some American shops it has been adopted to a large extent with satisfactory results, there is much less piece-work in practice in America than is generally supposed. The largest engine-building shop in the world has no piece-work whatever; but a modification of it with which you may perhaps not be acquainted, but is well worth study, is largely obtaining in America. I refer to the system known as the "premium" system, where the workman, while receiving in any case his rated wages, has a definite price fixed for each piece of work, and divides with the employer according to an agreed scale any profit made by producing at a lower cost than the fixed price.

Once more return to an assumption I made in an earlier part of my remarks—viz., that the management of our British manufacturing or undertaking businesses is on a par with that of corresponding businesses in the United States, and under the word "management" I would include not merely shop and works management, but all that makes for intelligent and scientific design and technical control. I will not attempt an answer as to whether the assumption is justified, but it is worth noting that our American competitors have given proof of their own views on this point by the fact that more than one are establishing works in this country. They at least must have come to the conclusion that the general conditions of manufacture are as propitious in England as they are in the States; that labour difficulties are no greater here than there; but that, by the introduction of the appliances they have so well worked out, the systems of shop management and the designs and technical control they have elaborated, they look for advantages which justify their emigration. Whether it be a fact or not that we have any leeway to make up in this direction, it is at any rate a profitable reflection to consider how we may have lost ground, if lost it we have.

This leads us into the large field of the right training of electrical engineers and managers for our electrical undertakings, a large field which I cannot do more than most briefly refer to. I, for one, would most heartily endorse the dictum of Sir Andrew Noble that the education of our English public schools and universities lays a foundation for successful struggle in the world's field of battle which is absolutely without rival; but it is a foundation only: upon it must be built an adequate superstructure of technical knowledge and skill. Much progress has been made and is being made in England, but it must be admitted we are still far behind, which I venture to think is chiefly due to the want of frank recognition of and hearty co-operation, not on the part of our public men but of our managers and designers, with the admirable institutions which already exist in this country. In laboratory and experimental equipment the technical schools and technical branches of the American universities far excel anything we have—with few exceptions—in this country; and it is not provided for the most part out of beer money or local taxation, but is the free and generous gift of manufacturing concerns and the captains of industry in the country, who are far-sighted enough to realise that by such support they are taking the first steps toward building up and ensuring the lasting prosperity of their own industries. We in the North of England have the opportunity afforded us for like support by the splendid institutions at our very doors, our university colleges and our municipal technical schools, all of them now provided with or rapidly making provision for adequate laboratories and workshops, and most scientific teaching, and lacking only the earnest co-operation of the responsible managers and controllers of our undertakings. As a significant illustration of what I have been saying, I may mention that the professor of engineering at Cambridge told me a few days ago that the management of a large American concern about to start in this country recently applied to him to recommend a dozen of his students to take up responsible posts, after brief further training in America, believing that nowhere else could they obtain better material for their purpose.

If in the future the scientific training in a technical school or the technical departments of our universities is to largely replace the old systems of apprentices and pupilage, a much wider responsibility is thrown on the teachers and professors than the mere imparting of knowledge or development of manipulative skill. It rests with them to teach the general principles upon which all successful manufacture must be based, and to influence the entire mental attitude of their pupils toward the profession for which they are training. If they fail in this, they may indeed instruct but will not educate, and we shall have a new class of "technics," who will hinder rather than promote industrial progress. This is no imaginary danger. Russia has made advances in the establishment of technical schools which are not thoroughly in touch with the great manufacturing establishments of the country, and to describe a man as a "technic" is equivalent to saying he is the last man to whose advice or opinion you would attach any weight. To avoid such dangers we cannot insist too strongly on the importance of the closest possible co-operation and interchange of opinion between the responsible and practical managers of our industries and members of the profession on the one hand, and the managers and teachers of our technical schools on the other hand. The free interchange of opinion and discussion of methods is essential to the welfare of both.

Take two illustrations of such general statements. We have been talking much of late, but doing less, towards standardisation of electrical work. Manufacturers know perfectly well the need of it, but

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are practically powerless, as they have no option but to provide what they are asked for. Now, if the profession generally could agree from time to time upon certain standards, and every young engineer before he leaves school or college be trained to repeat them, to understand the reason for them, and to look upon departure from them without cogent cause as bad practice, they would very soon be universally adopted. Or, as another example: I suppose nine-tenths of educated opinion in England has been for the last 10 or 20 years in favour of the adoption of the metric system, as tending toward more accurate work, involving much saving in labour of computation, and facilitating our relations in foreign markets. Enlightened manufacturers are fully alive to its advantages, but cannot make headway against the mere dead weight of characteristic English dislike to change. Now, if the teachers in technical schools would be bold enough to agree to write all their text-books in the metric system, set every problem or example in it, and make their pupils think in centimetre-grammes instead of foot-pounds, and be allowed to translate their results into hundredweights, ounces, drachms, pennyweights, inches, sixty-fourths of an inch, and any other of our national abominations, as valuable arithmetic exercise only, we should very soon have such a preponderance of influence in favour of the metric system that its national adoption would no longer be delayed.

Technical education does not end in school or college, but must be continued through life, and one at least of the chief instruments of it is our technical Press and the publications of our technical societies. It is always rash to criticise the Press; but perhaps I may be allowed to submit for the benign consideration of the proprietors and editors of the technical journals some considerations from the readers' point of view, or rather I should say the would-be readers' point of view, which militate against their usefulness. There are at least a dozen journals appearing weekly or monthly more or less exclusively devoted to electrical engineering. How can mortal man, or at least the busy mortal man, do more than purchase these, lay them on his office table, and marvel what the contents can be? If these dozen journals could be condensed into two or one with free use of scissors, and the excellent editorial and contributing staffs imbued with the fundamental idea that conciseness and perspicuity are the true criteria of style, and then published at a shilling instead of sixpence, if need be with (may I hint it?) the advertisements in a separate cover, I believe it would be of tenfold advantage to the electrical engineering profession. Such a step has been taken with most excellent results in the combination of the scientific abstracts of the Institution of Electrical Engineers and the Physical Society. Could not this be carried farther by the inclusion in the combination of the abstracts of the Civil Engineers—a subject which has been, I believe, discussed, and which possibly an expression of the views of our branch institution, young and provincial though it be, might in some small degree influence.

ON THE APPLICATIONS OF ELECTRICITY IN MEDICAL AND SURGICAL PRACTICE.

The following is an abstract of the discussion which took place at the Institution of Electrical Engineers on the 8th inst., in connection with Dr. Lewis Jones' paper on the above subject.

The PRESIDENT (Dr. S. P. Thompson) in declaring the paper open for discussion, called attention to the fact that the word "electrification" was used by the author in a manner somewhat different from that in which electricians were in the habit of using it. Electricians did not understand that when a current went through a thing that this thing was necessarily electrified; it was conducting, but not necessarily charged. If a person was electrified, in the sense which physicists ordinarily understood it, he asked Dr. Jones if the patient would be physiologically, pathologically, or any-other-logically affected.

Mr. JAMES WIMSHURST said he was pleased to see that electricity was coming to the front in medical work, and also that the statical machine was becoming prominent. With regard to the American machine, to which reference was made in the paper, he handed in a communication for publication in the *Journal*.

Major-Gen. C. E. WEBBER asked, with regard to the word "stimulus," whether the medical practitioner or physiologist meant that electricity was no more than a stimulus to the animal frame. The methods which had been described for localising injuries to nerves were almost identical with those used every day by the telegraph engineer for the localisation of faults in a telegraph system. He thought also that there might be some auxiliary actions going on within the human frame, the energy for which might possibly be obtained from possible electrical action within the system. Helmholtz had calculated that the heart could raise its own weight of 9oz. through 20,250ft. in one hour. The source of this energy was unaccounted for, and could not be explained by the tacit assumption made in all the medical or physiological books which he had studied—viz., that the heart was a pump. Possibly there was some electrolytic action going on which might account for the energy.

Mr. MUDFORD suggested that a possible means of measuring the amplitude of the discharge wave from an induction coil would be to "set up" the pointer of an ordinary milliampere meter, and observing when it was just kicked off. It would be a little troublesome in use, but it was simple.

Sir HENRY MANCE referred to the question of the polarisation which took place in the human body under the passage of a current. He remembered, many years ago, making some experiments to ascertain the resistance of the body from one wrist to the other. His results were much higher than they ought to have been when the effect of polarisation was eliminated. He tested two natives, one of whom had a resistance of 1,300 ohms and the other 1,200 ohms, while the third, a European, gave 900 ohms from wrist to wrist. There was considerable polarisation.

Prof. J. PERRY said he spoke as a Philistine on this subject. With regard to the charging of an accumulator from the ordinary public mains, he suggested that a lamp of lower voltage than that of supply be connected in series with the accumulator during charging. Might he tell Major-Gen. Webber that there was something just the reverse to electrolysis going on in the animal machine. The animal machine, a machine which consumed fuel and gave out mechanical energy, was, he thought most people believed, an electrical machine. It could not be a heat engine, unless one to which the second law of thermo-dynamics was inapplicable. The efficiency of the animal machine was quite 40 times higher than it ought to be, as calculated from the limits of temperature between which it worked. It might be that the second law of thermo-dynamics was evaded. At Baden-Baden last year he met Dr. Schlieb, who, he was greatly astonished to find, had been for 20 years actually making experiments on atmospheric electricity. This gentleman had been using a gold-leaf electroscope, by means of which he could say whether the air was positively or negatively electrified, and whether the electrification was large or small. But the most astonishing result he had obtained was that he could tell by his experiments when a certain type of patient was coming to him, and when his instrument indicated negative electrification he knew that all kinds of oppressed people would be coming to him for relief. It was the most interesting result he had ever come across. As a rule, it was a rising barometer that accompanied positive electrification.

Mr. COFFIN said it seemed to him that the President had himself put his finger upon the great drawback in the past in speaking of the terminology used in different senses by the medical man and the engineer, and in the fact that the physician had not been the physicist. He could well remember the occasion many years ago when Mr. Preece, as he then was, made a great point of the fact than even medical electricians, or men who had devoted themselves almost entirely to electrical treatment, were completely ignorant of such things as amperes, milliamperes or volts. Mr. Preece then thought that electricity was ordered and prescribed regardless of amount and quantity, which would be like sending a patient into a pharmacy to get as much as he wanted of a particular medicine. He himself thought that the measurement of electricity or electrification would always be different to the measurement of a drug, because the effect was such a difficult matter to estimate correctly. Electricity could not be used to replace the surgeon's knife. Everybody who had systematically used electricity would only endorse what Dr. Jones had said on the electrical water bath. The great ease and simplicity of working, and the beautiful results obtained, must certainly be made a great deal of. At the same time there was this difficulty—viz., they really did not know what current the patient was receiving. They knew the maximum current he might have, but the fact that the patient was in a conducting medium of water at different temperatures made it almost impossible to know exactly what took place.

Capt. W. P. BRETT (R.E.) said that the lecturer had referred to X-ray work as far as exploring the human frame was concerned, but had not mentioned anything about its curative effect. His curiosity was excited not very long since by seeing a series of photographs of lupus in the face taken at intervals of a week, the patient being subjected periodically to the X-rays. The results had been most remarkable, in that the disappearance of the disease had been effected in a very short time. He would like Dr. Jones to mention any instances of a curative effect, should he know of any. With reference to the need of a source for charging small cells, this had been felt very badly in the recent Egyptian campaign, when the X-rays had first been used in warfare. The difficulty had been got over by using a tandem bicycle manned by defaulters and connected to a small dynamo, and by this means they had kept the cells continuously charged. If this difficulty could be got over in the field, there would surely be no trouble in using a small motor to drive a small generator.

Mr. W. M. MORDEY suggested the use of thermopiles for charging small cells, which could easily be produced for such a purpose. He was quite sure that there would be a really large demand for a thermopile capable of generating a few volts and being sold at a reasonable price. While on this matter of apparatus, he mentioned that it would be a good thing if some engineers would take up the design of such apparatus as they saw exhibited that evening. There had apparently been no change in the design of the Ruhmkorff coil since it was invented, and he was quite sure that it had lasted long enough in its present form. Referring to a coil which was on the table, he said it quite frightened one to see such an instrument as that. The laminated pole piece was carefully short-circuited by a solid block of metal. Where they wanted magnetism to go in and out as easily as possible, every precaution was taken to prevent this. In these details he thought the Ruhmkorff coil might be improved by any of them who had had any experience of designing and who had the time to take the thing up; and this criticism could be applied to most of the apparatus sold by opticians. He was glad that Dr. Jones had avoided the use of such terms as "faradisation," "galvanisation," and a number of similar words often found in medical literature. Finally, he informed Major-Gen. Webber that he had worked out the horse-power of the heart in the example given by him, and found it to be only $\frac{1}{10000}$th of a horse-power.

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Mr. A. P. TROTTER suggested the use of an aluminium cell for charging accumulators from alternate current supply mains. He asked whether Dr. Jones wished to measure the milliamperes, milli-coulombs, mean volts, or maximum volts of the coil discharges, and asked if he would give information about the action of electric current on the body for removing the sensation of tiredness when muscles had been exerted, but without doing mechanical work.

Dr. LEWIS JONES, replying, said that he had tried to be as careful as possible with his terms, and he was sorry that he should, without knowing it, have used the word "electrification" in the way he had. It came about through the fact that patients were sent down to him from the wards with cards "To be electrified," "To be galvanized," &c., and he had got into the way of using the terms. Of course he understood the proper meaning of the term. It was one of the efforts of his life to teach the profession not to use such words. He had seen "Franklinisation," and quite recently he had seen, in a French electro-therapeutic journal, the expression "D'Arsonval-isation." Major-Gen. Webber had, it seemed to him, raised the question, "Is electricity related to vital force?" Of course it was very difficult for a living tissue to perform any function without the liberation of a certain amount of electrical action. As to the question of whether this was a mere waste or mere dissipation of a certain amount of energy, he had no doubt they could find traces of electrical action whenever any change was going on; but he could not say whether the electrical changes in a nerve or muscle were a waste or not. To go deeply into the question would involve him in difficulties which he would prefer not to consider that evening. The question of polarisation raised by Sir Henry Mance was, of course, a thing which medical men noticed continually in electrical applications. He was interested to notice one little matter in Sir Henry Mance's remarks—viz., that the European had a lesser resistance than the natives. This showed that the resistance of the skin was a question of the moisture or dryness of the surface, as it was natural to suppose that the European would perspire more than the natives. Prof. Perry's suggestion that the body was an electrical machine he was not qualified to deal with. With regard to the X-rays and lupus, he said there was no doubt that the X-rays had that therapeutic effect, not only on lupus, but on other skin diseases as well. A doctor was not able to charge his accumulator off his bicycle with the aid of a small dynamo. He was very sorry that the Cox thermopile had disappeared. He had had hopes that the thing would be useful, but when he wrote to the company they sent him particulars but no prices. At the same time, he thought there seemed to be some uncertainty as to the life of a thermopile. At the present time they could purchase the Gülcher thermopile in this country, but they wanted a lot of them, as their voltage was only one or two volts. Most of the electrical apparatus at present used by medical men was German; English makers did not pay much attention to it. Of course, the doctor wanted cheap apparatus: he had to pay for them out of his own earnings, and his position was entirely different to that of a person buying for a large public company. English instruments, though more beautifully finished, were too expensive; they were compelled to buy German apparatus and do the best they could with them. He had experimented with the aluminium cell, but had been unable to make it work satisfactorily. With regard to Mr. Trotter's question about the refreshing action of the electric current, a Paper on the subject by a physiologist in Italy named Capriati had been published, with many dynamometric measurements, which clearly showed that electrification—*i.e.*, the passage of a constant current along the spine—increased the muscular activity for some little time afterwards. It also showed that the application of electrical stimulation to the nerves of the arm would do the same thing for the arm. Whether it was a question of circulation or direct effect upon the activity of the nerve cells he could not say, but that there was some direct effect from the stimulation of the brain seemed undoubted. People who were treated for other things would sometimes notice an improvement in their general health which was quite apart from the object aimed at in such treatment. For example, he had sometimes tried to relieve different defects by electrical applications to the region of the auditory nerve. He applied one pole in front of the ears and the other pole at the back of the neck, and a person treated in this manner would often speak confidently of an improvement in general condition, although no advantage had been gained in the matter of hearing. With reference to the question of what he wanted to measure, this was an easy matter to answer. What he was asking for was something to measure milliamperes. No one had told him exactly what he wanted to know with regard to the condenser. He asked again whether, given a condenser of known capacity and a known voltage, a curve of discharge could be plotted for different values of the external resistance through which it was discharged. He would have liked to have known something about the modifications in the curve which were produced by increasing or decreasing the resistance. Also, if the external resistance was 1,000 or 2,000 or 4,000 ohms, whether by raising the voltage they would not diminish the differences in the shape of the discharge curve produced by the difference in the resistances.

A hearty vote of thanks was accorded Mr. Jones at the conclusion of the discussion.

The Electro-Chemical Equivalent of Silver.—A careful re-determination, made by Messrs. Richards, Collin, and Heimrod, of the value of the electro chemical equivalent of silver is described in the *Proceedings* of the American Academy of Science. The value obtained was 1·172 megohms per ampere per second. A re-determination of the electro chemical equivalent of copper gave 0·3292 megohms, leading to an exact verification of Faraday's law.

AN EXPERIMENTAL RESEARCH ON SOME STANDARDS OF LIGHT.*

BY J. E PETAVEL.

(*Continued from page 712*).

On the Lummer and Kurlbaum Incandescent Platinum Standard.

In 1894 Drs. O. Lummer and F. Kurlbaum proposed a new standard of light.† A strip of platinum foil 25mm. wide, 0·015mm. thick is brought to incandescence by an electric current of about 80 amperes. The temperature is increased until one-tenth of the total radiation is transmitted through a water trough 2cm. in width. This ratio is determined by means of a bolometer. The construction of the instruments requires the greatest care, and three months had passed before I was able to obtain the first observations. The instruments used for this work are shown in Fig. 4. The explanation appended to this drawing is sufficient to render further description unnecessary. It would be useless to give details of the experiments, which in the main confirm the results already obtained by Lummer and Kurlbaum. With the same apparatus used in the same manner the light is practically constant as long as the ratio of radiations is adjusted to 1/10 per cent. The adjustment of the temperature of the platinum foil with the required degree of precision is, however, most tedious, and in fact all but impossible except under the most favourable conditions. This consideration, together with the complicated nature of the apparatus, renders this light impracticable as a working standard.

At the beginning of the present Paper it has been pointed out that a standard must be constant, reproducible, and must emit light of a suitable colour. We have just seen that the source of light under consideration may be regarded as fulfilling the first of these conditions; with regard to the second and third, the conclusions are less favourable. By definition the ratio between the total radiation and that transmitted through the water trough must be as ten to one, 1 per cent. error in the electrical measurements causing 3 per cent. change in the light. To obtain the required degree of precision the galvanometer deflections must be reduced to equality. Three methods are available: (1) the bolometer current may be reduced in the ratio of one to ten; (2) a $\frac{1}{10}$th shunt can be introduced into the galvanometer circuit; (3) the distance between the bolometer and the radiator may be varied in the ratio of 1 to $\sqrt{10}$. None of these methods is entirely satisfactory. The reduction of the current through the bolometer involves a considerable complication of the apparatus, and interferes with the steady working of the instrument. It is also by no means impossible that the resulting change in the temperature of the bolometer films may change their coefficient of absorption. With a shunted galvanometer temperature changes and thermo-currents are a frequent source of error. The most reliable method is to change the distance of the radiator; but here again two objections arise. The enclosure containing the platinum foil is rarely at a temperature so closely approaching that of the bolometer films that shifting this large surface leaves the instrument unaffected. The law of inverse squares cannot strictly be applied, as the rays of light are refracted when passing through the water trough. In practice, marked variations were obtained when the method of determining the ratio of the two radiations was altered. The use of another form of bolometer produced a considerable change in the light emitted. The bolometer films are coated with platinum black by electrolysis. The composition of the bath, the electromotive force, and the current have been specified; but it was found that the temperature of the bath and the resistance of the film affected the nature of the deposit obtained.

Finally, the spectral composition of the light is unsatisfactory, the colour being much too red. We are thus driven to the conclusion that this light does not possess all the qualities required of a primary standard. Under certain circumstances it may be of the greatest value as a standard of reference. It is used in the Reichsanstalt to check the values of the Hefner lamps; for purposes of this kind it is well suited, and might with advantage be more frequently used.

Preliminary Research on the Molten Platinum Standard of Light.

The use of molten platinum as a standard of light was first proposed by J. Violle‡ at the Congrès International des Electriciens on Sept. 21, 1881.§ In 1884 Violle published an account of his experiments with the new standard, which was adopted in the same year

* Paper read before the Royal Society.

† *Berichte der Preuss. Akademie*, 1894, p. 227; *Elektrotechnische Zeitschrift*, 1894, p. 475.

‡ For Violle's researches see *Comptes Rendus*, Vol. LXXXVIII., p. 171, 1879; Vol. LXXXV., p. 543, 1879; Vol. XCII., p. 866, 1881; "Lumière Electrique," Vol. XIV., p. 475, 1884; "Annales de Chimie et de Physique," sér. 6, Vol. III., p. 373, 1884.

§ "*Comptes Rendus* du Congrès International des Electriciens," Paris, 1881. Assemblée générale, Troisième Séance, p. 50. See also "Procès-Verbaux de la Conférence Internationale pour la Détermination des Unités Electriques." Troisième Commission, Séance du 20 Octobre, 1882, p. 131.

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by the Conférence Internationale pour la Détermination des Unités Electriques on May 2, 1884.* The adoption was confirmed by the Congrès International des Electriciens on May 21, 1889, when it was specified that the practical unit should be the *bougie décimale*, and by the International Congress Congress in Chicago in 1893, and the Congrès International des Electriciens at Geneva in 1896, when the use of the Hefner lamp as a practical standard was recommended. Since the adoption of this unit the aim of most of the experimental work on the subject has been not so much to find a suitable method of using the Violle standard as to obtain a substitute for it. These efforts have resulted in the well-known instrument devised by W. Siemens† for fusing platinum foil, and in the proposal made by C. R. Cross‡ to use as a practical standard the light emitted by a thin platinum wire at its melting point. Physiological considerations render such a thing as an instantaneous photometric reading an impossibility, and herein lies the principal reason why the above proposals have had to be abandoned. Apart from this fact, it is extremely doubtful if either in the case of fine wire or thin foil the break occurs actually at the temperature of fusion of the metal.§ Cross admits that there were considerable differences in the quantity of light emitted per unit area when the diameter of the wire was changed. In connection with the present work a number of experiments were tried, both with wire and foil, but the results were by no means encouraging.

As far as I am aware, only one research has been carried out with a view of repeating the Violle standard on anything like the scale originally used. This research was made at the Reichsanstalt¶ in Berlin. The work proved unsuccessful, and a detailed account of the experiments has never been published. This renders it very difficult to suggest a reason why reliable results were not obtained. In the case of molten platinum, owing to the high rate at which heat is dissipated, it is quite possible for one part of the mass to be liquid while another part only a few millimetres distant is considerably below the temperature of solidification. This source of error should be minimised by the choice of suitable experimental conditions, and by reducing the results by some method similar to the one given below. Again, all the magnesia or lime bricks I have been able to secure contain a certain proportion of silica. This, as will be pointed out later, is sufficient to render them useless for the purpose in view. In the account of the Reichsanstalt experiments this difficulty is not mentioned. In common with all other pure substances, platinum has a constant freezing point; the length of time, however, during which the constancy of temperature will be maintained depends mainly on three factors.

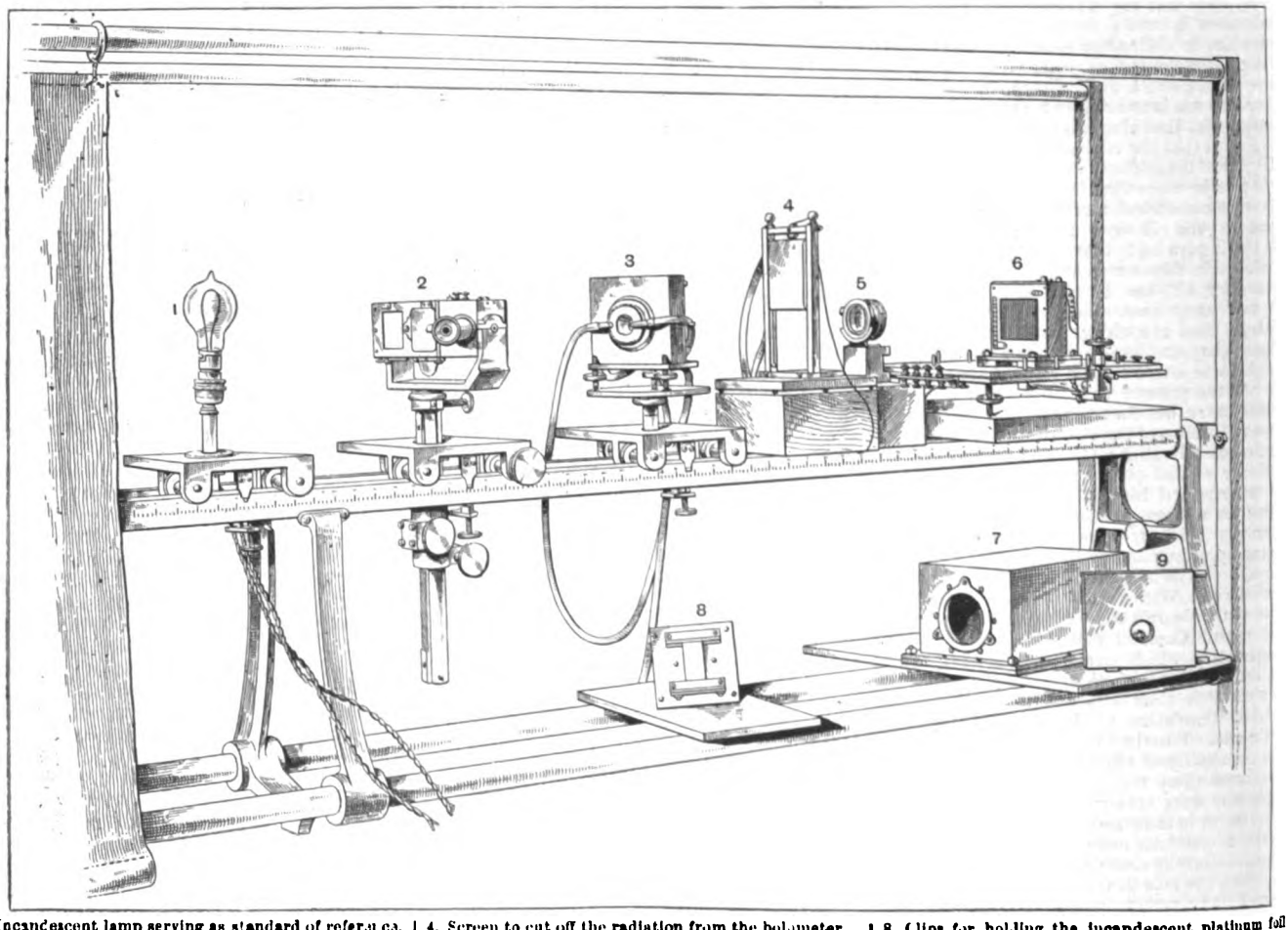
If we take D to represent the quantity of heat dissipated by the platinum per unit time when at its temperature of solidification, H the heat supplied to the metal per unit time, and L the total latent heat of the mass, and supposing for the present that the thermal conductivity is very great, the time during which the temperature will remain constant will be—

$$t = L/D - H.$$

For the object we have in view the time of constancy must be made as great as possible. One method of increasing the time t is to make H very nearly equal to D, or, in other words, to supply heat to the molten metal at nearly the same rate as the metal is losing it. We may supply the necessary quantity of heat H by means of an electric current; or, using a large surface of metal, we may keep the blow-pipe going on one part of the surface while the observations are being made on some other portion. If we abandon the idea of supplying heat during the time the observations are being taken, the formula becomes—

$$t = L/D.$$

In order to reduce the amount of heat dissipated, we must place the platinum in an enclosure at nearly the same temperature as the metal itself, take the observations through a relatively small opening, and make the thermal insulation of the mass as perfect as possible.



1. Incandescent lamp serving as standard of reference.
2. Lummer and Brodhun photometer head.
3. Enclosure in which the incandescent platinum foil is placed with the 1 sq. cm. diaphragm.
4. Screen to cut off the radiation from the bolometer.
5. Water-trough, with quartz sides 2cm. apart.
6. Bolometer, with the cover removed to show the films.
7. Bolometer cover.
8. Clips for holding the incandescent platinum foil: this plate fits on to the back of the enclosure 3.
9. One of the water circulation diaphragms used to keep any extraneous radiation from the bolometer.

FIG. 4.—Apparatus used for the Investigation on the Lummer and Kurlbaum Incandescent Platinum Standard.

* "Conférence Internationale pour la Détermination des Unités Electriques." Deuxième Session, Troisième Séance, Mai 2, 1884, pp. 23, 115. "L'unité de chaque lumière simple est la quantité de lumière de même espèce émise en direction normale par un centimètre carré de surface de platine fondu la temperature de solidification. L'unité pratique de lumière blanche est à la quantité totale de lumière émise normalement par la même source."

† *Elektrotechnische Zeitschrift*, Vol. V., p. 244, 1884.

‡ *The Electrician*, Vol. XVII., p. 514, 1886.

§ See "British Association Fourth Report of the Standards of Light Committee," App. II., 1888, p. 47.

¶ *Thätigskeitsbericht der Reichsanstalt*, 1890 and 1892-1894, or *Zeitschrift für Instrumentenkunde*, Vol. XI., p. 149, 1891, and Vol. XIV., p. 266, 1894.

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In the above formulæ, L being a function of the volume and D a function of the surface, we may, for any given circumstances, increase the time t by increasing the total volume of the metal. But it now becomes necessary to take into account the thermal conductivity of the metal. Strictly speaking, any given portion of the surface can only be at the standard temperature t_s for the very small fraction of a second during which the solid film is forming; later on the surface is at some lower temperature $(t_s - n)$ where n is the temperature interval which is required to cause the heat to flow from the parts of the mass where the process of solidification is actually in progress to the surface at the same rate as it is there being dissipated. Thus by increasing the mass of the metal we cannot indefinitely increase the time available for the photometric observations. Unless the rate at which the heat is being dissipated at the surface under observation is made small, the temperature will not remain constant during the process of solidification, but will fall more and more rapidly as a larger proportion of the mass becomes solid.

(To be continued.)

CORRESPONDENCE.

CAPE-AUSTRALIAN CABLE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: As there appears to be much misconception in Parliament and elsewhere as to the exact nature and extent of the arrangement about to be entered into by the Governments of New South Wales, Victoria, South Australia, Western Australia, and Tasmania with the Eastern Extension Telegraph Co., my directors would feel obliged if you would be good enough to give publicity to the following statement:—

The arrangement is—

1. For the company, in conjunction with the Eastern Telegraph Co., to provide, at their own cost—estimated at about one million and three-quarters—direct cable communication between South Africa and Adelaide, which, with the third route recently established between Great Britain and the Cape, would give Australia an alternative communication to the existing route via India, Egypt, and the Mediterranean.

2. To at once reduce the existing tariff between Great Britain and the contracting colonies (varying from 4s. 9d. to 5s. 1d. per word) to an uniform rate of 4s., with proportionate reductions for Government and press telegrams; and, as the traffic responds to the reductions, to further lower the tariff on a sliding scale down to 2s. 6d. per word.

3. On the laying of the Cape-Australian cable to reduce the tariff between Australia and South Africa from 7s. 1d. to 2s. 6d. per word.

In return, the Eastern Extension Co. only require the right of direct dealing with the public in the capitals of Australasia when the proposed Government Pacific or other competing cable is laid. This right has always been enjoyed in Great Britain—not only by British, but by foreign telegraph companies—and is recognised in Canada, South Africa, and elsewhere.—Yours, &c., F. E. HESSE, Manager.

Eastern Extension, Australasia and China Telegraph Co. (Ltd.),
Winchester House, London, E.C., March 14.

BOOKS RECEIVED.

Copies of any of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price.)

"Jahrbuch der Elektrochemie" for 1898. Edited by Dr. W. Nernst and Dr. Borchers. (Halle: Wilhelm Knapp.) 20m.

"*Proceedings* of the Royal Society." No. 425. Vol. LXVI. (London: Harrison and Sons.) 2s.

"Hydraulic Power Engineering." By G. Croydon Marks. (London: Crosby, Lockwood and Son.) 9s. net.

"Fortschritte der Electrotechnik." Year 1896, No. 4, and year 1899, No. 2. (Berlin: Julius Springer.)

"The Practical Engineer" Electrical Pocket Book for 1900. (Manchester: Technical Publishing Co.) 1s. 6d. net.

"The Management of Dynamos." By G. W. Lummis-Paterson. 2nd edition. (London: Crosby, Lockwood and Son.) 4s. 6d.

"Our Patent Laws." By James Keith. (London: Unwin Bros.)

"Mesure des Températures Elevées." By H. le Chatelier and O. Boudouard. (Paris: G. Carré et C. Naud.)

"Standard Polyphase Apparatus and Systems." By Maurice A. Oudin. (London: Sampson Low, Marston and Co.)

PARLIAMENTARY INTELLIGENCE.

TELEPHONE MUNICIPALISATION.

In the House of Commons, on Tuesday, Mr. HANBURY stated, in reply to Mr. Crilly, that applications had been received by the department for three telephone licences for local authorities. In one case, Glasgow Corporation, a licence had been granted for an area co-extensive with the Glasgow area of the National Telephone Co. The Postmaster General had also been in correspondence with 22 other local authorities, who were considering whether they should apply for licences. Two applications for licences had been made by companies. A licence had been granted to the Mutual Telephone Co. for Salford and certain adjacent rural districts, while the third application had been referred for approval to the Corporation concerned, in accordance with sec. 3 of the Telegraph Act, 1899.

WORKMEN'S COMPENSATION.

Mr. PICKERSGILL on Tuesday asked the Home Secretary whether his attention had been drawn to the judgment of the Court of Appeal in Lysons *v.* Knowles and Sons (Ltd.), by which it was decided that, in order to come within the benefit of the Workmen's Compensation Act, the applicant must have been at the time of the accident in the master's employment for at least two weeks, and whether, having regard to the importance of this decision, he would introduce or support an amendment to the Act in this respect.

Sir M. WHITE RIDLEY said the decision appeared to him to be so important that he would like time to consider the matter before giving a definite answer.

ELECTRIC POWER BILLS.

In the House of Commons yesterday Lord BALCARRES moved that the Committee of Selection do appoint a committee, not exceeding seven members, to whom shall be committed the following private bills by which it is proposed to supply electric power:—

Lancashire Electric Power Bill,
Durham (County of) Electric Power Supply Bill,
South Wales Electrical Power Distribution Bill,
Tyneside Electric Power Bill (read a second time on Thursday, March 1).

Mr. GALLOWAY moved as an amendment to omit the words "the Committee of Selection do appoint a committee not exceeding seven members," in order to insert the words "a Select Committee be appointed." His object was that the bills should be referred to an ordinary Select Committee of 15 members nominated by the House, upon which both opponents and supporters of the bills would be represented. It was impossible, he urged, to get an impartial committee under the motion before the House, as members would be bound to have their individual prepossessions.

Sir ALBERT ROLLIT seconded the amendment. He noted the absence of the President of the Board of Trade. At the time of the debate the right hon. gentleman made a suggestion which formed the basis of what then occurred, that the bills should be referred to a hybrid committee. Such a committee had its advantages and its disadvantages. One of its great advantages was the presence of experts, and the subject of these bills was essentially one in the consideration of which the help of experts was most desirable.

Mr. MONK hoped the amendment would be rejected, as the object of the original motion was that the strongest possible committee should be appointed by the Committee of Selection. An ordinary private bill committee had the great advantage that the members were under an obligation to attend and hear the evidence before they voted, and if the members did not attend they were reported to the House.

Sir FRANCIS POWELL said this was a matter deeply affecting the welfare of the people of the country, and the House should take great care as to the decision they came to. His own borough (Wigan) was deeply interested in this question, as they had before them a proposal to spend £90,000 upon electrical works.

Sir WILLIAM WALROND said that as the matter was of such great importance, it was advisable that the President of the Board of Trade should have an opportunity of being present. He therefore moved the adjournment of the debate.

The motion was at once agreed to, and the debate accordingly adjourned until to-day (Friday).

INDO EUROPEAN TELEGRAPHS.

In the House of Commons yesterday, Sir EDWARD SASSOON (who appears to have taken up matters telegraphic *vice* Mr. Henniker Heaton) asked the Secretary of State for India whether he had any information to the effect that the telegraphic convention with Russia had been renewed by the Indo-European Telegraph Co. on the basis of a return of 17½ per cent. to that Government from the gross earnings of the company, and whether this arrangement had been concluded with the knowledge of and after consultation with the Indian Government, as one of the joint purse partners.

Lord GEORGE HAMILTON: I have no information as to the renewal of the agreement between the Indo-European Telegraph Co. and the Russian Government, nor has the Government in India, so far as I am aware, been consulted on the subject.

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LEGAL INTELLIGENCE.

Eastern and South African Telegraph Co. (Ltd.) v. Cape Town Tramways Co. (Ltd.).

In the Supreme Court at Cape Town, South Africa, this action was commenced on Friday, Feb. 16, before the Right Hon. Sir J. H. De Villiers, P.C., K.C.M.G. (Chief Justice), the Hon. Mr. Justice Buchanan, and the Hon. Mr. Justice Laurence (Judge-President of the High Court of Griqualand West).

The plaintiffs were represented by the Attorney-General (Mr. Solomon, Q.C.), Mr. MacGregor, and Mr. Benjamin; and the defendants by Mr. Innes, Q.C., and Mr. Graham, Q.C. The action was brought to recover £50,000 as damages for alleged injury caused to the plaintiffs' business, plant and property by reason of the leakage of electric current from defendant company's tramways.

The ATTORNEY-GENERAL, in opening for the plaintiffs, described the method in which the plaintiff company carried on their business, the construction and position of their cables, and the powers conferred on defendants by their various Acts of Parliament. There were, he said, really three companies—the Metropolitan Tramway Co., the Southern Suburbs of Cape Town Tramway Co., and the City Tramway Co.—and these undertakings traded together under the name of the Cape Town Tramways Co. The first-named concern had powers to construct and work lines of tramway from Darling-street to the toll; the second had similar powers from Mowbray Hill to a point near Constantia-road, Wynberg; and the extended statutory powers of the old Cape Town and Sea Point Tramway Co. had been taken over. The third (the City Tramways Co.) had constructed the line from the toll to Mowbray Hill without any statutory powers. On Aug. 6, 1896, the City Tramway Co. started running their cars by electric power between the corner of Darling-street and Mowbray Hill, and at once the plaintiffs felt the effects of the current leakage from the tramways. It was found that the signals received at the station at Standard Bank-buildings were so distorted while the cars were running that it was always difficult and often impossible to decipher those signals. The tramway company kept extending its system, and between August, 1896, and January, 1897, the effect on the telegraph cable was such that no receiving work could be carried on except between 12.30 at night and 6 o'clock in the morning, the period during which the cars ceased running. What receiving was possible had to be taken on the eastern cable at Durban, and when, in December, 1896, that cable broke down, there was great delay and loss of business. Mr. H. D. Wilkinson, an electrical engineer of great experience, was sent out to Cape Town by the plaintiff company in May, 1898, to investigate the causes of these disturbances and to endeavour to find a remedy. He made a great many tests, and embodied his views in a lengthy report to the plaintiffs. The correctness of his tests was not disputed, and the conclusion he came to was that from 20 to 30 per cent. of the electric current generated to drive the cars, and which should have returned to the generating station, escaped into the earth. This wandering current naturally travelled into the earth under the sea, and thus came in contact with the cable, and, by the process known as induction, affected the copper conductor along which the electric current in the plaintiff company's submarine cable travelled. That was the cause of disturbance and the distortion of messages. The plaintiffs, hoping to find a remedy, laid down in Table Bay a five mile long "earth" cable alongside their main cable, with the view of neutralising the disturbance, and that proved an advantage. Then a ten-mile cable of a similar description was laid, with excellent results for a time; but as the tramway company's operations and system extended, so the "area of disturbance" widened, and the trouble became as serious as before. Therefore the company now sought the intervention of the Court, and asked for damages. They brought no charge of negligence or unreasonable use of statutory powers against the tramway company; but by certain sections of their incorporating Acts they bound themselves liable for damages caused to individuals or public bodies by leakage of electricity from their rails—the authorised medium of return-currents of electricity. As to the City Tramway Co., which had no statutory authority, the plaintiffs relied on recovering damages from them at common law. The first item in the account of damages was the rather substantial one of £20,000, set down as due to loss of and inconvenience to business since August, 1896. It was exceedingly difficult to estimate what damage was sustained through loss of business, but whenever the eastern cable was down, and all the receiving work had to be done on the western cable (and in consequence of the signals being distorted there had to be a great deal of repetition), great delay, amounting sometimes to two or three days, was caused, and the most lucrative portion of the company's business, the Stock Exchange traffic, largely ceased, because in the absence of news operators would not speculate. The plaintiffs were also advised that they ought to establish a cable station on Robben Island, and that would cost £1,500. Then there was the cost of a new twin-core cable, £8,500; maintenance (calculated at £500 a year, and capitalised at 20 years), £10,000; and other incidental expenses, which brought the whole claim up to £50,000. The substantial issue before the Court was really, What was the cause of the disturbance to the cables; whether the escaped current from the rails affected the cables; and whether that was an "electric leak" within the meaning of the Act, for which the tramway company would be liable?

Mr. INNES, for defendants, said there were other points. They said the word in the section "electrolysis" governed the construction of the words "or otherwise." Electrolysis was a physical injury or damage to a material substance, such as a water or gas pipe, and if the escaping current damaged that there might be ground of complaint. But he would contend that the mere interference with an electric current transmitting a signal along a wire was not such damage as was contemplated by the Act.

Mr. H. D. WILKINSON, M.I.E.E., said he had been practising in London since 1876. He had had a good deal of experience in submarine cable work—chiefly in the Java and China Seas—and was acquainted with the methods of working. In May, 1898, he came to Cape Town on behalf of the plaintiff company, to investigate the causes of their cables being affected and to supply proofs; and he conducted a long series of experiments with that object in view. In the proper conduct of the plaintiff company's operations it was necessary to produce perfect conditions that every fraction of electricity must go back to the originating station. In his experience there had been no instance of a submarine cable being affected by a tramway company's operations prior to this. His attention was first drawn to the matter by a Paper read and the discussion thereupon at Westminster, London, in May, 1897, when Mr. A. P. Trotter, the late electrical adviser to the Cape Government, dealt with the subject. After that witness gave a great deal of attention to it. When he arrived at Cape Town in May, 1898, the tramway company's system was in operation to Wynberg. The cable company were then working with a five-mile "return" cable, and were about laying down the ten-mile piece. He proceeded out into the bay, disconnected the cable, and made a series of experiments. The signals in the daytime, while the tramcars were running, were so mutilated as to be almost illegible; those sent at night, after the cars had stopped, were perfect. He was convinced, after further experiments on the cables and on the rails also, that those disturbances were caused by earth currents coming from the tram rails, and reaching the copper conductor of the cable by induction. The outside steel sheathing of the cable of course lay on the sea bottom, and was thus in contact with the escaping earth-currents. He had measured the amount of electricity sent out to a given length of rails, and fully 30 per cent. of that quantity escaped into the earth. That leakage could be stopped by a well-known method, and be reduced to a very small percentage. Electric leakage was a term quite understood in electrical science, both from insulated and non-insulated systems. The ten-mile cable laid alongside the main cable neutralised to a large extent the disturbance, but only for a time. The company had asked him to advise whether the duplex system could be worked. That was a system whereby messages could be dispatched and received at the same time on the same wire, and it added about 60 per cent. to the working capacity of the cable. The principle of the duplex system was the same, whether applied to a single or a twin-core cable, and he advised that until the area of disturbance had been defined and the effect of the "return" cable demonstrated, the plaintiffs should not lay the twin core cable. In his opinion the disturbances could be eliminated by having the two cores together in one sheathing. In order to discover the value of the twin-core cable it was necessary to have one end free and landed on Robben Island. He had looked through the account of damages claimed, and he thought the item of £1,500 for a cable hut on Robben Island could be reduced to £600. The charge for maintenance he thought could be put at £150 a-year.

Cross-examined: He was engaged in the first instance for three months, but he actually spent five months in Cape Town, making his experiments and preparing his report. His stay was afterwards extended to eleven months. Mr. Trotter, in the Paper mentioned, had recommended the twin-core cable as a perfect remedy for the disturbances, and witness knew that before he left England. Similar experiments to these had been tried at Coney Island, New York, but not with proper apparatus. When the plaintiff company tried the duplex system previously they had made no allowance for the "earth" in the bay. Mr. Trotter's assertion in his Paper was that one twenty-millionth part of the power generated by the tramway company would affect the cable, and witness did not doubt this. He knew that the area of disturbance affected the bay. He agreed with the weight of scientific opinion that a twin-core shore end was the only effective way of remedying these disturbances, but he had not recommended the laying of such a cable, as it would have meant disconnecting the main cable, diverting it to some other spot on the land, and a great interruption of traffic. His view was that the separate five or ten mile cable should be laid alongside the main cable, to neutralise the trouble. By his experiments between the five and ten mile cables he found that the area of disturbance extended slightly beyond Robben Island. He held, for several reasons, that the disturbances went out as far as the ten-mile cable. Matters were not improved by taking the cable to Robben Island and earthing it there. He had recommended the taking of the eight-mile cable from the point where it was originally earthed in the sea to Robben Island for accessibility and convenience generally, but it would have had no result in counteracting the disturbances. The five-mile cable might possibly have been moved whilst it was being repaired, owing to the boat which was grappling the cable having drifted. The disturbances to the working of the cable were due, not to the strength of the earth currents, but to the variation: if the current were continuous no effect would be produced, but if the output from the power station were increased and there were ten tramcars running instead of two, a very much bigger "kick" would be produced.

Mr. Justice LAURENCE: He considered that ten miles was the minimum of safety to lay the cable, but if the tramway system were to be extended he could not say whether in that case it would continue to be sufficient.

Cross-examination continued: The company at one time were thinking of taking the cable into St. Helena Bay. The distance from the sea of the cable hut had nothing to do with the disturbances, although to a certain extent it was better to be nearer the sea. He could not say whether in the case of the West Coast cable the core was smaller than the eastern one, but if it was it would not be able to do so much work.

Re-examined by Mr. SOLOMON: There was no such expression as "electro-tight" in the same way as water-tight, for it was possible that there might be a little leakage even with the very best insulation. This was the first case of the kind in which he had known of the disturbance

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from an electric tramway system reaching the submarine portion of the cable. It depended very much upon the position of the generating station, and also upon the nature of the soil. The disturbances increased as the tramway extended its system.

Mr. GEORGE BENHAM STACEY, superintendent of the plaintiff company at Cape Town, stated that when he came to the station in 1897 there was a five-mile cable laid alongside the main cable. At that time the disturbances were not very bad, although at times they were troublesome, but not sufficient to stop work. The disturbances would, on an average, cause a repetition in every second message, which of course delayed the traffic very much, and there was consequently a considerable loss of business. In 1893 a ten-mile cable was laid, and after that the disturbances were very much reduced—in fact, almost eliminated, except for the big kicks. At present the ten-mile cable was sufficient, but if the tramway company were going any further, it would not be sufficient.

Cross-examined by Mr. INNES: The capacity of the East and West Coast cables was about the same, but the East Coast would take more work, as it was working shorter lengths. If the East Coast cable was working, it would do all the work, provided there were no specially bad disturbances. It was capable of doing all the work in ordinary times. It was only in regard to the messages received in Cape Town that the disturbances had any effect, except in the case of repetitions.

Mr. H. JOHNSON SPETCH, clerk in charge of the plaintiffs' Cape Town station, said that immediately on the opening of the tramway system disturbances were experienced at the office, and a difficulty in reading the messages occurred. The disturbances affected them so much that they could not do the receiving while the cars were running, and many repetitions were necessary. Sometimes, in fact, the same message had to be repeated several times. Various experiments were tried in an endeavour to cure the disturbance. In regard to the loss of business, Government messages had preference, and were sent at half rates, so that if the Government messages shut out the other traffic there was a loss. After the five-mile cable was laid it was possible to work, but the kicks became bigger and more frequent, and the reading of messages was greatly impeded, the extension of the tramway system increasing the number and frequency of the kicks.

Cross-examined by Mr. INNES: There were, of course, delays on the land lines from Durban at times, and it would not be fair to charge the tramway company with such delays. Occasionally also there were disturbances caused by lightning.

Mr. GEORGE MITCHELL stated that he was acting clerk in charge after Mr. Spetch left and before Mr. Stacey arrived. Up to the time when Mr. Stacey arrived the five-mile cable was working all right. After the five-mile cable was laid the kicks gradually got worse, and made it very difficult to receive messages.

This concluded the evidence for the plaintiffs.

Mr. FRANK JACOB, F. Phys. Soc. Lond., said he had been for 21 years chief electrician to Messrs. Siemens Bros. and Co. (Ltd.). He had been personally connected with the laying of 22,000 miles of submarine telegraph cable in all parts of the world. It was the invariable rule, in order to obviate disturbance from the land, to make the shore ends of cables twin-cored. He considered that a twin-core cable two miles long in Table Bay would entirely do away with any disturbances arising from stray currents escaping from the tramway rails through the earth. The twin-core principle had been in use since 1886, as applied to shore ends. In his opinion, if this twin-core were carried out two miles in Table Bay it would do away with all risk of disturbance, even if the tramway company extended their system. He was rather against having a shore end on Robben Island, as he regarded the multiplication of shore ends as centres of disturbance. This two-mile cable would cost about £2,000 to lay. He knew the expression "electric leak" had frequently been used, but there was no such thing as a leak when it could not be prevented. There was not the slightest reason why the duplex system should not be worked on these cables. The disturbance that affected the simplex instrument would not affect the duplex any more markedly. He should have expected to find disturbances on the cable as soon as the trams commenced running, and if he had seen a proper plan that would have been clear from the beginning.

Cross-examined by the ATTORNEY-GENERAL: He was not sure that the submarine portion of the cable at Coney Island had been disturbed by tramway currents. The real reason why they ran twin-core at the shore end was not to get over the first splice, as there was no splice so close in. He had heard that at Madras the submarine cable was not in any way affected by the tramway currents. His estimate of the two miles of twin-core cable depended on the strength of the escaping current. If the company were running cars on only one section of the system, the effect on the cable might be smaller. His definition of an electric leak would be the contact of a telephone or telegraph wire with the trolley wire, thus permitting the current to escape by conduction. There would be no escape if the rails and the whole system were insulated, but that would constitute a danger to the public, as by contact with the rails they would complete the earth circuit and receive the full power of the trolley wire.

Mr. H. GIBSON, secretary of the South African Association, produced a chart he had prepared showing the periods of interruption of the two cables during the past five years and the fluctuations of the plaintiff company's income. The chief item of damage charged against defendants was for the interruption of work from July 27 to Sept. 21, 1897, £11,000. In that period the western cable was interrupted and down for 15 days, but no allowance was made for that. During last year the cable was interrupted from May 25 to June 9, but the traffic was actually greater during that period than it was in the preceding month. In three cases allowances were not made. He had checked every figure, and had also been handed a number of cable messages sent to the tramway company at Cape Town from London during 1897 and 1898. The average delay shown was 4 hours 19 minutes when there was no interruption, and 33 hours when there was interruption. He had also been supplied with a return of cables received by the Bank of Africa, and there was an actual delay shown when there was no interruption of 7½ hours: that was during the years 1895 and 1896.

Cross-examined by Mr. SOLOMON: He presumed that if there was a delay to the cable it must mean loss of business. The majority of the cables to which he had referred had been received p.m.

Mr. S. EDMONDS SMITH, secretary of the City Tramway Co., said he originally selected the cables from which the table shown had been drawn up. The New York and Philadelphia cables had been excluded, and there had been no selection in the matter at all. He had prepared a plan of the tramway line, which he now put in. He presumed the plans were submitted to the city engineer, for there was a blue print of a plan which was found at the tramway offices, which was signed by the then city engineer, but the formal sanction of the Town Council in writing was not received until May, 1898.

Cross-examined by Mr. SOLOMON: The distance from the toll-bar to Mowbray Cemetery was approximately a mile and three-quarters, and from the toll-bar to the Standard Bank a mile and a quarter. At the time that the City Tramway Co. asked for permission to run a tramway from the toll to Mowbray the power in use was horse power.

Mr. CHARLES E. SHIPTON, clerk, said the messages received by the bank, of which a selection had been handed to Mr. Gibson, were selected quite at random from the cables received by the bank in Cape Town.

This completed the evidence in the action.

In their judgment, delivered on Tuesday by Chief Justice De Villiers, the Court found for the defendants, with costs.

We understand that the plaintiffs have decided to lodge an appeal.

WORKMEN'S COMPENSATION ACT, 1897.

Redemption of Award.

An interesting point under the Workmen's Compensation Act was raised in the Wigan County Court, on an application made to the acting judge (Mr. Wharton) for the redemption of an award. It was stated that a labourer named Cunningham, formerly in the employ of the Lancashire and Yorkshire Railway Co., obtained on Dec. 19 last an award for the payment of 8s. 7d. a week for an accident, and the company now desired to ascertain what sum should be paid in redemption of the weekly payments. For the applicants it was stated that in case the accident had proved fatal, the amount which Cunningham would have been entitled to was £134, and it was contended that a greater sum ought not to be paid now, as there was nothing to prevent the man setting up in business in a small way. The man was not quite clear as to his age, but he admitted being 49. For Cunningham it was pointed out that he was satisfied with the award, and would prefer to receive weekly payments. The responsibility rested upon the company of providing the man with an equivalent sum to that he had already received, namely, 8s. 7d. per week, equal to an annuity of £22 per annum. His honour said that there was nothing in the Act to limit his discretion. He could not see why, when an order had been made, the injured man should be deprived of a single farthing of the award, and he ordered the company to pay £280, to be invested in the purchase of an annuity of £22.

Liability of Sub-Contractors.

The Court of Appeal on Saturday (Lords Justices A. L. Smith, Henn Collins, and Romer) heard the appeal action, Cooper *v.* Davenport, W. Winstanley as third party, the third party appealing from the decision of the County Court Judge of Warrington. Mr. RUEGG, Q.C., for the appellant, said that the action was brought by the widow of a workman against Davenport, the contractor for a workhouse infirmary which was being built. The County Court Judge made an award of £260, and ordered Winstanley to indemnify Davenport. Davenport had sublet the contract for plumbing to Winstanley, in whose employ Cooper was at the time of the accident. The man was killed by a fall from the scaffolding, and admittedly he had a claim against someone. The scaffolding was Winstanley's. Applicant proceeded only against Davenport, who brought in Winstanley as third party. Counsel submitted that Winstanley could not be liable, as he was not an undertaker as defined by the Act nor was he liable for negligence under the Employers Liability Act. No question of negligence was raised in the action. Respondent submitted that a sub-contractor was liable provided he was engaged in a substantial part of the work, and that it was within the Act. Sec. 4 of the Act gave the contractor a right of indemnity against Winstanley.

Lord Justice SMITH said the undertaker had been condemned by the learned judge to pay the applicant £260 damages, and that award was perfectly right. Now the contractor Davenport wanted to be indemnified by Winstanley the sub-contractor. But a sub-contractor could only be liable if he were an undertaker. This had not been proved and therefore Davenport could not be indemnified. The appeal must be allowed, with costs. The other Lord Justices agreed.

In the Court of Session, Edinburgh, on Tuesday an appeal by Messrs. Paterson, Cooper and Co., from award of Sheriff-Substitute Henderson, of the Paisley Sheriff Court, was considered. The respondent, Henry Earnshaw, joiner, was engaged in assisting at the installation by appellants of electric lighting apparatus in an unfinished ship at Middlesbrough. While thus engaged he fell down an opening in the deck of the vessel and was severely injured. Sheriff Substitute Henderson found that appellants, as employers, were liable to Earnshaw for compensation for his injuries, and awarded £1 per week from April 25, 1899. The case was now remitted to the Sheriff-Substitute to dismiss the action, the court holding that the appellants were not the undertakers in the sense of the Act.

TRADE NOTES AND NOTICES.

[Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.]

NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers, or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London:—

READY.

(Price 12s. 6d., by post, 13s. 3d.; Colonies, 14s.; abroad, 14s. 6d. (United States, 15s.)

"The Electrician" Electrical Trades' Directory and Handbook for 1900 (corrected to January 31st, 1900).—In addition to the well-known features of this Directory and Handbook (all of which have been carefully revised and brought quite up to date), a large addition has been made to the Handbook Division, including a Digest of the Law of the Telegraph and Telephone, for the use of municipalities and companies contemplating applying to the Postmaster-General for a Telephone Licence. This section of the book now includes the new model form of Licence issued by the Postmaster-General in January, the Telegraph Acts and Orders passed by Parliament in 1899, and other information in connection with this the latest development of electrical enterprise. The huge sheet tables of Electric Light and Power and Electric Railway and Tramway undertakings of the United Kingdom have been made complete up to the 31st January. These sheets form a most complete record of electrical engineering progress in connection with electricity supply and power and traction applications. The Directory Division has been carefully extended and corrected up to Feb. 2, and is the most reliable list of firms and persons engaged in the electrical and allied industries ever compiled. A number of additional sketches of the careers of well-known electrical experts have been added to the Biographical Division, together with many new portraits. The new volume is, we claim, the most complete and correct book of its kind ever published in any language. An analytical digest of the contents of this volume can be obtained post free.

"Localisation of Faults in Electric Light Mains."—By F. C. Raphael. Price 5s., post free. The book deals with the important subject of localising faults in electric light and power cables; and the various methods of insulation testing are here collected and discussed.

"Wireless Telegraphy: Signalling across Space without Wires by Electric Waves." A Review of the Work of Hertz and his Successors.—By Dr. O. J. Lodge, with a large number of illustrations, bringing this latest application of electrical science quite up to date. New and Enlarged Edition, 5s. nett. *Now ready.*

"Practical Notes for Electrical Students."—By Messrs. A. E. Kennelly and H. D. Wilkinson. Price 6s. 6d., post free. The authors give in a clear and concise manner a good summary of the general principles of electrical science.

"The Incandescent Lamp and its Manufacture."—By Gilbert S. Ram. Price 7s. 6d., post free. The principles underlying the manufacture of the incandescent lamp are carefully and fully dealt with in this volume.

"The Centenary of the Electric Current, 1799-1899."—By Dr. J. A. Fleming. Price, paper covers, 1s. net, post free 1s. 3d.; strong cloth, 2s. 6d., post free.

"Motive Power and Gearing for Electrical Machinery."—By E. Tremlett Carter, C.E., M.I.E.E. Price 12s. 6d., post free. In this comprehensive work an account is given of the scientific principles and modern practice in the use of engines for dynamo driving, not only for isolated power plants, but also for public electric lighting and power stations. The various forms of gearing in the power station and for electric motors are also dealt with; and the book contains, in addition, numerous tables giving exact data of the equipment and working of electric power stations.

"The Manufacture of Carbons for all Electrical Purposes."—by Francis Jehl. 10s. 6d., post free. This is a practical handbook, giving a complete description of the art of making carbons for electric lighting, electrodes, &c., with particulars of the various gas generators and furnaces used in carbonising. The work also contains particulars of the cost, &c. of erecting and working carbon works, and plans of a model factory.

"Electric Motive Power," by Albion T. Snell, contains the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. Price 10s. 6d., post free; abroad, 11s.

"Electrical Testing for Telegraph Engineers."—By J. Elton Young, M.I.E.E. The scope of the book aims at furnishing a fuller treatment of the subject, from the standpoint of the Telegraph Engineer, than it has hitherto received, whilst it endeavours to facilitate a thorough comprehension of the theory of testing as applied to electrical lines in general. Demy 8vo, fully illustrated. 10s. 6d., post free.

"Electric Lamps and Electric Lighting," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is handsomely bound, and full of original illustrations, designs, initials, &c. *New and Cheaper Edition now Ready.* 6s., post free.

"Submarine Cable-Laying and Repairing."—By H. D. Wilkinson M.I.E.E., &c., fully illustrated; price 12s. 6d. This work gives a detailed technical summary of modern practice in manufacturing, laying, testing, and repairing submarine telegraph cables.

"Electromagnetic Theory."—By Oliver Heaviside. *Vol. I.*, 12s. 6d. *Vol. II.*, 12s. 6d.

"The Art of Electrolytic Separation of Metals."—A second issue of Dr. Gore's book is now ready, price 10s. 6d., post free. The author treats fully both the theoretical principles of the art of electrolytic separation of metals and the practical rules and details of technical application on a commercial scale. The work is adapted to the use of the manufacturer as well as the student.

"Drum Armatures and Commutators," by Mr. F. Marten Weymouth, also ready. Price 7s. 6d., post free. Propsectus on application. This is a complete treatise on the theory and construction of drum winding, and of commutators for closed coil-armatures, together with a *résumé* of the principal points involved in their design, and an exposition of armature reactions and sparking.

"Laboratory Notes and Forms."—We have ready a set of 40 Elementary and Advanced Exercises for use with Electrical Engineering classes. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators, and Students. The object of the series is the saving of the time of the Teacher and his Assistants, and to serve as a record of the work done by the Student. Each Form is supplied either singly at 4d., or 3s. 6d. per dozen net; in sets of any three, 1s. net; or the set of Twenty (Elementary or Advanced) Exercises can be obtained, price 5s. 6d. net. The complete set of Twenty Elementary and Twenty Advanced Exercises are price 10s. 6d. net; or in handy portfolio, price 12s. net; or bound in strong cloth case, price 12s. 6d. net. Strong portfolios can be had, price 1s. each.

NOW READY.—The cheaper edition of Dr. J. A. Fleming's "Electrical Laboratory Notes and Forms." These cheaper Forms have been prepared for the use of students and teachers at the Polytechnics and other Science classes throughout the country. The demand for the original set of these Notes and Forms has led to a request for a cheaper set for use at the day and evening classes at many of the technical institutes. These new Forms, which differ only from the higher-priced set in being printed on smaller and cheaper paper, and with less space for tabulated records, are issued at half the price of the original set.

"The Alternate Current Transformer."—By Prof. J. A. Fleming, M.A., D.Sc., F.R.S. Vol. I.—*New Edition.* Price 12s. 6d., post free, Vol. II., price 12s. 6d., post free, is also ready.

"Magnetic Induction in Iron and other Metals."—By Prof. J. A. Ewing. Price 10s. 6d., post free. *New Edition ready in April.*

"Electro-Chemistry."—By Dr. G. Gore. Third Edition. Price 2s., post free.

"The Potentiometer and its Adjuncts": A Universal System of Electrical Measurement.—By W. C. Fisher. Fully illustrated. Price 6s., post free.

"The Students' Guide to Submarine Cable Testing."—A new edition of this book, by Messrs. H. K. C. Fisher and J. C. H. Darby, is now ready, price 6s. net; abroad, 6s. 3d. This work is intended to serve as a guide to operators already in the telegraph service, and to those who desire to enter that service. The great cable companies now insist that their operators and probationers shall pass certain examinations in electrical subjects. The book is very fully illustrated.

"The Steam Engine Indicator and Indicator Diagrams."—Edited and enlarged by W. Worby Beaumont. Price 3s. 6d., post free. This work is a concise guide to the objects, construction, and use of the steam engine indicator and to the interpretation of indicator diagrams.

"Bibliography of X-Ray Literature and Research."—A valuable compilation. Being an attempt to classify the data relating to X-Ray work. This work contains a quantity of general as well as special information bearing upon the whole subject of electrical discharge research. Edited by C. E. S. Phillips. Price 5s., post free.

"The Electrician" Primers.—In Two Volumes. Vol. I., Theory. Vol. II., Practice. Price, stout paper cover, 2s. 2d. each, post free; cloth, 2s. 9d. Single Primers, 3d. each, post free.

TENDERS INVITED.

The *Dublin* Electric Lighting committee invite tenders for the supply and erection of (*a*) six Lancashire and four water-tube boilers and two economisers, (*b*) two 1,000 kw. and two 500 kw. low-speed polyphase generators. Specifications, &c., may be inspected at the offices of the consulting engineer (Mr. Robert Hammond), 64, Victoria-street, London, S.W., after 15th inst. Further particulars are given in an advertisement. Tenders to the town clerk (Mr. Henry Campbell), City Hall, Dublin, by 4 p.m., April 26.

The *Dundee* Town Council invite tenders for the supply and delivery of feeder mains, joint boxes, and underground conduits for the tramways. Specifications may be obtained from the city electrical engineer (Mr. Walter H. Tittensor), Dudhope-crescent-road, and tenders must be delivered to the town clerk (Sir Thomas Thornton, LL.D.), City Chambers, Dundee, by Wednesday, 21st inst. An advertisement contains further particulars.

The *Sunderland* Corporation invite tenders for the supply of india-rubber-covered cables, wrought-iron and cast-iron piping, box frames and covers, and stoneware casings. Specifications may be obtained from the borough electrical engineer (Mr. J. F. C. Snell), Dunning-street, and tenders, addressed chairman, Lighting committee, must be delivered to the town clerk (Mr. Fras. M. Bowey) by noon of 30th inst. An advertisement contains additional particulars.

The *Southampton* Harbour Board invite tenders for a motor transformer with accessories. Specification may be seen at the offices of the electrical engineer (Mr. J. G. W. Aldridge), 9, Victoria-street,

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Westminster, S.W., and copies may be obtained of the clerk (Mr. A. H. Skelton), Harbour Offices, Town Quay, Southampton. Tenders must be in by April 7. An advertisement contains further particulars.

The *Maidstone* Corporation require tenders for the supply and erection of steam and water pipes and valves for their electricity works. Specifications, &c., may be obtained after 20th inst. on application to the engineers (Messrs. Stevens and Barker), St. Peters-street, Maidstone, and tenders should be addressed to the town clerk (Mr. Herbert Monckton) by 10 a.m. of April 3. An advertisement gives further particulars.

The *Keighley* Corporation invite tenders for wiring the new municipal offices. Copies of specification can be obtained from the borough electrical engineer (Mr. J. M. Smyth), Bridge-street, Keighley. An advertisement contains further particulars, and tenders (addressed chairman, Municipal Offices committee) must be delivered at Mr. Smyth's office by 10 a.m., 31st. inst.

As announced in an advertisement elsewhere, the *St. Annes-on-Sea* Urban District Council invite offers for the "free" wiring of premises in the district. Offers must be lodged with the clerk (Mr. Thomas Bradley), Council offices, Park-road, by 23rd inst.

Extension of Time.—The *Swansea* Corporation invite tenders for supplying and laying insulated electric mains, conduits, junction boxes, &c. Tenders to consulting engineers (Messrs. Kincaid, Waller and Manville), 29, Great George-street, Westminster, S.W., by *19th inst.*

The *Hanley, Stoke, and Fenton* Joint Hospital Board invite tenders for an electric lighting installation. Particulars from Mr. E. Jones, architect, Albion-street, Hanley.

The *Stockport* Corporation invite tenders until 22nd inst. for the electric lighting of the public baths (tenders to Councillor Wood, Gas Office), and also the free library, market hall, &c. (tenders to the mayor).

The *Doncaster* Corporation require tenders for the electric lighting of the Corn Exchange. Tenders to the chairman, Market committee, by 26th inst.

The *Manchester* Tramways committee require tenders for erecting an electric car shed at Cheetham. Tenders to chairman by 26th inst.

The *Leeds* Tramways committee invite tenders for one, two, or three steam dynamos. Tenders to town clerk's office, Town Hall, Leeds, by March 21.

The *Barrow-in-Furness* Corporation invite tenders for water-tube boiler and steam and other pipes and sundry ironwork, surface condenser, air and circulating pump, cooling tower, &c. Tenders to town clerk before March 19.

The *Dartford* District Council require tenders for the supply of generating plant for their proposed electricity supply works. Tenders to clerk, Sessions House, Dartford, by noon 27th inst.

The *Hull* Electric Lighting committee invite tenders for two steel Lancashire boilers, &c. Tenders to chairman of committee by 22nd inst.

Tenders are invited by the *Walthamstow* District Council for supplying and laying electric cables. Tenders to clerk (Mr. E. J. Gowen), by 5 p.m., 23rd inst.

The *Fulham* (London) Vestry invite tenders for the supply of electricity meters. Tenders to consulting engineer (Mr. F. H. Medhurst), 13, Victoria-street, S.W., by 19th inst.

The *Henley-on-Thames* Corporation require tenders for "free wiring." Tenders to Mr. R. Pratt, borough surveyor, by 22nd inst.

The Lancashire County Asylum Visitors committee, *Rainhill*, invite tenders for electric lighting plant. Tenders to chairman by March 22.

The *Plymouth* Corporation require tenders for twelve months' supply of alternating current meters and transformers and arc lamp carbons. Tenders to borough electrical engineer by 22nd inst.

The *Plymouth* Corporation also invite tenders for wiring the municipal offices, and for twelve months' supply of lubricating oils for the electricity works. Tenders by March 21.

The New Tramways committee of the *Newcastle-upon-Tyne* Corporation require tenders for steel poles. Tenders by 21st inst.

The *Birkenhead* Corporation invite tenders for overhead line equipment. Tenders by March 20.

The *Cardiff* Corporation require tenders for wiring the new fish market. Tenders to town clerk by April 3.

The *Withington* District Council require tenders for the electric lighting of the Baguley Lodge Sanatorium. Applications to J. B. Broadbent, 15, Cooper-street, Manchester, by 17th inst.

The *Blackpool* Tramways committee require tenders for 15 trams. Tenders to chairman by 27th inst.

The *Shipley* District Council require tenders for the temporary electric lighting of the destructor works. Tenders to clerk by 9th inst.

The *Norwegian* Telegraph Department invite tenders until 21st inst. for telegraph wire and apparatus.

The Municipal Council of *San Martin de Valdeiglesias* (Madrid) require tenders for lighting the town electrically for 20 years. Tenders to el Secretario del Ayuntamiento by March 24.

The *Cretan* Government invite tenders until April 7 for constructing and working tramway lines between Canea and the suburb of Halepa and the new Government offices.

Tenders are invited for an electric tramway concession at *Gijon* (Oviedo), Spain, until April 6.

TENDERS RECEIVED AND ACCEPTED.

The Wigan Corporation have received the following tenders for the supply of steam piping, Weir steam feed pumps and steam circulating pumps, feed water heaters, feed water piping, &c., for the electricity works :—

Crompton and Co. (including lagging)	*(accepted)*	£3,980
J. Spencer and Co.		4,550
Babcock and Wilcox (not to specification)		3,970

The Bath Corporation are recommended to accept the following tenders :—

Callender Co. (high and low-tension cables)	£7,357	8	0
W. Lucy and Co. (arc lamps, B.T.H. lamps, posts, and accessories)	2,991	0	0
British Electric Transformer Manufacturing Co. (condensers)	458	8	0
Cowans Ltd. (sub-station switchboards)	236	0	0
British Westinghouse Electric and Manufactuaing Co. (main works switchboard)	1,918	18	0

At yesterday's meeting of the Glasgow Corporation it was agreed to accept the following tenders for the electricity stations :—Messrs. Mechan and Son for fitting up 'bus bars, for £370 ; Messrs. J. and W. Aitken for foundations for boilers and engines, at £195 ; Messrs. Joseph Wright and Co. for the supply of a patent Berryman feed-water heater, at £418 : and Messrs. G. & J. Weir (Ltd.) for a direct acting feed pump, at £100.

The Keighley Corporation have accepted the tender of Messrs. Thomas Parker (Ltd.) for the supply of 120 kw. and 200 kw. high-speed direct-coupled steam dynamos (Allen engines). No decision has yet been come to in regard to the boilers.

The tender of Messrs. Higgs and Co. is recommended for acceptance for wiring the Greenock Town Council chambers, corridors, and provost's room.

The Wangford (Beccles) Guardians have accepted the tender of Messrs. W. Delf and Son for fixing and maintaining telephones at the workhouse.

The Salford Corporation have accepted the tender of Messrs Edward Wood and Co. for about 1,000 tons of structural iron and steel work for their new electricity station at Pendleton.

The Hastings Corporation have accepted the tender of the Wheeler Condenser and Engineering Co. for the supply and erection of a surface condenser, air and circulating pump, and cooling tower at £1,534.

The Burton-on-Trent Town Council have accepted the tender of Messrs. Gardner Bros. for an electric lighting installation at the sewage farm at £554. 11s.

The Stoke Guardians have accepted the tender of the Lancashire Dynamo and Motor Co. for electricity generating plant for the workhouse at £1,600. The tender of Mr. G. Margetts has been accepted for wiring and for the supply of accumulators at £1,126.

The Inverness Town Council have accepted the tender of the Brush Co. for the supply and erection of the whole of the plant for their electricity works (exclusive of boilers) at £21,000.

APPOINTMENTS VACANT AND FILLED.

The Sheffield Electric Light committee require an engineer to take charge of their electric light and power undertaking. Commencing salary £500 per annum. An advertisement contains further particulars, and applications must be sent in to the town clerk (Mr. Henry Sayer) by April 2.

The Mexborough District Council require a consulting electrical engineer. An advertisement contains additional particulars. Applications to the clerk (Mr. J. W. Hattersley) by 26th inst.

The Glasgow Corporation invite applications for the position of assistant manager to the Corporation telephone exchange. Minimum salary £200. Further particulars are set out in an advertisement, and applications must be lodged with the town clerk (Sir J. D. Marwick), City Chambers, Glasgow, before 26th inst.

The County of London and Brush Provincial Electric Lighting Co. require an assistant engineer for their Wandsworth station. Applications to chief engineer (Mr. C. P. Sparks), Moorgate-court, Moorgate-street, London, E.C., by 23rd inst. See advertisement.

The *Hanley* Town Council require an assistant engineer. Applications to borough electrical engineer by 31st inst.

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The Plumstead Vestry require an assistant electrical engineer. Applications to Vestry clerk by 27th inst.

Mr. Joyce has been appointed acting manager of the Brighton Corporation electricity works during the absence of Mr. C. C. Fowler, who is at the front.

Mr. E. Wilks, of Honley, near Huddersfield, has been appointed working electrical engineer at the Brighouse electricity work.

BUSINESS NOTICE.

Mr. A. P. Lundberg announces the removal of his works and offices from Kingsland to the Pioneer Electrical Works, 477-487, Liverpool-road, London, N.

It is only now officially notified that Messrs. G. C. Allingham and Wm. Fennell, electrical engineers, &c., and trading as Allingham and Fennell, at Harrow Green, Leytonstone, have dissolved partnership.

BANKRUPTCIES, LIQUIDATIONS, &c.

Madras Electric Tramways Co. (in Liquidation).—The creditors and shareholders of this company met on March 9, at the Board of Trade offices, London, to decide upon the appointment of a liquidator under a winding-up order.

Mr. WINEARLS, assistant receiver, reported that the company was incorporated in April, 1892, with a nominal capital of £100,000, to acquire a concession from the municipal authorities of Madras for the construction and working of tramways. Messrs. Digby and Chalk, who traded as Hutchinson and Co., sold the concession to the company for £10,000, payable in cash, Mr. Digby being chairman and Mr. Chalk managing director of the company, they paying the expenses of the promotion and subscribing for 2,000 shares. It was a condition of the concession that construction work should not be commenced until £75,000 capital had been subscribed, and in July, 1893, it was notified to the municipality of Madras that £77,797 had been allotted. Owing, however, to surrender and forfeiture, the present issue of share capital was only £64,900. The Electric Construction Co. (Ltd.), who were the petitioners under this liquidation, contracted to construct and equip the tramway for £59,950. The company decided to adopt the conduit system of electric traction specially designed to meet local requirements. The building of the power station was commenced in September, 1893, the construction of the permanent way of the first section in Jan., 1894, and the line was opened for traffic in May, 1895. In August, 1894, the company were unable to meet the payments becoming due to the contractors, and various differences arose, which were eventually referred to Mr. Jelf, Q.C., as sole arbitrator, who declared the balance then owing to the contractors at £27,000. The conduit system used on the first section proved a failure, and the overhead system had since been substituted over the whole of the tramway. In Jan., 1895, the trustee for the first debenture holders (the contractors) took possession of the tramway and appointed managers, who had since carried on the business. Various charges were given to the contractors, and in Feb., 1899, the company agreed the sum due at £64,881, whilst at the date of the winding-up order the amount owing to the contractors was £78,488, in respect of which they held charges over the whole property and undertaking of the company valued at £90,000. Sections 1, 2, and 3 and parts of the fourth and fifth sections of the lines had been completed and opened for traffic. In 1895-6 the gross receipts were £7,212, and 2,480,000 passengers were conveyed; and in 1898-9 the gross receipts from 3,900,000 passengers were £11,916. In Feb., 1899, the contractors commenced proceedings for enforcing their security as debenture holders, &c., and an application was now before the court to direct a sale of the property to the contractors for the amount of the claim. If that order was made, there would be nothing whatever for the other creditors or shareholders, and the deficiency to the contributors was shown at £68,871. The failure of the company was attributed by the secretary to loss of revenue, and to the fact that originally the conduit system of electric traction was not a success. It had been suggested that a new company should be formed to pay off the contractors and the other liabilities, and to take over and work the tramway on new lines.

Sir M. M. BHOWNAGGREE, M.P., a director and shareholder, hoped the sale would not be allowed to take place until it had been advertised in India and the people of Madras had been given an opportunity to take up the matter for themselves.

The meeting of creditors was formally adjourned for want of a quorum, but the shareholders passed a resolution for the official receiver to act as liquidator on their behalf.

At the London Bankruptcy Court on Wednesday Mr. Registrar Hope granted an order of discharge, subject to a suspension of three years, to Edward Lionel Joseph, Northampton Works, Northampton-grove, Canonbury, London. The official receiver reported that the bankrupt failed last May, with liabilities £7,616 and assets that had only realised £4. In March, 1896, he converted his business to a limited company and gave guarantees for certain liabilities in connection therewith, which guarantees he admittedly knew he could not meet if called upon to do so. The offences found were insufficiency of assets to pay 10s. in the £ to the creditors of contracted debts provable in bankruptcy without reasonable ground of expectation of being able to pay them. Other charges were preferred by a creditor, but were not gone into.

The liabilities in the failure of Arthur R. Earle, electrical engineer, 7, Theatre-street and Dial-yard, St. Miles, Norwich, are returned at £925. 14s. 10d.; assets £7. 12s. 6d. The principal creditors are :—

Perfect Arc Lamp and Accessories Co.	£53	Crystal Elec. Lamp & Rose & Bird	£38
Veritys Ltd.	48	Improved Electric Glow Lamp Co.	26
		Clarke, Chapman and Co.	13

A statement is issued by Mr. G. W. Chapman, official receiver and trustee of Jacob Gutmann, lately trading as J. Goodman and Co., 48, Commercial-street, London, as an electrical fittings dealer. The receipts from the estate are represented by the £5 deposit with the petition. There were no realisable assets, and a balance of over £7 is due to the official receiver, who now applies for his discharge.

In the bankruptcy of A. Blackburn and J. Walker (trading as Blackburn, Walker and Co.), electrical and mechanical engineers, Upper-lane Mills, Cleckheaton, a first and final dividend of 5s. 9½d. is payable at 31, Manor-row, Bradford.

Mr. R. J. Ward, 17, North-street, Brighton, has been appointed trustee in the bankruptcy of B. Symmons (trading as B. Symmons and Co.), electrical engineer, 2, North-street, Quadrant, Brighton, and 15, Holland-street, Hove.

The examination of R. D. Smillie, electrical and mechanical engineer, 39, Cadogan-street, Glasgow, takes place at Sheriff-Substitute Boyd's chambers, County Building, Glasgow, on 27th inst.

We are asked to state that, as some misunderstanding has arisen with reference to a notice sent to the creditors of Browett, Lindley and Co. (Ltd.), asking that claims against the company be sent in, this notice only refers to creditors of the old company, which is now being wound up for purposes of reconstruction. All the known debts and liabilities of the old company to its creditors and shareholders are stated to have been paid in full.

An application was made yesterday to Mr. Registrar Hope, at the London Bankruptcy Court, for the discharge of J. C. Howell, electrical engineer. It was stated that bankrupt had failed in November last, with liabilities of about £12,682 and assets £11,433, of which £11,393 represented an estimated surplus from shares held by creditors as security, but the realisable value of which was problematical. Other assets were expected to realise £30. Debtor started business in 1881 at Llanelly, and in 1892 converted his business into a limited liability company, with a capital of £25,000, receiving £10,000 in shares as vendor, and retaining the position of managing director at £800 per annum until 1899, when the company went into liquidation. As offences under the Act the official receiver reported (1) insufficiency of assets to pay 10s. in the £ to unsecured creditors, (2) trading with knowledge of insolvency. On behalf of the creditors Mr. Devonshire asked that the bankrupt's discharge should be suspended until the creditors had received 10s. in the £, and the Registrar made an order on these terms, the discharge being granted subject to this conditional order.

F. W. and R. H. Ball, electrical engineers and contractors, trading as F. W. Ball and Co., 3, Unity-street, Bristol, have executed a deed of arrangement with a view to the payment of a composition of 10s. in two instalments one on the execution of the deed, and the other on May 5. The liabilities are £1,368. 18s. 1d. The principal trading creditors are :—

General Electric Co.	£517	Heaton and Smith	£43
Electrical Co.	284	W. T. Henley's Co.	45
E. A. Sheppard	157	Veritys Ltd.	34
W. H. Hawkes	49	Brockie Pell Arc Lamp	13

Plant for Sale.—Messrs. Albright and Wilson (Ltd.), Oldbury, near Birmingham, have a Willans Crompton steam dynamo for sale. See advertisement.

As announced in an advertisement, the charging station of the London Electrical Cab Co. (Ltd.) (in liquidation), with the machinery, plant, licences, cabs, and premises, are to be sold by tender by order of Mr. Justice Byrne. Tenders to be in by noon of 20th inst. Particulars from the receiver (Mr. Walter Howard, C.A.), 27, Clement's-lane, E.C.; Messrs. Morley, Shirreff and Co., solicitors, 33, Gresham-street, E.C.; and Messrs. Steadman and Van Praagh, solicitors, 23, Old Broad-street, E.C.

"Engineering Magazine."—The contents of the March issue include articles on "The Future of Electrical Supply," "The World's Supply of Copper," and "The Revolution in Machine Shop Practice."

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from March 7 to March 13, with the ports of destination :—

Africa—Beira, £64; Cape Town, £679 (including £20 telegraph material); Durban, £929 (including £747 telegraph material); East London, £40. *Argentina*—Buenos Ayres, £497 (including £280 telegraph material). *Australasia*—Adelaide, £456 (telegraph material); Canterbury, £14; Launceston, £46; Melbourne, £339; Sydney, £738; Wellington, £516. *Belgium*—Brussels, £30. *Brazil*—Rio Janeiro, £25 (telegraph material). *Canada*—Halifax, £120,000 (telegraph cable). *Channel Islands*, £230. *Denmark*—Copenhagen, £16. *Germany*—Cologne, £25; Hamburg, £800 (telegraph material). *Gibraltar*, £7. *Holland*—Amsterdam, £300; Rotterdam, £500 (telegraph material). *India*—Bombay, £69; Calcutta, £1,024. *Japan*—Kobe, £941 (telegraph cable); Yokohama, £648. *Malta*, £61. *Russia*—Odessa, £150. *Sweden*—Gothenburg, £20 (telegraph material). Stockholm, £105 (telegraph material). *Uruguay*—Monte Video, £148. Total £129,748, against £10,424 in the corresponding week last year (March 8 to 14).

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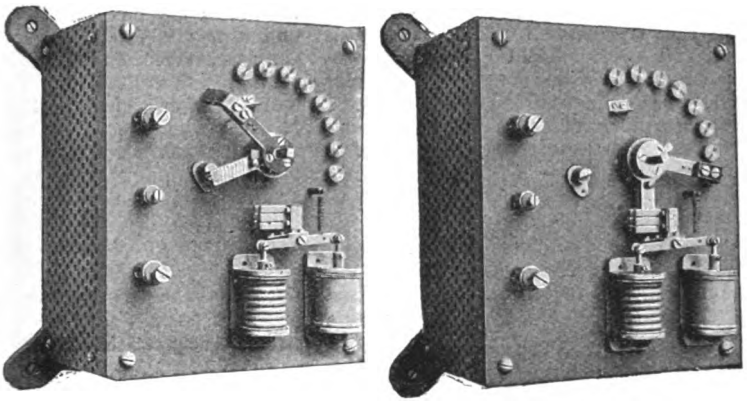
Automatic Starting Switches.—Messrs. W. McGeoch and Co. are putting on the market an automatic starting switch for shunt motors constructed according to Wilson's patent. The illustrations below show the switch in its "on" and "off" positions. It will be seen that the switch consists of two blades: the lower serves for throwing into circuit the field magnet winding of the motor and disconnecting the motor automatically in certain circumstances. The upper blade in the first instance merely operates the lower one, and after that closes the armature circuit, cuts out the starting resistance, and serves to regulate the speed of the motor when necessary. Starting from the "off" position, the handle, which is fixed to the armature blade, is turned in a counter clockwise direction until the projection on the side of the armature blade comes into contact with a pin on the lower or main blade. This latter is immediately carried round into a spring contact piece, where, if the shunt circuit is closed as it should be, and if also the supply circuit is also closed, the blade is held by the catch which is operated by the right hand or shunt solenoid. At this point the field magnet circuit of the motor is connected across the mains without an intermediate resistance, so that the magnets are fully excited. The main blade is now held in position, so that, as the handle is turned in a clockwise direction, the armature blade comes in contact with the resistance studs and the motor is started up through the resistance, which is gradually cut out as the motor gains speed. To switch off, the handle is turned in the reverse direction, until, on its passing the last of its resistance contacts, by means of a special short-circuiting device the main blade is automatically released and is pulled quickly off by a spring coiled round its centre. The motor



"OFF." "ON."

is thereby disconnected. The short-circuiting device is one of the chief features of the switch, and it is claimed that by its means an absolutely certain and quick break is obtained, no matter how slowly the handle may be turned off. An interesting point in the working of the switch is, that if the supply of current ceases from any cause, the armature circuit of the motor is automatically disconnected from the mains, so that on re-starting it cannot burn up before the field has excited. The action of the solenoids in moving the switch automatically is fairly apparent from the illustrations.

Trade Lists—A compact and useful trade list of stores and general supplies stocked in London by Messrs. W. F. Dennis and Co., 23, Billiter-street, E.C., is issued. Messrs. Dennis and Co. are sole agents for Great Britain for the Felten and Guilleaume Carlswerk Aktiengesellschaft of Mulheim-on-Rhine, who employ 4,500 hands. It is stated that the output of these extensive works is 80,000 tons per annum.

MUNICIPAL, FOREIGN, AND GENERAL NOTES.

Asylum Lighting.—The Fife Lunacy Board have instructed a committee to report upon the cost of lighting their Springfield Institution electrically. At the meeting of the Board on Tuesday Mr. David Lees said that electric lighting would be much cheaper than gas, and the Board wished to give notice of termination of their existing agreement with the Cupar Gas Co. before May.

Ayr.—In future the charge for incandescent electric street lighting is to be £2. 10s. per annum for 32 c.p. lamps instead of 16 c.p. lamps as at present employed.

Bath.—Offers have been received from various companies for constructing electric tramways in the city. The British Electric Traction Co. offer to electrically equip the existing lines on their acquisition by the Corporation, and to obtain power to construct new lines to Batheaston, Twerton, Devonshire Arms, and Lower Weston; to take electric current from the Corporation at 1·5d. per unit; to pay the costs of the Corporation in connection with the application, and, if successful, to pay £1,000 towards the costs of their previous application. The Corporation to have the option to purchase the lines at a price to be agreed, and to lease the same to the company for 35 years at a rental to cover repayments. The Bath Road Car and Tramway Co. also propose to introduce electric traction and to carry out certain extensions. This company would also take current from the Corporation at from 1·75d. to 1·4d. per unit, the Corporation to have power to purchase the undertaking at 21 years. Messrs. Brash, Wheeler, Umney and Co., on behalf of the syndicate who recently promoted the light railway order (which they failed to obtain) for the construction of electric tramways in Bath, made a third offer. This syndicate would take current from the Corporation at from 1¼d. to 1d. per unit. The route to be followed would be that of the present tramway system, with extensions to Bathford, Upper Weston, Twerton, Wells-road to Odd Down and Combe Down. The syndicate would pay a wayleave of £250 per annum, the Corporation to have power to acquire the lines in 32 years, or at the end of 14 years on terms to be agreed upon. The syndicate further undertook to reimburse the Corporation for the costs of the late inquiry to the extent of £1,500. These offers have been considered by the Electric Tramways committee, but they consider it desirable that the Corporation themselves should obtain the order, and it was decided to ask the applicants if, and on what terms, they would be prepared to take up the matter on this basis.

On the recommendation of the Electric Lighting committee, on Wednesday, the tenders recently submitted for extensions to the electric lighting plant and mains were considered, and certain tenders (set out on another page) were recommended for acceptance. The borough electrical engineer (Mr. G. F. Metzger) presented a report on the recent failures of the electric light. All the faults had occurred (Mr. Metzger reported) on mains and boxes which had not been disturbed since they were laid ten years ago. The breakdowns always occurred after heavy frosts and rains, when water got into the boxes and caused the trouble. A great quantity of them had been filled in, but there were some scores still empty and likely to give trouble again. He thought that the Callender Co. should put them right when they were carrying out the new contracts. The Callender Co. were willing, provided they obtained the contract for the cable extension, to rectify all the boxes on the circuits where they laid low-tension cables free of cost.

Brighton.—The Lighting committee propose to modify their agreement with the engineer and manager of the electricity works (Mr. Arthur Wright), by which he will be relieved of the superintendence of details, but remain consulting engineer at the same salary as at present. The engagement will be for five years, but may be determined by three months' notice.

The accounts of the electricity department for 1899 show that 3,815,743 units were generated during the year, of which 2,604,039 were supplied to private consumers, 602,584 to the public lamps, and 160,630 were used on the works. There are 257 arc lamps and 1,027 incandescents for public lighting. Including £229,687. 15s. 1d. due to capital, the liabilities at the close of the year were £308,295. 0s. 1d. The cost of generation was £17,269. 11s. 9J., and of distribution £11,745. 14s 6d. Private lighting realised £35,321. 3s., and public lighting was £8,546. 16s. 11d. To a profit on the year of £16,700 must be added £6,802. 0s. 7d. brought forward from the previous year, making £23,502. 0s. 7d., of which interest consumes £7,146. 0s. 5d. and sinking fund £8,099. 1s. 5d. £2,135 was applied in aid of district rate, £170. 2s. 10d. transferred to reserve, £4,496. 17s. 9d. paid to loans fund, and £1,454. 18s. 2d. carried forward.

Bristol.—The Electrical committee reiterate their recommendation to appoint Mr. K. O. Hale architectural and engineering draughtsman in connection with the erection of the proposed new electricity works. It will be remembered that the chairman (Ald. Pearson) recently tendered his resignation owing to this recommendation having been referred back. This resignation was, as announced in our last issue, withdrawn at the unanimous request of the members of the committee.

Carlisle.—The local tramways company recently disposed of their undertaking to the British Electric Traction Co., who propose to adopt electric traction. The latter company now wish to somewhat modify their scheme by omitting certain short lengths of the route, but the City Council decided, on Tuesday, to insist upon the original proposals being carried out.

Cheltenham.—Mr. T. Nevins, promoter of the Cheltenham Cleeve Light (electric) Railway, has agreed to take current from the electricity department of the Corporation. The mode of charging is to be upon the basis of a certain percentage upon the capital outlay on the tramway undertaking, plus a charge per unit for energy upon a sliding scale. The cost of changing over the pressure of supply has been estimated at £2,100 by Mr. Kilgour, and immediate application is to be made for power to borrow that sum.

Colwyn Bay.—The Council have received sanction to a loan of £5,100 for electric lighting.

Crewe.—An inquiry was held on Tuesday into the application of the Council to borrow £10,000 for electric lighting extensions. The town clerk (Mr. F. Coke) stated that the Council had already obtained

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sanction to expend £26,000 for electric lighting, and the present loan was wanted for lighting side streets. There was no opposition.

Customs Changes.—Telephones exported to Fiji are now classified as electrical machinery, and are consequently exempted from duty.

Devonport.—The Corporation are to erect electricity works at an estimated cost of about £75,000, but as the tramways of the Devonport and District Co. are expected to be ready for electrical working in August, it has been resolved to take immediate steps to provide plant (at a cost not exceeding £6,000) for supplying current to the company.

Dock Lighting.—The Mersey Docks Board are installing the electric light at the coal jetty on the East Float.

Dublin.—The *Nation* of the 9th inst. contains a report of the city accountant (Mr. P. J. Kerrigan) on the working of the electricity department for the past year, and an estimate of the income and expenditure of the department for the year ending 1901, prepared by the city engineer and surveyor (Mr. S. Harty). The gross income for 1899 was £10,704. 4s. 4d., and the expenditure £9,279. 8s. 2l., leaving a surplus of £1,424. 16s. 2d., or 1·69 per cent. upon the capital expenditure (£84,171. 11s. 9d.). The surplus has been carried to net revenue, and after taking into account sinking fund (£2,661. 6s. 8d.) and interests on loans, &c. (£1,596. 18s. 10d.), there was a debit balance of £2,823. 9s. 4d. on the year's working. The deficit is due to a decrease in income as well as an increased expenditure. While the units sold (326,484) increased by 2,716, the income was reduced owing to the abolition of transformer rents, which in 1898 amounted to £490. 17s. 7d., and to the increased discounts to consumers, which amounted to £1,176. 16s., against £507. 4s. 10d. in 1898. The increased expenditure was due to the higher price of coal (£606. 14s. 6d.) and in repairs and maintenance of generating plant, &c. (£483. 8s.). The total amount of loans repaid to Dec. 31 was £15,453. 6s. 8d., and the amount of interest paid £10,965. 0s. 1d. Loans received to that date amounted to £78,200, leaving due £62,746. 13s. 4d The expenditure for the present year is put at £8,532, the details being: Generation £6,220, distribution £250, public lighting £465, rent, rates, taxes, salaries, insurance, &c., £1,597. The estimated income for the year to March 31, 1901, is put at £11,967. 2s. 9d., showing a credit balance of £3,385. 2s. 9d.

Friern Barnet.—The clerk has been appointed to take the necessary steps to obtain a provisional electric lighting order.

German Colonial Telegraphs.—The Budget committee of the Reichstag has refused to vote a sum of 20,000 marks for telegraph lines in German East Africa. 20,000 marks have, however, been voted for preliminary work in connection with the construction of a line from Dar-es-Salaam to Kilosa.

Glasgow.—The Corporation yesterday decided to alter the charge for current to a fixed rate of 4d. per unit to domestic consumers on the 100 and 200-volt circuits, and to 3½d. per unit to consumers on the 250-volt circuit. The hope was expressed that this would lead to the general adoption by domestic consumers of the latter system, which would fit in with the night-load on the station at a time when the demand for office and warehouse lighting ceases. There are now 2,998 consumers on the department's books including 338 domestic consumers. The units sold for the past year amounted to 2,965,410.

The Corporation is leasing from Messrs. G. and J. Maclachlan for 28 years two top storeys of a large building in course of erection at the corner of Renfield and West Regent-streets. These premises are to be used for an exchange in connection with the Corporation's municipal telephone scheme. The premises are expected to be ready by about Sept. 1.

Govan.—The Electricity committee have decided to supply electric current for power purposes at 6d. per unit for the first hour's maximum demand and 2d. afterwards, but where current is required for five hours or over a uniform charge of 2d. per unit will be made.

Greenock.—The Tramways committee recommend the acceptance of the terms of the Greenock and Port Glasgow Tramway Co. for leasing the tramways.

Hammersmith (London).—At the Vestry meeting on Wednesday it was decided that, as the Vestry had elected to spread the cost of the proposed electric light extensions over 42 years, they should supply renewals of plant and machinery out of a sinking fund to be created for the purpose, or out of the maintenance account.

Hove.—The Council have decided to engage an electrical engineer to advise as to the best mode of carrying out the provisional electric lighting order for Aldrington.

Hyde.—Mr. A. H. Gibbings has been appointed consulting engineer to prepare a report upon the carrying out of a joint electric lighting and tramway scheme for Hyde, Stalybridge, Mossley, and Dukinfield.

Imports of Electrical Goods into Great Britain.—In the accounts relating to the trade and navigation of the United Kingdom for the months of January and February, 1900, the value of electrical goods and apparatus imported into this country during February was £60,780, and for January £63,153, making the total imports to Feb. 28 £123,933. The details issued with regard to these imports show a great improvement, but still leave much to be desired.

Leicester.—The half-yearly report of the Gas and Electric Lighting committee was presented to the Council on Wednesday by Ald. Lennard. The working profit of the electric lighting department, after allowing for interest and sinking fund, was £1,089. 16s. 1d., the total net profit for the year being £1,426. 18s. The accounts were approved.

Leith.—The Edinburgh and District Tramways Co. have revised their offer for leasing the local tramways, and have agreed to the terms of the Tramways sub-committee set out in our issue of 9th inst. The lines are to be equipped electrically within four years.

Light Railways.—At the Guildhall, Westminster, on Wednesday, the Light Railway Commissioners opened an inquiry into the application of the Middlesex County Council and the North Metropolitan Tramways Co. for an order for the construction of a system of light (electric) railways in Tottenham, Wood Green, Southgate, Finchley, and Hendon. Mr. Cripps, Q.C., appeared in support, and said that unless some such scheme were adopted it would be impossible to carry people to the outlying districts of London. The Council would find the money and maintain the whole of the roads, while the company would pay interest on capital and take the risk of working for 25 years, after which period the Council could purchase the undertaking. Mr. Littler, Q.C., C.B., chairman of the Middlesex County Council, gave evidence in support of the scheme, and said that since 1891 32,000 houses had been built in the county, that the population in 1891 was 559,392, and now was 723,000. Under the contract the Council would get 4½ per cent., which within ½ per cent would be enough to repay principal and interest. Besides that, the Council would get 45 per cent. of the profits, after allowing the company the same amount on their outlay as they would get. In about 10 years he believed the whole of the cost of the roads would be paid for by the profits of the tramways. The inquiry was adjourned until yesterday (Thursday), when further evidence was taken.

Objections to the Cheltenham-Cleeve Hill light railway order will be considered by the Board of Trade on 22nd inst.

Lincoln.—In order to prepare for next winter's load, the Council have decided to borrow £6,000 for additional generating plant. The capacity of the station will thus be increased from the equivalent of 18,000 to about 25,000 8 c.p. lamps.

London County Council.—At Tuesday's meeting the Highways committee recommended that proceedings be taken against the London Electric Supply Corporation for failure to supply electric energy in three specific cases in the district of the Vestry of St. George the Martyr, Southwark. The recommendation was adopted.

Maidstone.—The Council propose to borrow £40,000 instead of £30,000 for electric lighting.

Mandalay (Burmah).—The Municipal committee have adopted a scheme for the construction of the electric tramway recently submitted by the Burmah Electric Works Syndicate.

Municipal Trading.—A Paper on "Municipal Trading" was read before the Scottish Society of Economists at Edinburgh on Wednesday by Mr. John Harrison, chairman of the Edinburgh Chamber of Commerce. He contended that local authorities had no right to conduct any undertaking for making profit, and that every enterprise they engaged in should be for the direct service of the individual members of the constituency. No more flagrant violation of that rule could be cited than the resolution of the Glasgow Council to establish a municipal telephone exchange. The money of the 150,000 ratepayers was being risked to found an undertaking which at the best was not likely to be used by 10 per cent. of the citizens. He also held that Councils should not interfere in any business unless they possessed a monopoly. In that point, too, Glasgow Corporation seemed to him to err when it entered into competition in the telephone business against such an undertaking as the National Telephone Co. Tramways undertakings should be leased and electric lighting systems should be licensed to companies, while telephone wayleaves should be sold to the Telephone Co. Parliament was collectivist at bottom, and he found that influence both in the last Electric Lighting and the more recent Telephone Acts.

At the annual meeting of the Associated Chambers of Commerce on Wednesday Mr. Sydney Morse moved—

That this association considers it desirable that Parliament should define the limits of municipal trading, and, while regretting that Her Majesty's Government were unable to appoint the Joint Committee on Municipal Trading promised by the leader of the House of Commons in the session of 1899, trusts that effect may be given to his promise during the present session; and that, pending the contemplated inquiry, no enlarged powers for trading purposes may be conferred on municipalities.

Mr. Morse criticised the action of various municipal bodies in regard to their trade undertakings, and said that amongst the trading undertakings by municipalities and other local bodies already commenced

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or proposed were municipal bakeries, pawnbroking, fire insurance, banking, printing, tailoring, supply of sea water, bazaars, and Turkish baths. After discussion, the motion was agreed to with a slight verbal alteration.

Perth.—The Police Commissioners have decided to apply to the Secretary for Scotland for a provisional order to authorise the borrowing of £100,000—£50,000 for electric lighting and £50,000 for gas extensions. The electricity station is to be erected upon municipal land at the shore.

Private Bill Legislation.—An important decision has been given by Mr. Campion, one of the examiners of private bills, in connection with the Glasgow and District Tramways Bill. The Paisley Corporation had lodged a memorial against the bill, and although their conditional consent was subsequently given, on Tuesday the resolution was produced to the examiner in which the consent was refused. Mr. Campion held that, inasmuch as at a former appearance before him it was proved that the consent of the Paisley Corporation had been given, subject to the consent of the burghs of Johnstone and Renfrew being also obtained, and an adjournment had been granted for the production of these further consents, which were now tendered, it was not competent for him to consider any resolution of the Paisley Corporation purporting to rescind or cancel the consent previously given by them. He could not, he said, go into the question as to whether the former action of the Corporation was legal or illegal, nor could he wait for them to consider what they would do now. It was enough that he had allowed the promoters time to satisfy him that the conditions laid down had been complied with, and that they had so satisfied him. He gave his decision on the ground that there had been conditional consent, and the standing order did not prescribe any particular form in which that consent should be given. The bill will therefore be allowed to proceed.

Sheffield.—The management of the electric light and power undertaking is to be divided into two departments—electrical and commercial. The head of the former department will be styled the electrical engineer of the light and power department, and of the latter the commercial manager, each to be directly responsible to the Electric Light committee. The electrical engineer is to be responsible for the generating station, for the design and carrying out of all future extensions and alterations, as well as for the preparation of specifications for, and superintending the construction and erection of, all new machinery and plant, the management of the staff, &c. All machinery, stores, &c., will be purchased through the commercial department, and the accounts will also be kept by the commercial manager. All salaries, wages, and other payments incidental to the carrying on of the undertaking, including moneys payable in respect of work done or otherwise, by the engineer's department, will be paid by the city accountant. The commercial manager will also keep particulars of current supplied, collect all income receivable by the department, canvass for new consumers, manage the sale and wiring and fitting departments, provide machinery, plant, stores, and requisites for the electrical engineer's department and otherwise. Mr. Robert Hammond has been appointed standing consulting engineer at a retaining fee of 100 guineas per annum. His duties will be to advise the Corporation from time to time on the management and development of the undertaking and on specifications for new machinery and plant, and compliance of machines and plant supplied with specifications. As announced in our last issue, Mr. Parton has been appointed commercial manager, and the position of resident electrical engineer is advertised in another column of the present issue.

Sutton Coldfield.—The Council have decided to establish electricity supply works, and a loan of £26,000 is to be raised for the purpose. The consulting engineer is Mr. W. C. C. Hawtayne.

Telephonic Communication with the Continent.—At the meeting of the Associated Chambers of Commerce yesterday (Thursday), the following resolution was passed :—

That, in the opinion of this association, the time has now arrived when some effort should be made to establish telephonic communication with Germany, Holland, Belgium, and other Continental countries, and that application be made to Her Majesty's Postmaster-General with this view.

Telephone at Manchester.—The officials of the Mutual Telephone Co., Ltd., appear hurt at the lack of sympathy evinced by the Manchester Corporation in their efforts to establish a competitive telephone service in the city and district. The following letter expresses the views of the chairman of the company :—

I should like to ask, on behalf of those who have been induced to spend their money and time on the strength of a resolution passed by the Corporation of Manchester of 14th April, 1897, to the effect that they would support the Mutual Telephone Co., for an explanation of the delay since October last in fulfilling that promise. Consistently with their resolution, they did support the company on several subsequent occasions, and notably on May 5 last, when they sent a deputation with the Mutual Co. to ask the Chancellor of the Exchequer to grant the company a licence. After that the Post Office intimated that their request would be granted subject to the Corporation confirming their resolution of April 14, 1897 (which was regarded as a legal formality consequent upon the passing of the Telegraph Act, 1899). Will any member of the Council explain how it comes that the Council are now considering whether they should take over the telephone service themselves?

Underground Telephone Wayleaves.—The West Riding of Yorkshire County Council have entered into an agreement with the National Telephone Co. for laying their cables under the main roads in the West Riding at an annual payment of 2s. 6d. per furlong or part of a furlong of cable, and a charge of 10s. per annum for each large box and 2s. 6d. per annum for each small box, the company to reinstate the road and remove the wires and apparatus on notice.

Vienna.—The City Council have decided to establish municipal electricity works, and the contract has been placed with the Austrian Schuckert Co.

Wigan.—The market hall, fish market and municipal buildings are to be lighted electrically at an estimated cost of £783. 10s.

Wolverhampton.—The Corporation have applied to the Board of Trade for sanction to borrow money for the acquisition of the lines of the Dudley and Wolverhampton Tramways Co. The purchase price was recently fixed by arbitration at £26,750.

PATENT RECORD.

The following list of Applications for Patents and Specifications published has been compiled for this journal by Messrs. J. C. CHAPMAN and Co., *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs, and Trade Marks may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after the acceptance of the complete Specification. The names within parentheses are those of communicators of inventions. When complete specification accompanies application, an asterisk is affixed.*

February 10, 1900.

2,662. THE LANCASHIRE DYNAMO AND MOTOR CO. (LTD.), A. P. WOOD and R. S. MCLEOD. Liverpool. Improvements in brush holders for dynamo-electric machinery.

2,670. G. T. HUTCHISON and H. K. PACKARD. London. Improvements in the production of vacuum bulbs for electric incandescent lamps.

2,684. N. ROBINSON. London. A non-sparking (or sparkless) current collector for electric tramcars or other electric motors where bare supported mains are used.

2,691. H. EDMUNDS. London. Improvements in electric cables.

2,700. R. D. MERSHON. London. Improved method of and means for indicating speed or current frequency of electric generators. (Date applied for under Patents, &c., Act, 1883, Sec. 103, July 12, 1899, being date of application in United States.)*

2,702. E. H. REITER. London. Improved electromagnetic brake dynamo meter.

2,703. A. DE CASTRO and H. W. SCHLOMANN. London. Process and apparatus for electrolytically impregnating textile fabrics of all kinds by means of metallic salts.*

2,710. W. M. MORDEY and G. C. FRICKER. London. Improvements in electricity meters.

February 12, 1900.

2,734. W. R. STEARNS. Kingston-on-Thames. Improvements in apparatus for signalling the approach of electric trams operated on the overhead system.

2,742. F. MAYLÄNDER. Germany. Improvements in apparatus for firing submarine mines by means of Marconi's wireless telegraphy.*

2,755. G. W. BOLSER. Kingston-on-Thames. Improvements in collectors for electric trams on the overhead system.

2,767. J. NESSEL and J. F. GOUIN. London. Improvements in long-distance relay magnetic telephones.*

2,783. J. Y. JOHNSON. London. Improvements in electrical arc furnaces. (The Deutsche Gold und Silber Scheide Anstalt vorm. Roessler and Birzir Carlson, Germany.)

2,797. A. S. POPOV. London. Improved telephonic receiver for messages sent by means of electromagnetic oscillations and signs of the Morse alphabet.*

February 13, 1900.

2,843. R. HACKING. London. Improvements in clips or devices for holding electric lamps or the like.

2,850. C. K. FALKENSTEIN. Surrey. An improved device for adjusting the height of electric lamps or fittings.

2,862. C. RICHTER and R. T. ESCHLER. London. Improvements in electric traction motors.*

2,880. W. H. COOLEY. London. Improved system of and means for regulating electric machines.

2,897. W. CHAPMAN. London. Improvements relating to electric railways.

February 14, 1900.

2,929. W. T. CHAPMAN and W. E. BATT. Manchester. Improvements in electrolysers.

2,948. G. W. HOLT, of the Imperial Electrical Engineering and Stamping Co. London. Improvements relating to fuels for electric circuits.

2,951. J. F. WAKELIN, C. J. WESTON, and W. BUNN. London. Improvements in the method of insulating electrical conductors.

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2,952. J. F. Wakelin, C. J. Weston, and W. Bunn. London. Improvements in the method of insulating and fixing electrical conductors.
2,964. A. H. Howard. London. Improvements in and apparatus for the manufacture of pipes or conduits for electrical conductors, or for conveying liquids or gases, or for analogous purposes.
2,994. M. Kugel. Liverpool. An improved process for the electrolytic deposition of nickel or its allied metals.

February 15, 1900.

3,013. J. Cudworth. Newcastle-on-Tyne. Electrical displacement switch.
3,021. J. T. Hale and F. G. Hale. Liverpool. The automatic trolley pole arrester for electric tramcars.
3,031. C. W. G. Little. Lincolnshire. Improvements in electricity meters.
3,033. F. L. Berners and J. A. Smith. London. Improvements in and connected with electric accumulator plates or electrodes.
3,043. C. Raab. Liverpool. Improvements in voltmeters and ammeters.
3,056. V. I. Feeny. London. Improvements in electric meters. (Allgemeine Elektricitäts Gesellschaft, Germany.)*

February 16, 1900.

3,063. R. A. Bolton. Dublin. An improved method of controlling trolleys of electric cars.
3,081. A. E. Radbourne. Birmingham. Improvements in electrical apparatus for signalling from passengers in a moving train to the engine driver and guard.
3,105. L. C. Reed, W. B. Reed, and E. H. Farrar. London. Improvements in systems of electrical distribution and safety apparatus therefor.*
3,106. L. C. Reed, W. B. Reed, and E. H. Farrar. London. An automatic electric circuit breaker.*
3,107. L. C. Reed, W. B. Reed, and E. H. Farrar. London. An improvement in isolated, alternating low-tension systems of electrical distribution.*
3,108. W. C. Johnson and A. Wunderlich. London. Improvements in arc lamps.
3,120. H. W. Butler. London. Improvements in means for regulating pressure in electric mains.
3,124. E. Weston. London. Methods of and apparatus for manufacturing movable coils for use in connection with electrical measuring instruments.*
3,143. E. W. Brown. London. Improvements in or relating to electric relays.
3,141. E. W. Brown. London. Improvements in or relating to telephones.
3,150. R. P. Strachan. London. Improvements in trolleys, poles, and standards for electric traction.

February 17, 1900.

3,174. M. C. Mengis. Manchester. Improvements in and connected with long-distance telephony.*
3,192. A. de Castro and H. W. Schlomann. London. Electric battery and its arrangement in connection with electric motor cars.*
3,200. V. Thomas. London. Improvements in and in the process of manufacturing filaments for electric incandescence lamps. (Date applied for under Patents, &c., Act, 1883, Sec. 103, August 8, 1899, being date of application in France.)
3,203. J. Lecarme and L. Lecarme. London. Improvements in interrupters for electric circuits.*

February 19, 1900.

3,257. Chamberlain and Hookham (Ltd.) and S. H. Holden. London. Improvements in electricity meters.
3,254. A. M. Taylor. Old Charlton. Improvements in and connected with underground conduit and surface-contact electric railways.
3,258. A. F. Spooner. London. Improvements in electric switches. (B. L. Neveur, France.)
3,264. C. Perdrisat. London. Improvements in and relating to the armatures of electric motors, also applicable as a meter for electric currents.
3,272. E. Wells. London. Improvements in and relating to electrical ignition devices for gas and like internal combustion engines.

February 20, 1900.

3,303. H. B. Bond. Birmingham. Improvements in cord grips for lamp holders and other electrical purposes.
3,315. A. G. Brookes. London. Improvements in and relating to electric heating apparatus. (Boston Electric Heating and Power Co., United States.)*
3,343. A. Muirhead. London. Improvements in telegraphic transmitting, receiving, and translating arrangements.
3,352. A. Just. London. Improvements in or relating to incandescence bodies for electric glow lamps.
3,361. J. G. Hathaway. London. Improvements in the manufacture of secondary batteries.*
3,371. E. F. Porter. London. Improvements in and relating to electric heaters and switches therefor.*

February 21, 1900.

3,441. M. Byng and F. G. Bell. London. An improved system of telephonic communication and signalling.*
3,461. The Westinghouse Brake Co. (Ltd.). London. Improvements in electromagnetic brakes. (F. C. Newell and E. M. Herr, United States.)

February 22, 1900.

3,468. T. Kay. Stockport. Improvements in electrical generating machinery.
3,469. H. Noble and Pearson Lund. Newcastle-on-Tyne. Improvements in cutting the slots or teeth in the armature cores of dynamo-electric machines and the like.
3,481. L. Newitt. Newcastle-on-Tyne. Improvements in and relating to resistances for electric circuits.
3,501. W. C. Hill. Old Charlton. Improvements in electric alarums.
3,520. H. W. Butler. London. Improvements in means for regulating pressure in electric mains.
3,524. W. P. Thompson. London. Improvements in features for the anodes in electrolytic apparatus. (H. Becker, France.)
3,532. J. W. Gibbs. London. Improvements in electric rollers for therapeutical and massage purposes.*
3,534. Eversheds and Vignoles (Ltd.) and S. Eversheds. London. Improvements in electric supply meters.
3,535. G. Hookham. London. Improvements in electricity meters and electric clocks.
3,545. M. Frank. London. Improvements in and relating to the insulation of electrical conductors.*

SPECIFICATIONS PUBLISHED.

Note.—All Specifications can now be obtained at the uniform price of 8d. each.

1899.

1,394. Stockall. Ratchet gearing and locking for electric clocks and general registering or other like machines.
1,438. Neill. Electric mechanism for driving turret and other clocks.
1,765. Thompson and Walker. Surface-contract electric traction system.
2,144. Heffernan. Primary batteries.
2,268. Brown. Cord grip for electric lampholders, fittings, and the like.
2,482. Stevens, Vyle and Milner. Means or apparatus for recording and repeating and transmitting Morse characters for use with telegraphic instruments.
2,660. Lemström. Electrical influence machines.
2,665. Zworikin and de Blumenthal. Automatic electrical apparatus for indicating and removing leakage in ships.
3,028, Lake (Cutter). Combined automatic magnetic circuit-breakers and resistance controlling switch.
3,177. Bell. Electrically illuminated advertising mediums or the like.
3,412. Barker. Electrical apparatus for recording the time of working of machines and for like purposes.
4,312. Imray. (G. L. Thompson Manufacturing Co.) Electric welding and apparatus therefor.
4,415. Lake (Boissier). Apparatus for use in electro-plating.
4,632. Reed. Operation of electric motors at different speeds.
4,633. Reed. Method of and means for operating electric motors. (Date applied for under International Convention, August 7, 1898.)
4,725. Howard. Electric incandescent lamps of glowing refractory substances.
5,229. British Thomson-Houston Co. (Ltd.). (Hewlett.) Method of and apparatus for making and breaking or varying high-potential electric currents.
5,416. Walklate. Spring break switches for electric currents.
6,052. Webb and Thompson. Apparatus for working railway points and signals by electricity.
6,220. Siemens Bros. and Co. (Ltd.). (Siemens and Halske Aktien Gesellschaft.) Electrical incandescence lamps.
6,335. Gehre. Device for producing electric current at sea by the action of the waves.
6,593. Cunningham. Combination brake coupling for electrically connecting railway vehicles fitted with vacuum brake for communication or signalling purposes.
6,685. Heinrich. Voltaic cells.
6,820. Magrini (Villa). Trolley or like current collectors for electric railways and tramways.
6,894. Townsend, Wilson and McClelland. Electrical measuring instruments.
7,427. Imray (Soc. Anon. pour la Transmission de la Force par l'Electricité). Rotatory converter or transformer for simple or polyphase alternating electric currents.
7,823. Sangster. Contact breakers for the firing devices of internal combustion engines.
8,155. D'Arlincourt. Electro-magnets.
8,483. Lavens and Lavens. Electrical signalling apparatus.
9,209. Upton. Electric arc lamps.
10,134. British Thomson-Houston Co. (Ltd.). (Case.) Controlling devices for electric motors.
10,699. Jones. Street lampposts, electric light standards, and the like.
10,768. British Thomson-Houston Co. (Ltd.). (Fleming.) Electric arc lamps.
13,565. British Thomson-Houston Co. (Ltd.). (Armstrong.) Methods of and apparatus for controlling alternating electric current motors.
13,566. British Thomson-Houston Co. (Ltd.). (Haskins.) Thermostatic electric circuit breakers.
13,819. Starr. Automatic magnetic circuit breakers.
16,132. British Thomson-Houston Co. (Ltd.). (Steinmetz.) Method of and means for inducing magnetism in magnetic circuits applicable to alternating-current motors, transformers, and the like.
16,133. British Thomson-Houston Co. (Ltd.). (Steinmetz.) Alternating electric-current motors.
20,237. Bourdillon. Method and apparatus for the manufacture by electro-deposition of articles plated with platinum, gold, and silver.
20,803. British Thomson-Houston Co. (Ltd.). (Thomson.) Electric meters.

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21,651. BRITISH THOMSON-HOUSTON Co. (LTD.). (Potter.) Electric railways and controlling devices therefor.
21,653. BRITISH THOMSON-HOUSTON Co. (LTD.). (Case.) Regulation of electric motors and brakes for electric railway vehicles and the like.
21,654. BRITISH THOMSON-HOUSTON Co. (LTD.). (Case.) Electric brakes and methods of operating the same.
21,657. BRITISH THOMSON-HOUSTON Co. (LTD.). (Barry.) Electric train control systems.
21,658. BRITISH THOMSON-HOUSTON Co. (LTD.). (Stewart.) Signal systems for electric railways.
21,661. BRITISH THOMSON-HOUSTON Co. (LTD.). (Hewlett.) Cut-outs and switches for high-potential electric circuits.
21,667. BRITISH THOMSON-HOUSTON Co. (LTD.). (Steinmetz.) Systems of electrical distribution and measurement.
21,669. BRITISH THOMSON-HOUSTON Co. (LTD.). (Thomson.) Electric meters.
22,016. BYNG and BELL. Electrical switches for telephonic systems and other purposes.
23,284. BRITISH THOMSON-HOUSTON Co. (LTD.). (Thomson.) Systems of electrical distribution and cut-outs therefor.
23,292. BRITISH THOMSON-HOUSTON Co. (LTD.). (Union Elektricitäts-Gesellschaft.) Electric locomotives or motor cars for adhesion and rack railways.
23,617. ROSENBERG. Holders for record cylinders of phonographs, graphophones, and the like.
23,696. BROOKES (Woodman and Fiske). Electric alarm systems for the protection of buildings or for like use.
23,737. BRITISH THOMSON-HOUSTON Co. (LTD.). (Libby.) Pneumatically operated contact shoes for third-rail electric railway systems.
23,740. BRITISH THOMSON-HOUSTON Co. (LTD.). (Steinmetz.) Controlling alternating electric current motors.
24,643. BRUKE. Magnet frames for dynamo electric machines and motors.
24,717. MILLS (Gamewell Fire Alarm Telegraph Co.). Fire alarm telegraph apparatus.
24,832. KAEPPERLE. Method of making commutators for electrical machines.

COMPANIES' MEETINGS AND REPORTS.

City of London Electric Lighting Co. (Ltd.).

The ordinary general meeting of this company was held yesterday, Sir DAVID SALOMONS, Bart., presiding.

The MANAGER and SECRETARY (Mr. J. Cecil Bull) having read the notice convening the meeting,

The CHAIRMAN said: The twelve months that have passed since I last addressed you have brought about great changes in the position of the company. At that period competition within our area was threatened; at the present time it is an accomplished fact, due mainly to the action taken by the Corporation of the City of London. I will not weary you with the past history of this company, nor with the peculiar conditions which led to certain contracts being made between the City authorities and the company. With these particulars and with the application of the Charing Cross Co. to compete within the City area, the Board of Trade inquiry which followed, and finally the passage of the company's bill through Parliament, you have been kept informed from time. The directors offered strenuous opposition to this competition, feeling this to be their duty towards the shareholders. The directors also offered to sell the company's undertaking to the Corporation, and in every way left no stone unturned in your interests. That the Corporation have broken the pledges they gave when the contracts were made no man in his senses could doubt; and if any proof is conclusive, it is the fact that they are defending the application which we have made to the High Court to declare our contracts with the City valid and existing. The Corporation rely mainly in their defence on a certain Act of Parliament which declares that a contract is void if any member of the Corporation contracting has an interest, direct or indirect, in such work. In this particular instance the interest consists in the purchase or holding of shares, which the company could not prevent. In other words, the Corporation is taking advantage of its own wrong, which is inadmissible by English law. In fact, if the courts uphold the contention of the City authorities, further legislation will become necessary to render municipal business possible. In another action to interpret the contract, in which the company were successful, the City authorities have lodged an appeal; but this remains in abeyance until the question of the validity of the contracts has been decided. In consequence of the threatened competition, the directors felt that they had no alternative but to lower the price of current on a par or below that of the competing company; and at the present moment the cost of electrical energy in the City is lower than in any other part of the metropolis. Two difficulties arise from this course: (1) decreased revenue for the same amount of work done, (2) the much greater demand which we are called upon to meet. Since the low rate has been in force the demand in lamps has exceeded that for the corresponding period of the previous year by over 12,000. This has put a great strain upon the engineering staff and upon the generating station, and this at a time when coal could only be obtained with great difficulty and expense. This coal difficulty has been the cause of low pressure, a difficulty which has been experienced by other companies, as the reports of the police courts will show. Every effort is being made to effectually guard against a recurrence of this trouble. The percentage of generation and distribution expenses to gross earnings for the year considerably exceeds that of last year, and this is accounted for by the facts set out in my preceding remarks. The directors fully expect that this figure will be greatly modified in our favour for the present year. If no unforeseen troubles arise, there will be a larger output; the coal difficulty is likely to decrease, and the standing charges will remain practically unaltered, Every year the board had made provision for additional machinery twelve months in advance, to the extent of about 60,000 lamps, to meet current average demand. Owing to the backwardness of contractors, this provision had rarely been fully carried into effect. For the future it was fairly certain that these advance orders must exceed those given in the past, and provision would have to be made for from 75,000 to 100,000 lamps, and machinery must be ordered two years in advance. The equivalent number of 8 c.p. lamps now supplied by the City of London Co. was 468,831. The number awaiting to be connected was approximately 22,000. The company's capital expenditure had exceeded the subscribed capital at par value by £113,456. 0s. 10d. This was absolutely necessary, as they could not allow the demand to exceed the supply. The directors therefore intended offering the remaining authorised capital of the company to the preference and ordinary shareholders *pro rata* at par. Part of their depreciation had been taken from the premiums fund. The City of London Co. laboured under the disadvantage that Parliament had imposed on the company the necessity of keeping a depreciation reserve fund in securities outside the company, and the directors were endeavouring to alter this in the bill at present before Parliament. Other companies were able to reinvest in their own business, which was clearly to their great advantage. Upon the statement of accounts shown the directors considered themselves justified in declaring a dividend of 4 per cent., the overspent capital being replaced by the issue of shares just mentioned. During the past year exceptional expense had been incurred in connection with the opposition of the Charing Cross Co. The directors had also decided to wipe off the suspense account. Further, for six months (representing the best paying part of the year) they had been working at the lower charge for current and before the increased demand had had time to be felt in their returns. The price of coal had also been phenomenal. It might therefore fairly be recorded that the company had passed through a somewhat stormy time, and calm was still far ahead. As to the future prospects of the company, Mr. Bailey, their chief engineer, had made an exhaustive report showing that when all the machinery on order was delivered, they would be able to supply 824,571 8 c.p. lamps connected and allowing for reserve 630,643 lamps. Consequently they would be able to connect up a further 185,034 lamps. Any competing company would start at a great disadvantage, and would require a capital far larger than that of the existing company to give the same output. Plant and material were much higher in price now than when the City Co.'s stations and mains were erected and equipped. Their station was close to its work, and losses in distribution were thus avoided. He thought the Charing Cross Co. little realised the difficulties which would have to be encountered, and the directors regarded the attempt of that company to compete successfully with the City Co. as foredoomed to failure. The argument that the competing company would have the advantage of the most modern and efficient machinery, whilst that of the City Co. was out of date, was entirely erroneous, as their machinery was neither antiquated nor out of date. Of its kind no better could be obtained to-day, and similar types of machinery were being every day erected. Their past six months' experience had shown that an all-round maximum 4½d. rate for lighting did not pay. Their customers might be divided into two classes—those who used their lamps for short hours, and those who run their lamps for long periods. The short-hour section required a large amount of plant installed to supply their needs for a very limited time; the long-hour consumers paid the company much better, and consumers who used their lamps in this manner the company could afford to supply with electric energy at low rates. The directors had therefore come to the conclusion to adopt a scale of charges by which the price per unit was reduced according to the length of time the lamps were in use. The readjustment of their charges would place the whole of their plant in a position to earn a fair return and increase the company's profits. Turning to other subjects, he might say that in the case of all the reservists who had been called from the service of the company to go to the front, the directors had acted in a patriotic spirit, and had decided to assist the families during the men's absence. Having referred to the proposed re-election of Mr. P. D. Tuckett and himself as directors, Sir David said the directors very highly appreciated the services of the manager and secretary, Mr. Cecil Bull, of Mr. Frank Bailey, their chief engineer, of Mr. Jackson, their second engineer, of Mr. Toy, their accountants, and of the various superintendents and other members of the staff at the offices, the works, and elsewhere, during a period of strain and pressure not unmixed with great anxiety. He concluded by moving the adoption of the report and accounts and the payment of the dividend as recommended.

Mr. GEORGE HERRING seconded the resolution, and said that when the company was first started the difficulties that would have to be faced were well know—one in particular was that for about 12 hours' work they would receive one hour's good pay. Thanks to the Corporation repudiating their agreements, on the plea that one of their members had bought shares, which the directors could not help, the company had been brought to its present position. That position was, he granted, a bad one, but he saw no reason to despair; and one of his reasons for saying so was that they now commanded the greatest city in the world as regarded its lighting. Their competitors proposed to form a company, with a capital of £800,000. He considered that a ridiculous amount, as they would not be able to establish competitive supply for such a sum. Everything they would require would cost more than it had cost the City Co., and he considered the new company would require £1,500,000; and he asked if it was at all likely that the new

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company would succeed in raising this sum in order to compete with the City Co. on ground already covered. The new company would be liable to all the difficulties that the City Co. had gone through. The City Co. now wanted more money. They had started originally with the idea of having 360,000 lamps connected as a maximum, and had already 460,000, and the number was still increasing. If the shareholders had confidence in the directors, they would supply the requisite capital to enable the company to cope with its growing demands.

Mr. PREVOST, referring to the law action with the Corporation, said he had been informed that the company had brought an action and had failed, but he supposed his informant was wrong. He understood that the company was going to apply for powers to supply an additional area, and he hoped this would prove satisfactory. He wished to know whether the directors had stopped for good the payment of interim dividends, or whether this failure applied only to the past year.

Mr. YELVERTON said that, with regard to the issue of the new shares, he believed he could go to his brokers and buy the company's shares for £9. 15s., and he therefore did not think the shareholders would pay £10 for them. He would like to ask the chairman whether there was any truth in the statement that the company's supply of electricity was not a satisfactory one. He was told that it had been laid in iron pipes. He was not an engineer, but members of the Stock Exchange informed him that that was one of the reasons for the low price of the shares in the market. (Laughter.) He was informed that it was an unusual thing for electricity supply to be through iron pipes, as it had the disadvantage that if a defect occurred in the connections, and any consumer failed to get his supply, search had to be made for a long distance along the iron pipes, whereas the proper way was to lay the supply down so that a defect could be got at by having some form of movable top or in some other way. (Laughter).

The CHAIRMAN said he thought the gentleman who had just spoken should be appointed as chief engineer when Mr. Bailey retired. He, however, appeared to have been looking at the gas pipes instead of the electric mains.

Mr. YOUNG, a large shareholder, said he thought the directors should offer the shares to the shareholders at a lower price than £10. He wished to offer the board his sympathy for the harsh and ungenerous treatment they had received at the hands of the Corporation, who had acted in a manner that no other Corporation in England would have done. With regard to the competition, he would urge the directors not to despise their enemy. It was true the new company would work under serious disadvantages, but the Charing Cross Co. was a pushing one. It had come into competition with other companies, and had done very well. He urged the board to look the new situation straight in the face.

The CHAIRMAN, before putting the resolution, said that he was quite certain the directors did not intend to give the City Co. away to the Charing Cross Co., or to anybody else. If they had not the competition of the Charing Cross Co. they might have somebody else come in. The board therefore would do their utmost to make the company's charge for current a reasonable one, and to find a scale that would pay both the shareholders and the customers. The question of the price of the Company's shares on the Stock Exchange was one that he did not personally pay much attention to. If they were to buy 1,000 shares, they would see what a difference there would be in the price. The shares of the company were well held, as the directors knew by the transfers at the office, and the majority of the transactions which were published were paper ones, and never reached the company's offices to any substantial amount. The interim dividend had been unpaid, as the directors did not see how they could pay it.

Mr. J. P. BRAITHWAITE asked, with regard to the revised scale, what effect this would have in revenue?

The CHAIRMAN said the result would be a largely increased net sum to the company's benefit. There was no doubt about it. What the scale would be he could not say, as they had seven or eight different scales under consideration.

The report and accounts were then unanimously adopted and the dividends duly approved. The meeting then approved the bill before Parliament "to empower the City of London Electric Lighting Co. (Ltd.) to acquire lands and work generating stations, and for other purposes."

Sir David Lionel Salomons, Bart., and Mr. Philip Debell Tuckett were re-elected directors of the company; and Messrs. W. H. Pannell and Co. were reappointed auditors.

A cordial vote of thanks to the chairman and directors, which was carried unanimously, terminated the proceedings.

Metropolitan Electric Supply Co. (Ltd.).

The thirteenth ordinary general meeting of this company was held on Tuesday, at Winchester House, under the presidency of Mr. W. HARRISON CRIPPS.

The SECRETARY (Mr. E. Cunliffe Owen, C.M.G.), having read the notice convening the meeting,

The CHAIRMAN said: Gentlemen, dealing first with the capital expenditure portion of the accounts, which at the end of 1898 amounted to £993,761, you will see that by the end of last year that sum was increased to £1,244,254, being an increase of £250,493 during the year. Of this additional expenditure £141,000 is for the new generating station at Willesden, the remainder having been practically expended in carrying out the work of altering from high-pressure to low-pressure mains, and providing two additional sub-stations, one of which has not yet been completed. This change has, as you know, been in the course of operation for some years past, and will, when completed, have the effect of materially reducing our working expenses. It is our intention to complete this much-needed work as speedily as possible. Turning to the credit side of the capital account, it will be seen that the receipts have increased by £231,470, of which £106,470 is the balance of the instalments received from the holders of founders' shares for the ordinary shares issued to them under the agreement made in 1898. The remainder is the £125,000 additional debenture stock referred to in paragraph 3 of the report. Our old debentures were issued at 4½ per cent. With regard to this creation of 3½ per cent. mortgage debenture stock, it appears to me that it is a strong proof of the soundness of the company's position that we were able to make a successful issue at 97 per cent. I may state that no portion of the issue was underwritten. As the completion of the present works at Willesden and their extension for next winter, and also the company's operations generally, will require an outlay of further capital, the directors have had under their consideration the expediency, for the purpose of our more immediate requirements, of issuing the remaining half of this debenture stock at an early date. Having regard, however, to the present condition of the market, I am doubtful whether it will be possible to obtain for it quite such satisfactory terms as was the case last summer. I will deal now with the revenue account, from which you will see that a large increase has taken place in the sale of current. The number of units sold has grown from 6,800,000 to 8,300,000 (an increase of 22 per cent.), and the revenue has grown from £146,974 to £173,374, being an increase of £26,400. Both these increases are the largest ever obtained in the course of the company's history, and represent the doubling of the units sold in three years and of the revenue derived from the sale of current in 4½ years. The total increase of revenue for the year has been £27,584, as against which the total expenses have increased £14,755. The greater part of the increase in working expenses is in the item of coal: it has cost £10,192 more than in the previous year. This increase is partly due to the increased price of coal, and partly to the extreme pressure under which we had to work before Willesden was ready to assist the town stations. The directors considered it better, even at serious increase in cost, to strain every effort to maintain the company's supply. With this end in view forced draught had to be used almost continuously. Now that this extreme pressure has been removed, we shall hope to obtain considerable economies in the working of the town stations. We shall also derive benefit from the changes which have been made from high to low pressure distribution over considerable portions of our districts. During the past year extensive repairs have been made at the various town stations, advantage having been taken of the slack season during the summer to execute these repairs. They were undoubtedly rendered greater by the pressure at which the company was working even in the previous winter in consequence of the constantly growing demand for current. I do not think any other item on the expenditure side of the revenue account calls for special attention, except perhaps Parliamentary charges. These remain at a higher figure than we should like to see them, but it was necessary for the protection of the company's interests that a considerable expenditure on this account should again be incurred last session. With regard to the sum of £13,000 which has again been set aside for depreciation, I would say that the question of depreciation has recently been carefully gone into by the directors. With the approval of the auditors, a basis has been arrived at which establishes the sufficiency of previous appropriations, and will secure the adequate increase of the fund year by year in the future. Deducting the increase in expenses from the increase in gross revenue, there remains, after deducting the £13,000 for depreciation, a balance of £53,392 to be carried to revenue account. This balance exceeds the sum carried to the credit of that account last year by £12,829, and is further increased in the net revenue account by an additional return of £712 for interest on investments. On the other hand, interest on debenture stock has required £719 more than last year. After deducting this increased payment and other items, including the interim dividend paid in August last, there remains a balance of £25,660. 6s. 3d. available for dividend. This sum is sufficient to provide for the proposed dividend at the rate of 5 per cent. per annum for the second half of the year, and to leave a credit balance to be carried over to the next year of £4,410. 6s. 3d. This is almost £3,000 more than was carried forward a year ago. I trust the shareholders will concur with the directors in considering this a not unsatisfactory result, having regard to the exceptional difficulties of the past year, to the fact that no part of the expenditure of about £201,000 on the Willesden works became productive until the last fortnight of the year, and because the economies resulting from the changes which we are making in certain of our districts could not be fully obtained during the year. It is with much satisfaction that I am able to state that our Willesden works have proved themselves in every way satisfactory. Certain mechanical troubles, such as hot bearings and governor adjustments, which every engineer will understand are inseparable from the starting of a new undertaking of this magnitude, delayed us from running the machinery as soon as we had hoped. These have, however, long since been overcome, and it is with special satisfaction that I can state that since the starting of the works not a single electrical hitch of any importance has occurred. When it is realised how much is involved in delivering electricity over so great a distance, how the pressure has to be transformed up and transformed down, and how in adopting a two-phase alternating supply new problems had to be considered and special apparatus designed, I am sure you will agree with me in considering that great credit is due to our engineers and contractors for having achieved so great a success, more especially as there was no time for experimental running. A few days ago the directors invited a representative party to accompany them over the works, and I am quite sure those who saw what the company had been doing there during the last two years would be ready to acknowledge the efforts which had been made to increase the means of meeting the requirements of the public in

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a way which has not hitherto been attempted. As you are aware, shareholders have also had the opportunity of seeing the works on recent Wednesday afternoons, and it is still open for any shareholder who desires to do so to visit the works on application to the head office. The present capacity of these works is 4,500 kilowatts, which provides for the requirements of a connection of about 270,000 lamps and we have already made arrangements to increase this output, so that by the end of the year we shall be able to rely upon a supply of 6,000 kilowatts. We shall then have power for a connection of 360,000 lamps at these works alone. Paragraph 6 of the report refers to the negotiations which were conducted with the London County Council in connection with the new street to be made from Holborn to the Strand. This street will cut through the centre of our existing works at Sardinia-street, and it was of the utmost importance to us that not only should full compensation be obtained, but that every precaution should be taken that the existing works are not interfered with until the new works which are to take their place are in proper working order. For the conditions obtained I would refer those interested to the London Improvements Act of 1899, which describes the protection given by Parliament to the company. With regard to the Central Electric Co., who obtained powers for erecting a generating station in our Marylebone area, we obtained a clause limiting their powers of supply to the districts of the Westminster and the St. James' and Pall Mall Companies. The directors have thought it desirable to strengthen the board by the election of two new members. Mr. Carr Saunders' name is a familiar one in the City, and his financial knowledge and experience has been of great assistance to us. Mr. Leverton Harris is one of the largest shareholders. We are pleased to be able to state that we have secured the services of Mr. Conacher, late general manager of the North British Railway, as the general manager of this company. I ought perhaps to mention that we have a certain number of reserve army men in our employment, and I feel sure that you will approve of our decision to pay a portion of their wages to their wives during the time they are serving their country, and they will be reinstated to their positions on their return. Before closing my remarks I wish to take an opportunity of alluding to the exceptional difficulties which overtook the company towards the close of last year. It is scarcely necessary for me to enter at length on an explanation of these difficulties. They all arose from the same cause. Although we made every effort to get the works at Willesden completed in time, yet, owing to the failure of some of our contractors to do the work at the right moment, we found ourselves in the middle of October short of the necessary current, but only to a very small amount. Most of our customers behaved very well, and burnt as little light as they could, but a few others thought it necessary to apply to the magistrate to inflict upon us a penalty for not fulfilling our obligations. I will read you a short abstract of the judgment of the magistrate. He said: "Now, it is clear that they have done and are doing their best, as is shown, I think, by the almost pathetic statement which Mr. Muir made with reference to the work which they have done and are doing to meet the excessive amount of extra encouragement which this company is receiving on all sides in the shape of applications to be supplied with electricity by them, not only in one district, but in other districts which they have power to supply, and have been and are appreciating to the fullest extent the powers they have got and the liabilities which they are under in consequence of those powers." He ended his judgment with these words: "Although people are bound by Acts of Parliament, we cannot say to them, 'There is the Act of Parliament; we will not consider anything as to the difficulty you have been placed in by circumstances entirely beyond your control; we will bind you strictly to the letter of the law, and we will make you pay the uttermost farthing we have the power of imposing.' I do not think it possible to do a thing of that sort when you see a company not standing by doing nothing, but spending thousands of pounds and employing hundreds of men, and doing everything for the purpose of carrying on their trade according to the Act of Parliament which they have obtained for the purpose of carrying on their trade. When you see that, I do not think anyone can say that they have failed deliberately. They have failed through misfortune, most of which is beyond their control. The penalty which I am about to impose will be one which will certainly mark my view as to the matter—namely, that they have not complied with the requirements of the Act of Parliament—but at the same time that it has been mostly through misfortune which they could not foresee and which they could not prevent. Instead of imposing a fine of £5 each day, I shall fine them 2s. 6d. for each day." I think that that exonerates us, and especially our officials, from any blame for the interruptions of supply which occurred; and we regard this judgement as all the more satisfactory, in that it was the result of an independent and unbiassed inquiry after the whole of the facts had been laid before the judge. I need hardly say that it was with extreme regret that we were forced to withhold the supply of current from a limited number of our customers during hours of greatest demand. I feel sure that you will endorse the action of the board in their having considered it right to meet those of the company's customers who were thus affected in what we regard as a fair and reasonable manner. Since Dec. 15, when current was first supplied from Willesden, our supply has, with but few temporary exceptions, worked satisfactorily, and we have now ample reserves of power to meet all demands. I now move the adoption of the report and accounts, and the payment of the dividends therein set out.

Sir JAMES PENDER, Bart, M.P., seconded the motion which was carried unanimously.

On the motion of Mr. Frank Bailey, Mr. W. Harrison Cripps, and Mr. F. Leverton Harris, the retiring directors, were re-elected; as were also the retiring auditors, Messrs. Deloitte, Dever, Griffiths and Co.

Mr. GIBSON proposed a cordial vote of thanks to the chairman, directors, and staff, for their management of the company's affairs in the past year, which had been one of much trouble.

The motion was carried unanimously.

The CHAIRMAN responded, and the meeting terminated.

South London Electric Supply Corporation (Ltd.).

The ordinary general meeting of this company was held yesterday, at Winchester House, Old Broad-street, E.C., Mr. GEORGE ELLIS, J.P. (chairman of the board) presiding.

The SECRETARY (Mr. Sydney H. Webster) read the notice convening the meeting.

The CHAIRMAN said: Gentlemen, in addressing you to-day I am pleased to report that the generating station and works were practically completed on Nov. 28 last, as on that day we were enabled to energise (in their entirety) the whole network of mains from our own machinery. It will be a matter of interest to you to know that, with the exception of the delay in acquiring the land at the outset, the central station has been erected and the machinery placed in position, and put to work within six months of the time originally estimated—a result most satisfactory having regard to the magnitude of the work and to the congested state of the engineering trade in this country. Some idea of the size of the undertaking may be realised when I tell you that it has been designed and is now ready to supply electric current over a district approaching 4,000 acres, and we think it a matter of congratulation that we have been able to get to work within such a short period of our original forecast. Up to date we have not been able to use the dust destructor for the purpose of raising steam, although we have for some weeks past been burning about 50 tons of ashbin refuse per day. The reason for this is that the contractors have not been satisfied that the massive firebrick furnaces are sufficiently dry for it to be safe to raise the temperature to the high degree necessary for producing steam. This prohibition will doubtless be withdrawn in a few days, when we trust that the daily consumption of coal will be largely reduced, and that we shall obtain all the hoped-for advantages from the destruction of refuse. We are arranging with the Lambeth Vestry to supply us on and after March 25 with 100 tons daily at the agreed upon price of 11½d. per ton. The generating machinery consists of four steam alternators capable of developing at this moment over 2,600 H.P., while the fifth machine in course of construction will give a further output of 1,400 H.P., making a total of 4,200 H.P.—ample for any requirements we may have for some time to come. The mains consist of a network extending pretty well over the whole area of supply, and one of the most hopeful features of our business is that we are obtaining consumers from all parts of the parish, and not from one or two prosperous centres only. [The position of consumers' premises was shown diagrammatically by means of a map on the wall.] Although at this period many shareholders may consider the revenue small in comparison with the capital outlay, it must be remembered that the company was formed to erect as speedily as possible an electric light station for Lambeth, and to equip it right away with machinery and plant powerful enough to develop energy for the requirements of the vast area I have alluded to. These are the conditions under which this company was formed. It was not contemplated to erect a station piecemeal and lay down machinery as required. The experience of those companies who have so proceeded has been that they have always found themselves in great difficulties as their business expanded, owing to want of plant and insufficient room in which to erect more. The conditions of our existence safeguard us against this great mistake, for, as I said, we have adequate plant to meet all requirements, so far as they can be seen for some time. I venture to say that no other station in the kingdom has succeeded in obtaining so heavy a load (over 25,000 lamps) previous to the date of its first running its own machinery. Every possible effort is being made to obtain business, and I am pleased to say steady progress is being made. We hope soon to be able to reduce the price to below 6d. per unit, provided a provisional order is obtained for that portion of the parish outside our present order. This additional area would enable us to increase our output so as to justify us in reducing our charges.

In response to the invitation which I issued verbally to the shareholders at the last meeting, our secretary tells me that very few visited the station at Bengeworth-road, Loughborough Junction; but this does not prevent me from again urging upon you to go yourselves and look at the property you have there, and I am sure you will consider the money which you have entrusted to us for investment has been well spent. Of course a great deal of the capital is represented by assets not visible, having been spent upon underground mains, but I think you will find the visible assets worthy your examination. I now have much pleasure in moving the adoption of the report and accounts.

Mr. J. B. ATHERTON seconded the motion.

Mr. A. BOLTON inquired whether the item of £61,820 in the capital account represented the total cost of the destructor, including its erection, or whether other things were comprised in it.

The CHAIRMAN: It is a lump sum. The contractor contracted for the whole of the work for this sum, except the boilers.

Mr. BOLTON remarked that he looked on the item in question as one requiring to be watched very carefully. He was afraid it would be a losing figure otherwise. Was it proposed to keep any accounts showing the current consumed and the cost of labour attending the destructor, so that they might see how the thing worked out? Surely the destructor was a separate item in the tender?

The CHAIRMAN: No, it was not.

Mr. BOLTON remarked that that was extraordinary.

The motion was agreed to unanimously.

Mr. ALGERNON TURNOR, C.B., proposed the re-election of Mr. Bennett Fitch. He said Mr. Fitch was a director of the St. James' and Pall Mall Co., one of the most successful companies in London. He was

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also a civil engineer of 30 years' standing, and had brought to the discharge of his duties as a director zeal, which should commend him to the shareholders.

Mr. SAMSON seconded the motion.

Mr. J. B. ATHERTON said that the remarks made with regard to Mr. Fitch were perfectly true, but some of the very large shareholders in the company felt they should have more representation on the board, and this would be to the advantage of the shareholders generally. Any opposition to Mr. Fitch was not of a personal character. He concluded by moving the election of Mr. F. G. Leslie, of Liverpool, as a director.

Mr. PEARSON seconded this amendment. He thought that at the end of three years more headway should have been made by the company. He had felt for the last 12 months that something should be done to infuse new blood into the concern.

Mr. FITCH said he was sorry the opposition had occurred to his election, but in the first instance it had been directed both against Capt. Ironside Bax and himself when they came up for re-election. Mr. Bax had received a letter from Mr. Atherton pointing out that after the company had been floated for three years its shares were 20 per cent. below par. Mr. Atherton was a large shareholder, and the decline in the value of the company's shares was of course a serious matter from his point of view; but it was impossible for the company to pay a dividend before the works were finished. As these works had only been completed three months, he thought the company had done remarkably well in getting 25,000 lamps ordered in the time that had since elapsed. His re-election was, however, a question for the shareholders.

The amendment was then put, and the chairman announced that 15 voted for and 20 against. A poll was demanded by Mr. Atherton.

Capt. E. IRONSIDE BAX was then re-elected a director, and said that while he did not wish the shareholders to look upon their district as one of the finest electrical areas in London, he still thought that it was a good district.

Mr. J. B. ATHERTON suggested that an additional director should be elected. He proposed Mr. Jacob Atherton.

This was seconded, and on being put to the meeting was lost by one—17 to 18. A poll was demanded by Mr. Atherton.

The auditors having been reappointed, the CHAIRMAN said he proposed to take the poll that had been demanded, and at its conclusion he announced the result as follows: For Mr. Fitch 11,034, Mr. Leslie 22,874. For the election of an additional director in the person of Mr. Jacob Atherton 23,924, against 130.

Mr. Leslie and Mr. Jacob Atherton were thereupon declared duly elected, and the proceedings terminated.

Brompton and Kensington Electricity Supply Co. (Ltd.).

A meeting of this company was held yesterday under the presidency of Mr. HENRY RAMIÉ BEETON.

The SECRETARY (Mr. Thomas J. Owens) read the notice convening meeting, and the report of the directors was taken as read.

The CHAIRMAN said: In moving the adoption of the report and accounts there are one or two observations which I should like to make. The revenue account for the year, beyond showing more satisfactory progress than previously, I do not think calls for any special notice. I may, however, point out that there is a slight reduction in the works costs and in the total costs, notwithstanding the rise in the price of fuel. The fuel bill this year is rather over 10 per cent. more than it was last year. Another rather interesting feature in connection with the business this year is that both the number of lamps and the consumption of current have been larger than in any previous year, although the rate of increase in the number of customers was larger in 1898—a circumstance which testifies, in common with the experience of other companies, that the appetite for the electric light is growing. Turning to the capital account, you will notice that the expenditure has been the largest in any year in the history of the business with the exception of the first year. A large expenditure, of course, has been incurred in connection with the renewal of machinery and mains, which have been rendered obsolete partly by wear and tear and partly by antiquation. The policy of adopting up-to-date plant, which has been foreshadowed in the reports and at our meetings for the past two years, may be said to have culminated in 1899. At the close of last year plant representing an original cost of £25,000 had been removed from the station, £7,000 on account of exhaustion, and £18,000 on account of antiquation; and when further plant representing a cost of about £3,000 has been dealt with in the current year, so far as we can see at present the renovation of our station will be complete. In order to provide the net cost of the plant which has been removed, the directors propose, after calling upon the revenue account for a contribution of £4,500 for wear and tear, to appropriate £2,500 out of profits and £7,000 from depreciation account, which leaves a balance of £14,202 to be dealt with in the future, when the profits will of course benefit from the operation. You will notice that, when the rate of increase in our net revenue is compared with the rate of progress in our capital expenditure, we ought not to have any difficulty in dealing with that balance in the future; and indeed we may reasonably look forward, I think, to an increased dividend. There is one other item in the report to notice—that relating to the change in the name of the company. The change was considered desirable, in order that the name of the company should convey its business more accurately than it did previously, and that it should be in some way associated with the area of supply, which it was not before. Another point in the report relates to the abolition of the managing directorship, which has been discharged for so many years by Mr. Page with great relief to his co-directors and great advantage to the company. The fact of the matter is that our station now—the building—is complete; there is no further extension of the works; the plant is definitely decided by experience, and the type of plant is so standardised that the directors do not feel that it calls for quite the same measure of supervision on their part that it did; but we have made arrangements whereby we shall still keep in touch with the works, and indeed the rest of the directors will perhaps see more of the work than they have done hitherto. I do not know that there is any other point that I have to refer to on the face of the accounts, but I shall be very glad to answer any questions. I now move "That the report and accounts for the year ended 31st Dec., 1899, be approved and adopted, and that the following dividends be declared: (*a*) on the preference shares a dividend of 7 per cent. per annum for the half-year to Dec. 31, making 7 per cent. for the year; and (*b*) on the ordinary shares a dividend at the rate of 7 per cent. per annum for the half-year to Dec. 31, making, with the interim dividend of 5 per cent. already paid, 6 per cent. for the year."

Mr. WILLIAM F. LEESE seconded the motion, which was at once unanimously adopted.

The re-election of the retiring directors (Mr. Beeton and Mr. William Page) was unanimously approved, and the auditors (Messrs. Miall, Wilkins, Randall and Co.) were re-elected.

A vote of thanks to the chairman, directors, and staff terminated the proceedings.

MEMORANDA.—Bank rate 4 per cent. (since Jan. 25, 1900). Price of silver 27 9/16d. per oz. (Mar. 15). Consols (2¾ per cent.) 101—101¼ for money, 101¼—101½ for account; 2½ per cent. 98¼—98½ (Mar. 15). Stock Exchange Settling Day: Consols, April 4; Stocks and Shares Continuation Days, Mar. 27 and Apl. 9; Ticket Days, Mar. 28 and Apl. 10; Pay Days, Mar. 29 and Apl. 11; Mining Share Carry-over Days, Mar. 26 and Apl. 6.

COMMERCIAL CABLE CO.—The accounts of this company for 1899 show that, after paying dividends amounting to 8 per cent., placing $150,000 to reserve for insurance of stations, apparatus, and repair steamer, and transferring $350,000 to reserve fund, there remains a balance of $228,063 to be carried forward, against $404,462 in 1898.

DAVIS AND TIMMINS (LTD.).—At a meeting of this company, held under the presidency of Sir H. C. Mance on Wednesday, the chairman was able to announce that the year's trading would allow for the payment of a dividend at the rate of 8 per cent. per annum on the ordinary shares after due payment of the preference interest.

DIRECT SPANISH TELEGRAPH CO. (LTD.)—The directors have decided to pay, in addition to the dividend at the rate of 10 per cent. per annum on the preference shares, a dividend at the rate of 4 per cent. (tax free) on the ordinary shares, for the half-year ended Dec. 31, payable on April 1.

EXPLORATION CO. (LTD.)—The directors' report states that the success of the Compagnie Générale de Traction, of Paris, foreshadowed in the last report, is now an accomplished fact, and its shares stand at a substantial premium. Considerable investments have been made in Continental electric tramways, especially in Paris companies.

GATESHEAD AND DISTRICT TRAMWAYS CO.—The directors anticipate shortly starting the work of reconstruction of the lines. The order extending the company's system awaits the formal confirmation of the Board of Trade. At the meeting on Wednesday Mr. Emile Garcke said the capital expenditure involved was estimated at £200,000. They would start work almost immediately. Some of the rails had been already delivered, and they intended to lose no time in getting electric traction into operation and the extensions completed. Although their light railway order for the outside districts had not yet received the approval of the Board of Trade, that would not hinder them proceeding with the general scheme of extension.

NEWMARKET ELECTRIC LIGHT CO. (LTD.)—The annual meeting was held on Monday. The chairman (Mr. G. H. Verrall) said the authorised capital was £30,000, and it had been decided to issue £15,000 in £10 shares and £15,000 in 5 per cent. debentures. In the nine months ended December they had made a profit of £99. 16s. 5d., or £47. 8s. 9d. less interest on debentures issued. They were now supplying current to the equivalent of over 2,000 8 c.p. lights, and had applications for nearly another 1,000. They were compelled to increase their plant to such an extent that they could double their output.

SWANSEA IMPROVEMENTS AND TRAMWAYS CO.—The directors' report states that the completion of the electrical equipment of the tramways has been delayed much beyond expectation. Most of the work, however, is now finished, and it is hoped that electric traction will be in operation very shortly. The company's application for a light railways order to extend the tramways was refused in consequence of the opposition of some of the local authorities.

WESTERN UNION TELEGRAPH CO.—The company have declared the usual quarterly dividend of 1¼ per cent. The statement for the quarter ended March 31 shows net profits $1,250,000, an increase of $20,000; balance after charges $1,016,000, an increase of $11,000. The total book surplus now amounts to $8,230,000, an increase of $374,000.

WIRELESS TELEGRAPH AND SIGNAL CO. (LTD.)—At an extraordinary meeting, held on Tuesday, on the motion of Major S. Flood Page, seconded by Mr. J. F. G. Bannatyne, the resolution passed on the 23rd ult., changing the name of the company to that of Marconi's Wireless Telegraph Co. (Ltd.), was unanimously confirmed. A resolution was also confirmed fixing the remuneration of the directors at £1,000 per annum, with the addition, in any year in which the dividend on the ordinary shares should be in excess of 7 per cent., of £500 for every extra 5 per cent. paid, but limiting the entire remuneration in any one year to £3,000.

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Oxford Electric Co. (Ltd.).

The annual meeting was recently held at Oxford. The directors' report, which appeared in our issue of 23rd ult., was adopted. Sir HENRY C. MANCE, C.I.E., who presided, said there had been a steady growth in the number of lamps connected to the mains, and the equivalent of more than 3,600 8-c.p. lamps had been added during the year. This satisfactory result was no doubt largely due to the hire-purchase system of installation, which appeared to have become popular. Considerable additions had been made to the installations at New College and Exeter College. Additions or new installations had been made at various establishments in the city, and two churches (SS. Philip and James and St. Aldates) had been connected. The Clarendon Press had also adopted the electric light during the year. The most marked increase, however, had been in the number of private residences in the north of Oxford, 40 additional consumers having been obtained in that quarter. The Radcliffe Infirmary had added to ttheir number of lights, and the Eye Hospital was now one of their customers. The increased demand for current in New College had rendered it desirable to establish an additional sub-station in the college, and a second transformer and a set of storage batteries had been installed at Ship-street sub-station. The mains had been extended in various thoroughfares. They had only issued £2,350 of debentures, so that to enable them to meet the capital expenditure some temporary assistance had been obtained from the bank: other debentures would be issued at their convenience, and when the time was more favourable than at present. They had had to pay an increased price for coal, but the coal cost per unit generated compared favourably with that of the previous year, being 0·63d., compared with 0·65d. in 1898. The efficiency of the system had also improved, being 74 per cent., or 2 per cent. higher than the year before. Maintenance charges were higher, due partly to the fact that a greater portion of the expenditure on buildings might fairly have been debited to capital. Dynamo and transformer maintenance was responsible for the greater portion of the increase: generators had required but little attention, but several of the original transformer armatures had been entirely rewound and remodelled, their efficiency and capacity being thereby increased. The sales by meter had increased nearly 13 per cent. The additional consumers numbered 83. They proposed to make a substantial reduction in the price of current, and this reduction would be retrospective, commencing with the beginning of the present quarter. The maximum price would be reduced from 7d. to 6d. per unit, but they proposed to discontinue the 2½ per cent. discount. Oxford was a somewhat exceptional city as far as regarded electric light enterprise. A great number of the consumers were absent for a considerable portion of the year, and at times when other electric light companies were earning their best revenue they occasionally found that invidious comparisons were made between the price paid for current in Oxford and other places. It was somewhat difficult to frame a scale of charges which should satisfy everyone and be fair to all classes of their customers. To provide for the half hour of maximum demand, they had to instal at a heavy cost machinery which was idle 22 hours out of 24. Indeed, such was their capacity that if they were to run continuously they could manufacture enough electricity in three weeks to supply the whole of Oxford for a year.

Brush Electrical Engineering Co. (Ltd.).

The directors' report for the half-year ended Dec. 31 states that the available gross profit amounted to £37,233. 13s. 3d. After deducting maintenance, general charges, debenture interest, and cost of issuing £75,000 perpetual second debenture stock, there remains a net profit of £19,410. 1s. 7d. The directors recommend that this sum be applied as follows: Dividend at the rate of 6 per cent. per annum on preference shares for half-year, £5,400; dividend at the rate of 6 per cent. per annum on ordinary shares for half-year, £5,400; bonus to employés under profit-sharing scheme, £1,080; depreciation, £2,500; balance forward, £5,030.1s.7d. Capital expenditure to the extent of £23,571. 3s. 11d. was incurred during the half-year on extensions of buildings and plant at Loughborough.

The works are well filled with orders for steam engines, electric lighting and traction machinery, and tramway rolling stock.

An issue of £125,000 4½ per cent. perpetual second debenture stock has been made during the half-year. Of this £75,000 was subscribed for by the public, the balance of £50,000 being reserved to enable holders of existing redeemable second debenture stock to exchange their holdings for the new stock at par. Holders of redeemable second debenture stock for £33,710 have exercised this option, and notice has been given to the holders of the remaining £16,290 that they will be paid off at £105 per cent. on July 1.

Bournemouth and Poole Electricity Supply Co. (Ltd.).

The report of the directors for the year ended Dec. 31, states that the whole of the undertaking of the Bournemouth and District Electric Supply Co., Ltd., (in voluntary liquidation), has now been vested in the company. An expenditure of £39,264. 2s. 9d. has been incurred during the year on capital account in respect of the Bournemouth provisional order, 1890. The agreement of Nov. 6, 1899, for the purchase of the interests of the County of London and Brush Provincial Co. in the Richmond (Surrey) Electric Light and Power Co. has been carried out. The balance of the authorised share capital of the company was issued to the shareholders in December, and the premium received therefrom has been carried to reserve. The balance from revenue, together with the balances from last year, amount to £8,993. 8s. 7d., from which must be deducted interest charges, depreciation, &c., leaving £6,799. 13s. 5d. to credit of net revenue. Out of this the full year's dividend on the preference shares (first issue) has been paid, and the directors now recommend the payment of a dividend on the ordinary shares (first issue) at the rate of 5 per cent. (less tax) for the year. These payments absorb £5,510, leaving £1,289. 13s. 5d. to be carried forward. The equivalent of 44,096 8 c.p. lamps were connected to the company's mains in Bournemouth at Dec. 31, an increase of 10,364 8 c.p. lamps for the year, and applications representing a further 681 8 c.p. lamps were then awaiting connection. Terms have been arranged for the supply of power for a period of years to the Poole and District Electric Traction Co. for working the tramways between Bournemouth and Poole. A provisional order for the borough of Christchurch, the urban district of Winton, and the rural district of Christchurch has been obtained. The Richmond (Surrey) Electric Light and Power Co. has declared a dividend upon its ordinary shares at the rate of 4 per cent. per annum for the year ended Dec. 31, and of the revenue received from the Richmond undertaking, £2,400 has been applied to reduction of cost of purchase in respect of interest and dividends accrued at date of purchase.

Richmond (Surrey) Electric Light and Power Co. (Ltd.).

The directors' report for the year to Dec. 31, 1899, states that the capital account shows an expenditure during the year of £8,620. 5s. 4d., chiefly upon land, machinery, and mains, making a total of £59,866. 9s. 4d. The balance to credit of net revenue account, including balance brought forward and after payment of interest charges and reserve for depreciation, is £1,522. 8s. 6d. Out of this sum the directors recommend the payment of a dividend on the ordinary shares at the rate of 4 per cent. for the year (less tax), absorbing £1,211. 8s. 6d., leaving £311 to be carried forward.

The equivalent of 14,256 8 c.p. lamps were connected to the company's mains at Dec. 31, an increase of 1,904 8 c.p. lamps for the year.

The County of London and Brush Provincial Co.'s interests in the company have been taken over by the Bournemouth and Poole Electricity Supply Co., to whom the company is now indebted for the amount of its loan account. £850 received from the County of London Co. in respect of an option over the unissued share capital of the company has been appropriated to writing off the suspense account. A substantial reduction is to be made in the price of current and in the charges for meter rentals after March 31. Mr. Aymor H. Sanderson and Mr. R. Percy Sellon have been appointed directors of the company.

Potteries Electric Traction Co. (Ltd.).

The directors' report for the period from Nov. 21, 1898, to Dec. 31. 1899, states that 20,000 ordinary and 20,000 5 per cent. cumulative preference shares of £10 each were allotted in November, 1898. The tramways of the North Staffordshire Co. (about 6½ miles) were opened for working by electricity on May 16 last, and since then various sections of the extension tramways (about 6 miles) have been opened for traffic. The construction and equipment of the extension tramways and light railways are being pushed forward. The total capital expenditure at Dec. 31 on account of construction of permanent way and electrical equipment of the Potteries extension tramways and Potteries light railways, including cost of Parliamentary powers and preliminary expenses, amounted to £275,085. 18s. 9d. The company holds £73,400 first mortgage debenture bonds, £30,100 second mortgage bonds, 1,933 preference and 11,542 ordinary shares of the North Staffordshire Tramways Co., being 96·65 per cent. of the issued preference and 96·18 per cent. of the issued ordinary shares of that company, and all the issued debentures with the exception of £20,000 first mortgage bonds. The directors propose to offer for subscription £125,000 4½ per cent. debenture stock, part of an authorised issue of £200,000.

The Potteries Co.'s gross profits amount to £20,884. 8s. 11d., including amounts received from the North Staffordshire Co. After deducting all expenses chargeable to revenue, there remains a net profit of £10,949. 16s. 3d., which the directors propose should be applied as follows: Dividend on cumulative preference shares from Aug. 15 to Dec. 31, 1899, £3,750; repayment to British Electric Traction Co. of amount advanced for dividend on cumulative preference shares to Aug. 15, 1899, and income tax thereon, £5,833. 6s. 8d.; depreciation, £500; forward to next account, £866. 9s. 7d.

Until a larger proportion of the lines is completed and opened for traffic it will not be possible to work the system with greater economy and efficiency, but the directors consider the results of the electrical working satisfactory and encouraging, having regard to the fact that during the whole period the system has been incomplete and in a state of transition. To remove complications of accounts arising out of the agreements made by the North Staffordshire Co. prior to the formation of this company, the directors have made an agreement to collect all traffic receipts, and will pay all expenses in respect of the working of the North Staffordshire tramways as from January 31 last, in consideration of the payment by this company of the debenture charges and a fixed dividend on the shares of the North Staffordshire Co. The retiring directors (Mr. Emile Garcke and Major T. E. Pilkington), being eligible, offer themselves for re-election.

Imperial Tramways Co. (Ltd.).

The report of the directors to Dec. 31 last states that the operation of the Middlesbrough, Stockton, and Thornaby electric tramways has been conducted with the greatest regularity and smoothness, and is highly appreciated by the populations of the three municipalities, the number of passengers carried in the twelve months being 8,307,322. The gross receipts were £45,372. 13s. 8d., expenditure (including provision for depreciation and renewals) £30,761. 2s. 3d., leaving a net profit of £14,611. 11s. 5d., representing 6¾ per cent. upon the capital employed.

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The light railway extensions proposed at Middlesbrough were favourably entertained by the Commissioners, but owing to the difficulty in making arrangements with the owners of three toll-gates and with reference to railway crossings on the route, the progress of the order remains in abeyance.

The working of the Darlington tramways has resulted in a net profit for the year of £1,009. 12s. 8d. The Light Railway Commissioners have decided to grant the order for the proposed system of electric light railways to take the place of the existing horse line. Details of the scheme remain to be agreed with the Corporation before the order can be issued, and negotiations are still in progress.

During the year the Imperial Co.'s interest in the London United tramways has been increased by a further 15,000 6 per cent. preference shares, the capital for the purpose being provided by the issue of additional Imperial debenture stock.

The Reading Corporation have given notice of intention to acquire the Reading Tramways Co.'s undertaking under the Tramways Act, 1870, but the company dispute the legality of the proceeding.

The Imperial Co. have an available balance of £30,251. 2s. 1d., and after payment of interest on debenture stock and interim dividends on the preference and ordinary shares in respect of the half-year to June 30 last (amounting to £18,375), it is proposed to appropriate the balance as follows: In payment of dividend at 6 per cent. per annum on the preference capital (£3,000), final dividend at 8½ per cent. per annum on the ordinary capital (£8,500), and to carry forward £376. 2s. 1d.

London United Tramways (Ltd.).

The report of the directors for the year to Dec. 31, 1899, deals with the subject of the conversion of the lines to electric traction. Satisfactory progress has been made with the conversion and the extension of the tramways. The erection of the power station has been undertaken by the company without the intervention of a contractor, and contracts are in a forward state of execution for the steam and electrical equipment of the station and for 150 electric cars, the first instalment of the new rolling stock. The directors anticipate that the first portion, covering about 10 miles of tramways, will be operated by electric traction during the ensuing summer. The company's application for light railway extensions intended to bring the districts of Twickenham, Teddington, Hampton, and Hampton Wick into connection with the authorised electric system came before the Commissioners in June last. The proposals were supported by the whole of the local authorities, but opposed by the London and South Western Railway Co. on the ground of competition, so that, while expressing themselves favourably towards the scheme, the Commissioners had no alternative, in view of the protection afforded the railway company by the Light Railways Act, but to decide that the scheme must be submitted to Parliament. Accordingly, a Tramway Bill is being promoted in the present session to authorise the Hampton Court extensions, and agreements have again been concluded with all the local authorities concerned except the Teddington Council. Powers are also sought for the authorisation of the connecting line between the existing tramway at Acton and the authorised lines at Hanwell, and agreements have been come to with the Ealing Council, as well as those of Acton and Hanwell, who supported the company's application on the former occasion.

Barcelona Tramways Co. (Ltd.).

The report of the directors for the year ended Dec. 31, 1899, states that the traffic receipts for the twelve months were £88,233. 16s. 6d., and after adding sundry receipts £997. 15s. 7d., the total amounted to £89,231. 12s. 1d. Revenue charges came to £84,099. 9s. 8d., leaving a balance profit of £5,132. 2s. 5d., which, with the balance of £79. 12s. 4d. from 1898, totalled £5,211, 14s. 9d. The number of passengers carried was 21,736,264, compared with 14,801,528 in 1898. The traffic receipts were £40,801. 16s. from animal traction and £47,432. 0s. 6d. from electric traction (part of year only), making a total of £88,233. 16s. 6d., an increase of £26,438. 1s. 5d. compared with 1898. The working expenses in Spain and in England (including loss of £7,350. 7s. 7d. on exchange, but excluding debenture and preference share charges and interest) amount to £66,018. 9s. 5d., against £55,886. 16s. 11d.; other expenses bring the total to £71,431. 9s. 5d. The balance at credit of net revenue, including £79. 12s. 4d. from previous year, is £5,211. 14s. 9d., and the directors propose to apply £4,000 in payment of dividend at rate of 2 per cent (4s. per share) for 1899, carrying forward £1,211. 14s. 9d. To cover cost of conversion to electric traction, and to provide additional electric motor cars, the balance of preference shares (£70,000) and £48,100 of the 4½ per cent. debenture stock, were issued last year. Electric working commenced on Jan. 26, 1899, with five cars. The number of cars was increased during February to 10, and then gradually up to 73 in November, the number now running. In addition to the 85 motor cars originally estimated as sufficient, 40 more are expected to be running within the next few weeks. Mule traction will then entirely cease. Permission to adopt electric traction on the Ensanche Co.'s system will, it is hoped, be soon obtained.

EASTBOURNE ELECTRIC LIGHT CO. (LTD.)—The final ordinary general meeting of this company was held on Monday. The report, which appeared in our last issue, was adopted. The chairman (Mr. G. Boulton) congratulated the shareholders on the excellent result of last year's working. Mr. Langham referred to the origin and history of the company. He had only been in the town a year and a half when he took up the electric light question. He obtained a concession for Eastbourne and Hastings, and, in conjunction with Ald. Sutton, Mr. Boulton, and others, made a start. They had to encounter many difficulties. The lighting of the Parade was got through with especial difficulty, for the decision really rested with a few members of the local authority, most of the councillors being interested in the gas company, while he himself was the holder of the concession. However, it was accomplished, and the company had gradually been relieved of its difficulties, and had attained success. The remuneration of the directors for the past year was fixed at £300, and Mr. Hollins moved that the company pay £1,000 as compensation to the manager and secretary (Mr. Towner), in addition to the £2,000 paid by the Corporation, and £2,000 to the engineer (Mr. Wilkinson); and Mr. Hollins warmly eulogised the services of both officers, who had largely contributed to the success of the company. The motion was agreed to. It was then decided to give £1,000 to the directors in recognition of their services. The sum of £150 was also granted to the employés in gratuities.

An extraordinary meeting was then held, when the chairman formally proposed "That the company be wound up voluntarily." Mr. Langham seconded, and the motion was carried. Mr. H. Towner was appointed liquidator, and the confirmatory meeting was fixed for March 26.

DOVER ELECTRIC SUPPLY CO. (LTD.)—The directors' report for the year to Dec. 31 states that the results, in view of the increased cost of coal and other materials, may be regarded as satisfactory. Exceptional attention has been paid to the efficient upkeep of the plant and buildings, which accounts for the increase in those items of expenditure, besides which £500 has been placed to depreciation. During the year applications have been received for an equivalent of 2,552 8 c.p. lamps, against 2,407 in 1898, and the total output of the station has increased by 20 per cent. over the previous year. The directors have decided to offer consumers the choice of a fixed rate of charge for current for lighting at 6d. per unit, or, at the consumers' option, the existing sliding scale system of charge; and to supply current for heating and power at 2½d. per unit. These modified rates are resulting in a satisfactory increase of connections, and the use of electricity for heat and power is extending. The gross profit for the year is £2,739. 9s. 4d. After paying debenture and other interest there remains £1,325. 13s. 11d., and the directors recommend payment of a dividend at the rate of 3 per cent., absorbing £1,313. 11s. 8d., the balance being carried to credit of suspense account. The steadily increasing business of the company necessitates the issue of further capital in the near future.

MERSEY RAILWAY CO.—At a special meeting of this company last Friday resolutions authorising the working of the railway and the lines connected with it by electricity, and authorising the company to work the traffic on their railways by electrical or other mechanical motive power, were passed. The chairman (Mr. James Falconer) said he felt that for the first time they were taking practical steps towards giving the company a chance of establishing their fortunes. In seeking powers to work the line by electricity they aimed at providing a practically continuous service at intervals of 2½ to 3 minutes and of shortening the time at present occupied in making the journey from one side of the Mersey to the other. Moreover, they would get rid of the polluted atmosphere of the tunnel due to steam locomotion, and it was believed that as the result the traffic would be largely increased. The board were advised that under the proposed new system there would be a substantial saving in working expenses. Local opinion in favour of the scheme was very strong. The Wirral Co. had also applied to Parliament for powers to work their undertaking electrically. Their relations with that company had been most friendly, and the proposal was to construct a joint generating station. If it should afterwards be found impossible to come to terms with the Wirral Co., they would have to provide a separate electrical system for themselves. In that case it was estimated that about £428,000 would be required, allowing for contingencies and the payment of interest out of capital during five years. About £500,000 would be the outlay in the event of the joint arrangement being carried out.

NEW COMPANIES, STATUTORY RETURNS, &c.

ADAMS ELECTRICAL GENERATOR CO. (LTD.)—This company was registered on March 6, with a capital of £5,000 in £1 shares, to acquire and develop the invention of G. L. Adams for an improved apparatus for generating electrical pressure. The subscribers are G. L. Adams (electrical engineer), W. S. Jerome, P. B. Pearce, J. B. Reiner, H. Vroom, jun. (civil engineer), R. Pastorelli, and H. H. Howard. The first directors are G. L. Adams, W. S. Jerome, H. H. Howard, R. Pastorelli, and P. B. Pearce.

HANDS LTD.—This company was registered on March 8, with a capital of £50,000 in £1 shares (10,000 preference), to acquire the businesses of Mr. Albert C. Hands, Messrs. W. T. Burbey and Co., and Mr. Harold Davis, and to carry on the business of art metal workers, electrical and mechanical engineers, electricians, tool makers, makers of electric, magnetic, and other appliances, &c. The subscribers are B. H. Jenkinson (electrical engineer), W. J. Wallis, E. F. Goodrich, H. Challoner, H. C. Channing, A. E. Higgins, and G. Hands. The first directors are Albert C. Hands, William T. Burbey, Harold Davis, George Hands, B. H. Jenkinson, and one other to be appointed by the Law Guarantee and Trust Society (Ltd.).

INGRAM AND KEMP (LTD.)—This company has been registered, with a capital of £30,000 in £1 shares, to acquire the business carried on under the style of Ingram and Kemp, and to carry on the business of chandelier, bracket, electrical and other fittings manufacturers, stamped and pressed work manufacturers, metal founders and general art metal workers. Mr. Clifford W. Kemp is sole director, and may retain office for life.

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KLONDYKE CORPORATION (LTD.)—This company was registered on March 6, with a capital of £200,000 in £1 shares, to carry on in the Klondyke district the business of railway, tramway, and general engineers, electricians, miners, &c.

TRAMWAYS AND LIGHT RAILWAYS ESTATES CO. (LTD.)—This company was registered on Feb. 28, with a capital of £100,000 in £10 shares, to carry on the business of owners of and dealers with land, buildings, wharves, docks, &c. The subscribers are E. Garcke, S. Morse, G. Stevens, T. Vickers, C. H. Dade, E. Hopwood, and G. J. Somerville.

HEADLAND'S PATENT ELECTRIC STORAGE BATTERY CO. (LTD.)—The annual return to Jan. 11 gives the capital as £20,000 in £1 shares, all of which have been taken up, 14,993 shares are considered as fully paid, and £1 has been called upon each of 5,007.

CITY NOTES.

BUENOS AYRES ELECTRIC TRAMWAYS CO. (LTD.)—During the week this company invited applications for 35,000 £5 six per cent. cumulative preference shares and £175,000 five per cent. first mortgage debentures.

BRITISH INSULATED WIRE CO. (LTD.)—Letters of allotment and regret for the new issue of capital, which was largely over-subscribed, have been posted.

COUNTY OF LONDON AND BRUSH PROVINCIAL ELECTRIC LIGHTING CO. (LTD.)—The directors recommend the payment of a dividend on the ordinary shares for the year ended Dec. 31, 1899, at the rate of 4 per cent. per annum, after placing £10,500 to reserve for depreciation, repairs and renewals, and carrying forward about £12,000.

SCARBOROUGH ELECTRIC LIGHTING CO. (LTD.).—The resolution recently passed increasing the capital to £100,000 by the creation of 5,000 new shares of £10 each has been confirmed.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee has appointed 21st inst. a special settling day in £108,710 4½ per cent. perpetual second debenture stock of the *Brush Electrical Engineering Co. (Ltd.)* and 20,000 6 per cent. £5 (£4 paid) cumulative preference shares (Nos. 1 to 20,000) of the *Electric Lighting and Traction Co. of Austria (Ltd.)*, and has ordered the first-named stock to be quoted in the official list. The committee has also been asked to allow the further issue of 18,000 4½ per cent. £5 preference shares of *W. T. Henley's Telegraph Works Co. (Ltd.)* to be quoted in the official list.

TELEGRAPH MANUFACTURING CO. (LTD.)—The transfer books of the preference shares of this company will be closed from 17th to 31st inst. inclusive, preparatory to payment of dividend for the half-year ending 31st inst.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	1900	£	£		£	£
*Birmingham Tramways.	Mar. 10	4,104	+ 329	10	39,328	+ 1,782
Blackpool Corporation...	„ 8	162	+ 24	49	22,046	+ 4,427
Blackpool and Fleetwood	„ 12	182	− 30	10	1,472	− 204
Bradford Corporation...	„ 11	391	+ 93	82	27,409	...
Brisbane Trams	Jan. 24	1,744	+ 525	17	36,063	+10,892
*Bristol Trams & Carriage	Mar. 9	2,568	+ 110	10	25,874	+ 1,076
*Buenos Ayres & Belgrano	Feb. 11	2,365	+ 821	6	14,156	+ 4,312
City & South London Ry.	Mar. 11	1,303	+ 231	10	11,775	+ 632
Dover Corporation	„ 10	141	+ 6	49	9,650	+ 1,022
Dublin United	„ 9	2,831	+ 275	11	27,950	} +2410
Dublin Southern Dist....	„ 9	644	+ 19	10	5,773	}
*Glasgow Corporation ...	„ 12	8,360	+ 143	...	...	...
*Liverpool Corporation...	„ 3	7,027	+1,330	9	59,125	+ 7,310
Liverpool Overhead Rly.	„ 11	1,369	+ 5	10	14,301	+ 1,319
*Sheffield Tramways	„ 11	1,891	+ 657	10	18,045	+ 5,669
*South Staffs. Trams.....	„ 9	645	+ 57	10	5,956	+ 22

* Partly electrical.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	NAME.	Previous Week's Price, March 7.		Price Wednesday, March 14.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending March 14. Highest	Lowest
			TELEGRAPHS.					£ s. d.			
£110,900	100	4%	*African Direct Telegraph 4% Mort. Deb. (red.)	99	103	99	103	3 17 8	January and July.....	...	...
25,000	10	...	Amazon Telegraph.....	3	4	3	4	...	June and December ...	...	...
£125,000	100	5%	Do. 5 per Cent. Debentures	85	90	85	90	5 11 1	...	...	...
£875,520	Stock	28/6	Anglo-American	63	66	63	66	5 11 5	Feb., May, Aug., Nov.	64½	63
£3,062,240	Stock	30/0	Do. Preferred	114½	115½	115	116	5 3 5	„ „	116	115
£3,062,240	Stock	27/0	Do. Deferred	14¼	14⅜	14	14½	9 6 3	...	14 5/16	14⅛
$10,000,000	$100	$2½	Commercial Cable Capital Stock	165	175	165	175	4 12 1	Jan., Apr., July, Oct.	...	...
£1,563,078	Stock	4%	* Do. 4 per Cent. Debenture Stock	103	105	103	105	3 16 8	„ „	104⅜	103½
16,000	10	8/0	Cuba Submarine Ordinary	9	10	9	10	8 0 0	February and August	9⅛	...
6,000	10	10/0	Do. Preference 10 per Cent.	19	20	19	20	5 0 0	„ „	19⅜	...
12,931	5	2/0	Direct Spanish Ordinary.....	4	5	4	5	4 0 0	April and October.....	...	...
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference	9	10	9	10	5 0 0	„ „	9⅞	...
£30,000	50	4½%	Do. 4½ per Cent. Debentures	101⅝	105⅝	101⅝	105⅝	4 5 9	January and July.....	...	...
60,710	20	3/0	Direct United States Cable	11⅛	12	11⅛	12	5 16 8	Jan., Apr., July, Oct.	11 1/16	...
£120,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red.)	99	102	99	102	4 8 3	June and December ...	...	...
£4,000,000	Stock	5%	Eastern Ordinary	155	160	155	160	4 7 6	Jan., Apr., July, Oct.	157½	155
£1,795,000	Stock	3½%	Do. 3½ per Cent. Preference Stock	98	101	98	101	3 9 3	„ „	100¾	99
£1,432,268	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.)	116	121	116	121	3 6 8	May and November ...	...	...
250,000	10	2/6	Eastern Extension	15⅝	16⅛	16	16⅛	4 4 10	Jan., Apr., July, Oct.	16⅛	15 7/8
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	115	120	115	120	3 6 8	February and August	116	...
£6,700	100	5%	* Do. 5% (Austln. Gov. Sub.) Deb.,1900 (reg.) ...	100	103	100	103	4 17 1	January and July.....	...	...
£26,600	100	5%	Do. (Bearer)	100	103	100	103	4 17 1	„ „	100½	...
£300,000	100	4%	*Eastern and S. African 4% Mort. Deb., 1909.....	100	103	100	103	3 18 5	February and August	...	...
£200,000	25	4%	Do. 4 per Cent. Mauritius Sub. Debs.(red.) ...	101⅝	104⅝	101⅝	104⅝	3 16 10	May and November ...	...	...
180,227	10	1/9	Globe Telegraph and Trust	11½	12	11⅞	12	4 7 6	Jan., Apr., July, Oct.	11 3/16	11⅜
180,042	10	3/0	Do. 6 per Cent. Preference	15½	16	15½	16	3 15 0	„ „	15⅝	15⅝
150,000	10	5/0	Great Northern of Copenhagen	31	33	31	33	3 15 9	January and July.....	32⅛	...
£86,300	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb.(red.) ...	99	102	99	102	4 8 3	...	...	...
17,000	25	12/6	Indo-European.....	50	54	50	54	4 12 7	May and November ...	53½	52
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904 ...	104	107	104	107	5 12 2	March and September	...	...
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.)	101	104	101	104	3 16 11	June and December ...	...	...
11,839	8	4/0	Reuter's.....	7	8	7	8	5 0 0	April and October.....	7¼	...
3,381	£100 Cert.	6%	Submarine Cables Trust	126	131	126	131	4 13 5	„ „	127	126½
15,609	10	...	West African Telegraph	2½	3½	2½	3½	4 9 3	December and July ...	...	...
£200,000	100	5%	* Do. 5 per Cent. Debentures (red.)	96	99	96	99	5 1 0	March and September	...	...
30,008	2½	...	West Coast of America.....	½	1	½	1	...	...	...	...
£150,000	100	4%	* Do. 4 per Cent. Debentures	100	103	100	103	3 17 8	January and July.....	...	...
88,321	10	6d.	West India and Panama	⅞	1⅛	⅞	1⅛	...	May and November ...	1⅛	1 1/16
34,563	10	6/0	Do. 6 per Cent. 1st Preference	9¼	9½	9¼	9½	6 3 1	„ „	...	...
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	7	8	7	8	7 10 0	„ „	...	...
£80,000	100	5%	* Do. 5 per Cent. Debentures	104	107	104	107	4 13 6	January and July.....	...	...
£389,731	Stock	4%	Western & Brazilian 4 per Cent. Debenture Stock ...	100	104	100	104	3 16 11	June and December ...	...	...
207,930	10	3/0	Western Telegraph (late Brazilian Submarine)	14⅜	15¼	14¼	15¼	4 11 10	Mar., June, Oct., Dec.	15 3/16	14 7/8
£275,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1900)	106	109	106	109	4 11 9	June and December ...	...	...
£158,100	100	6%	*Western Union 6 per Cent. Sterling Bonds (red.) ...	97	102	...		5 17 8	March and September	...	...
			TELEPHONES.								
44,000	£5	3/0	Chili Telephone (fully paid)	2	3	2	3	6 13 4	August	...	...
224,850	10s.	0/1½	Consolidated Telephone Const. & Manufacturing ...	⅛	¼	⅛	¼	4 15 3	July	...	...
72,680	1	2½%	Monte Video Telephone Ordinary	¾	⅞	¾	⅞	5 0 0	November	...	...
86,492	1	1/0	Do. 5 per Cent. Preference	¾	1	¾	1	5 0 0	„	...	...
490,000	5	3/0	National	5	5¼	5	5¼	5 14 3	February and August	5 3/16	5 1/16
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Preference ...	14	15	14	15	4 0 0	„ „	...	...
15,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference ...	14	15	14	15	4 0 0	„ „	...	...
250,000	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref. ...	5⅛	5⅜	5¼	5½	4 10 11	„ „	5⅜	...
2,000,000	Stock	3½%	* Do. Debenture Stock 3½ per Cent. (red.)	97	100	77	100	3 10 0	June and December ...	98⅜	97
171,504	1	0/4	Oriental	¾	1	¾	1	5 0 0	April and October.....	1/16	1/16
58,000	5	2/6	United River Plate	4¾	5⅛	4¾	5⅛	7 2 10	July	5 1/16	4 13/16
16,639	5	1/4	Do. 5% Cumulative Preference	4¾	5¼	4¾	5¼	4 15 3	June and December ...	...	...
£179,947	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	103	106	103	106	4 14 4	„ „	100	...

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, March 7.	Price Wednesday, March 14.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending March 14. Highest	Lowest
			ELECTRICITY SUPPLY COMPANIES.			£ s. d.			
100,000	1	...	Bl'ckh'th & Gr'nw'ch D'st'ct Elec.Lt.Ord.(fully pd.)	⅞ ⅞	⅞ ⅞	...	...	...	...
6,000	10	7/9⅜	Bournemouth and Poole Elec. Supply Ord.	12 13	12 13	3 0 0	...	...	...
6,000	10	4/6	Do. 4½ per Cent. Cumulative Pref.	10 11	10 11	4 1 10	...	...	...
19,661	5	2/6	Brompton & Kensington Electricity Supply Ord.	7 8	7 8	3 15 0	...	7⅞	...
12,000	5	3/6	Do. 7 per Cent. Preference	8½ 9½	8½ 9½	3 13 8	March and September	...	...
20,000	5	...	Calcutta Elec. Supply Ordinary (fully paid)	6½ 7½	6¾ 7¾	...	...	...	...
30,000	5	5/0	Charing Cross & Strand Electricity Supply Corp.xd	9½ 10⅜	10	4 10 0	February and August	...	...
20,000	5	4/8	Do. (Nos. 30,000 to 50,000) xd	9 10	9 10	...	...	...	...
20,000	5	2/3	Do. 4½ per Cent. Preference	5½ 6	5½ 6	3 15 0	,, ,,	...	...
34,000	5	2/6	Chelsea Electricity Supply Ordinary xd	7 8	7 8	3 15 0	March	7⅜	...
£150,000	Stock	4½%	* Do. 4½ per Cent. Debenture Stock (red.)	110 112	110 112	4 0 11	June and December...	...	...
$1,200,000	$1,000	5%	Chicago Edison 1st Mort.5% 30 year Gold Bonds(red.)	100 110	100 110 xd	4 10 11	April and October	...	...
60,000	10	7/0	City of London Electric Lighting Ordinary	9½ 10½	9½ 10½	3 6 8	February and August	10	9½
40,000	10	6%	Do. 6 per Cent. Cumulative Preference	13 14	13 14	4 5 9	January and July	13⅜	13⅛
£400,000	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	122 127	122 127	3 18 9	June and December ...	...	...
40,000	10	...	County of London and Brush Prov. Ordinary	9½ 10⅛	9½ 10⅛	...	...	10⅛	10
20,000	10	6/0	Do. 6 per Cent. Cumulative Preference	12⅝ 13⅝	12⅝ 13⅝	4 8 11	March and September	13⅝	13⅜
£200,000	Stock	4½%	Do. 4½% Deb. Stock Certs.(all pd.) (red.)	109 112	109 112	4 0 11	...	110	107
15,000	5	10%	Kensington and Knightsbridge Ordinary	12 13	12½ 13½	4 1 6	...	...	...
10,000	5	6%	Do. 6 per Cent. 1st Preference	7 7½	7 7½	4 0 0	January and July	...	...
110,000	3	...	London Electric Supply Ordinary	1⅝ 2⅛	1⅝ 2⅛	...	...	1 1/16	...
48,050	5	3/0	Do. 6 per Cent. Preference	4½ 5	4½ 5	6 0 0	...	...	...
£250,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures	101 103	100 102	3 19 3	Mar., June, Sept., Dec.	...	...
85,000	10	5/0	Metropolitan Elec. Supply Ord. xd	14 15	13½ 14½	3 9 0	April and October	13½	13½
£220,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage	114 117	114 117	3 16 11	June and December ...	...	...
£125,000	Stock	24/8	Do. 3½ per Cent. Mort. Deb. Stock (red.)	95 97	95 97	3 12 2	...	...	...
6,452	10	8/0	Notting Hill Electric Ordinary xd	16 17	15½ 16½	4 4 10	March	...	...
10,000	5	5/0	Oxford Electric Ordinary xd	6¾ 7½	6¾ 7	3 11 5	,,	...	...
300,000	1	8%	Rand Electric	⅞ ⅞	⅞ ⅞	10 13 4	...	...	...
£130,070	Stock	5%	River Plate El.Lt. & Tr'ct'n, Ltd., 5% 1st Mor.Deb.	75 85	75 85	5 18 0	...	...	...
150,000	$100	$2	Royal Electric Company of Montreal Shares	150 170	150 170	4 14 2	...	...	...
£123,200	100	4½%	* Do. 4½ per Cent. 1st Mortgage Debentures	104 106	104 106	4 5 6	April and October	...	...
40,000	5	9/6	St. James's and Pall Mall Electric Ordinary	14½ 15½	14½ 15½	4 13 7	February and August	14⅝	14⅜
20,000	5	3/6	Do. 7 per Cent. Preference	8⅝ 9⅝	8½ 9½	3 13 8	,, ,,	8⅝	...
65,000	5	...	South London Electric Supply Ordinary (fully paid)	3½ 4¼	3½ 4¼	...	...	...	...
79,900	5	8/0	Westminster Electric Supply Ordinary	13½ 14½	13½ 14½	4 9 8	March and September	14	...
			ELECTRIC MANUFACTURING, &c., COMPANIES.						
125,000	1	7½d.	Aron Electricity Meter 6 per Cent. Cum. Pref.	⅜ ⅜	11/16 13/16	7 7 8	...	...	...
45,000	1	...	British Electric Works Co. Ordinary	1 1/16	1 1/16	...	...	...	...
50,000	1	...	Do. 5 per Cent. Cumulative Preference	⅞ 1	⅞ 1	...	...	...	...
£50,000	100	4½%	Do. First Mortgage Debentures	99 101	99 101	...	...	...	...
40,000	5	15/0	British Insulated Wire Ordinary	11 12	11 12	4 3 4	...	...	...
27,500	5	3/0	Do. 6 per Cent. Preference	5⅜ 6¼	5⅜ 6¼	4 16 0	...	...	...
100,000	5	...	British Westinghouse, 6% Preference	4⅝ 5⅜	4⅝ 5⅜	...	...	5	...
90,060	2	2/0	Brush Electrical Engineering	1⅝ 2⅛	1⅝ 2⅛	4 14 1	September	1 15/16	...
90,000	2	1/2⅝	Do. 6 per Cent. Pref. Non-Cumulative	2¼ 2½	2¼ 2⅜	4 16 0	,,	2⅜	2⅛
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Deb. Stock	108 113	108 113	3 19 8	February and August	...	...
£50,000	Stock	4½%	* Do. 2nd Debenture Stock (red.)	102 105	...	4 5 9	June and December ...	...	...
20,000	5	5/0	Callender's Cable Construction Ordinary	14 15	14 15	5 0 0	,, ,,	14⅞	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5½ 6	5½ 6	4 3 4	...	5⅝	...
£90,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb. (red.)	111 115	111 115	3 18 3	November and May	...	...
300,000	1	0/9⅜	Castner-Kellner Alkali Co. (fully paid)	1⅛ 1⅜	1⅛ 1⅜	5 16 5	...	...	...
60,000	1	0/7½	Chadburn's Ship Telegraph Ordinary	⅝ 1⅛	⅝ 1⅛	5 6 8	...	...	...
60,000	1	0/7½	Do. 6 per Cent. Cumulative Preference	⅝ 1⅛	⅝ 1⅛	5 6 8	...	...	...
32,098	3	1/9⅜	Crompton and Co. (Nos. 1 to 32,098)	3½ 4	3½ 4	4 10 9	January and July	...	...
£100,000	100	5%	* Do. 5 per Cent. First Mortgage Deb. (red.)	98 101	98 101	4 19 0	,, ,,	...	...
60,000	1	0/3	Davis and Timmins 6 per Cent. Cum. Pref.	¾ 1	¾ 1	...	...	...	...
99,261	5	1/9⅜	Edison and Swan United ("A" Shares) (£3 paid)	2 2⅛	2 2⅛	7 3 9	February and August	2 1/16	...
17,139	5	2/9⅜	Do. (£5 paid)	3½ 4¼	3½ 4¼	6 13 4	,, ,,	...	...
£344,023	Stock	4%	Do. 4 per Cent. Mortgage Deb.Stock (red.)	93 95	93 95	4 4 3	June and December ...	93½	...
26,100	5	5/11½	Edmundson's Electric Corporation Ord.(fully pd.)	4⅜ 5⅛	4⅜ 5⅛	5 14 3	Half-yearly	...	...
112,100	2	1/2⅞	Electric Construction Co. (Limited)	2⅜ 2⅝	2⅜ 2⅝	4 16 0	January and July	...	...
25,000	2	2/9⅜	Do. 7 per Cent. Cumulative Preference	2⅞ 3⅛	2⅞ 3⅛	4 6 2	July	...	...
182,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	104 107	104 107	3 15 2	January and July	...	...
30,000	5	11/0	Henley's Telegraph Works Ordinary xd	14 15	13½ 14½	3 15 10	February and August	14⅛	...
30,000	5	1/6	Do. 4½ per Cent. Preference xd	5½ 6	5½ 5¾	3 18 3	,, ,,	...	...
£50,000	Stock	4½%	Do. 4½ per Cent. Mortgage Deb.Stock (red.)	110 114	110 114	3 18 11	,, ,,	...	...
50,000	10	10/0	India Rubber, Gutta Percha, &c., Works	21 22	21 22	4 11 10	,, ,,	21⅛	21⅛
£300,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	100 104	101 105	3 17 8	March and September	102⅜	102⅛
37,350	12	24/0	Telegraph Construction and Maintenance xd	37 41	36 40	4 9 11	March and July	39	38
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909	102 105	102 105	3 16 2	...	...	...
20,000	5	3/0	Do. Manufacturing Ordinary	9 10	9 10	3 10 0	...	...	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5½ 6	5½ 6	4 3 4	...	5⅝	...
30,000	5	5/0	Willans and Robinson Ordinary	11 12	11 12	3 15 0	April and October	...	7⅞
30,000	5	3/0	Do. 6 per Cent. Cumulative Preference	7¼ 7¾	7¼ 7¾	3 17 5	,, ,,	7¾	...
£100,000	Stock	4¼%	Do. 4½ per Cent. 1st Mortgage Debentures	104 106	104 106	4 0 2	May and November	...	...
			ELECTRIC RAILWAYS, TRAMWAYS, &c.						
12,000	10	10/0	Blackpool and Fleetwood Tramways	17 18	17 18	4 8 11	...	...	...
£167,900	100	5%	Brisbane Tramway 5 per Cent. Debentures	104 106	104 106	4 14 4	...	...	...
50,000	10	8%	Bristol Tramways and Carriage Ordinary xd	22½ 23½	22½ 23½	...	February and August	...	...
25,000	10	4%	Do. Cumulative Preference (£6 paid)	6¼ 6⅝	6¼ 6⅝	...	...	...	...
£100,000	Stock	4%	Do. 4 per Cent. Debentures	117 118	117 118	3 7 3	...	...	...
12,000	10	...	British Columbia Electric Railway 5% Pref.	10⅜ 10⅝	10⅜ 10⅝	...	...	10⅝	...
30,000	10	9/0	British Electric Traction Ordinary (Nos. 1 to 30,000)	17 18	17 18	3 6 8	...	17⅝	17½
£15,000	10	...	Do. (Nos. 60,001 to 75,000)	16½ 17⅜	16½ 17½	...	...	16⅝	...
30,000	10	6/0	Do. 6% Cum. Pref. (Nos. 30,001 to 60,000)	13½ 13⅝	13 13⅛	4 8 11	...	13⅜	...
£200,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures	126 129	126 127	3 18 0	...	126⅛	...
40,000	5	1/9	Buenos Ayres & Belgrano 6% "A" Cum. Pref.	4⅞ 5⅛	4⅞ 5⅛	5 17 1	...	5 1/16	...
27,500	5	...	Do. "B"	4 4⅛	4 4⅛	...	...	...	...
320,000	Stock	5%	Do. 5 per Cent. Debentures	105 108	105 108	4 12 7	...	...	...
213,553	10	3/0	Central London Ordinary	9¾ 10¼	9¾ 10¼	2 18 6	June and December ...	10⅛	10⅛
£855,000	Stock	1½%	City and South London Railway Con. Ordinary	61 64	64 68	2 15 2	January and July	67	64
37,500	10	...	Do. (Nos. 22,501 to 60,000) (£5. 10s. paid)	4 5	4½ 5½	...	...	6½	5
£150,000	Stock	5%	Do. 5 per Cent. Perpetual Preference (1891)	140 145	140 145	3 9 0	January and July	...	...
£200,000	Stock	5%	Do. (1896)	132 137	132 137	3 13 0	...	...	...
£187,701	Stock	4%	Do. 4 per Cent. Perpetual Debenture	125 130	125 130	3 1 11	May and November	127½	127½
20,000	10	7½%	†Imperial Tramways Ordinary	23 24	23 24	...	March and September	...	...
10,000	10	6%	† Do. 6 per Cent. Preference	15 15½	15 15½	3 16 2	,, ,,	...	...
£300,000	Stock	4½%	† Do. 4½ per Cent. Debenture	113 115	113 115	3 17 11	January and July	...	...
30,000	10	1/3	Kidderminster & District E. L. & Tr'ct'n 5% Pref.	10	10 10½	4 15 3	May and November	...	...
37,500	10	2½%	Liverpool Overhead Railway Ordinary xd	9 5/8 9 5/8	8½ 8⅝	4 4 6	February and August	...	...
10,000	10	5%	Do. 5 per Cent. Preference xd	12⅝ 13⅜	12⅜ 13⅜	3 15 7	,, ,,	...	...
125,000	Stock	4%	Do. 4 per Cent. Debenture	105 107	105 107	3 14 11	January and July	...	...
24,000	5	...	New General Traction Ordinary	3½ 4	3¾ 4¼	...	...	3 7/16	...
30,000	5	6/0	Do. 6 per Cent. Cumulative Preference	4½ 5¼	4½ 5¼	5 14 3	May	5⅜	...
4,000	10	...	Oldham, Ashton and Hyde Elec. Tramway Ord.	18 19	18 19	...	February and August	...	...
4,000	10	5/0	Do. 5 per Cent. Preference	10½ 10⅞	10⅜ 10⅞	4 11 11	,, ,,	...	...
13,334	10	...	Potteries Electric Traction Ordinary	11⅛ 12⅛	11⅛ 12⅛	...	...	...	...
20,000	10	5/0	Do. 5 per Cent. Cumulative Preference	10 11	10 11	4 10 11	...	...	...
£540,000	Stock	3%	Waterloo and City Ordinary	101 104	101 104	2 17 8	June and December	...	...

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption.
† The London Stock Exchange Committee refuses to quote these.

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THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED. First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,140. [No. 22. Vol. XLIV.] FRIDAY, MARCH 23, 1900. PRICE SIXPENCE (by post, 6½d.), Abroad, 8d., or 16 cents. or 80fr., or 70pf.

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NOTES.

Considerable pressure was brought to bear on Mr. Balfour, in the House of Commons on Wednesday last, to carry out his promise to appoint a Committee on Municipal Trading this session. As a sample of the opposition to the appointment of this committee, we may cite Mr. John Burns' absurd remark that beyond a few company promoters who met at the Society of Arts, he did not know of anybody who was interested in the question. Mr. John Burns' knowledge is evidently very limited. Mr. Balfour stated that some difficulty would be found in bringing the matter before the House; but, feeling the force of the appeal made to him, he promised to endeavour to find an occasion for discussion of the motion, and said that in the meantime opportunity might arise in the interstices between other business within the next week or two.

We print this week an abstract of the discussion on Prof. Jamieson's Paper relating to the action of electric tramway currents on submarine telegraphs, which appeared in our issue of the 2nd inst., p. 661, together with an account of a series of experiments undertaken by Prof. Jamieson at Mr. M'Whirter's works in Glasgow, with a view to determine whether there can be any inductive effect on a length of cable completely sheathed by conducting metal. We also publish a letter from Prof. Jamieson commenting upon the same subject. The experiments show conclusively that electromagnetic induction does take place when varying currents are passing along the conducting sheath. Prof. Jamieson's letter raises, in an interesting manner, the question as to the cause of this phenomenon. He first suggests that, as the magnetic force inside a closed tube carrying a uniformly distributed current must be zero, it would appear that no induction could occur. The fact is, however, that induction does occur; and he examines the conditions which would lead to the rejection of the inference just stated. Although no magnetic field exists within the tube itself, and the conductor therefore is in a region destitute of such force, Prof. Jamieson shows that the simultaneous variation of elements of current in parallel portions of the tube will combine to set up an induced current in the conductor, all the elements acting in the same direction. Moreover, the fact that the conductor within the cable forms but a portion of the closed conducting system would lead us to expect an induced current in that system whenever the magnetic flux through its core varies in any manner. The variation of any current flowing along the sheath necessarily produces a change in this magnetic flux.

Every worker on the electrical properties of rarefied gases will admire the simplicity and elegance of the method devised by M. Bouty, and described in another portion of this issue, to determine whether a rarefied gas acts like an electrolyte or a common dielectric. The method consists in observing how a vessel containing the substance under examination affects the capacity of a plate condenser when it is inserted between the plates. It is found that for all classes of conducting liquids, even those whose conductivities are so different as mercury and distilled water, the observed increase in capacity was about 50 per cent.; whereas for air at atmospheric pressure, and likewise for all rarefied gases, this increase was only of the order of 2 per cent. So marked are these differences, that absolutely no difficulty would be experienced in determining to which of these two classes—conductor or dielectric—any given substance belongs. Applying this method to some of the rarefied gases previously examined by Prof. J. J. Thomson, it is, we think, conclusively proved that all such gases under normal conditions are true dielectrics, in every respect like air at atmospheric pressure. In special conditions, however—such as under the influence of very strong fields—they suddenly change over from the one class to the other, from dielectric to electrolyte. This sudden transition is always accompanied by a slight luminosity, thus only proving again what Prof. J. J. Thomson, Stoletow,

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and many other physicists had previously shown, that a gas behaves like a conducting liquid *when an electrical discharge passes through it.* M. BOUTY appears to have entirely misapprehended or to have overlooked this provisional clause in Prof. THOMSON's statement, supported as it is by numerous experiments made by Prof. THOMSON and others. In his book on "The Discharge of Electricity through Gases" Prof. J. J. THOMSON clearly says: "When an electric discharge passes through a gas, the gas is, *for the time being*, converted into a conductor" (p. 105). The failure to obtain any appreciable amount of electrolysis in the case of M. WIEDEMANN'S experiments on compound gases might readily be explained by assuming that the conditions of these experiments were such that the discharge was really oscillatory in character. The conclusion is forced on us that Prof. THOMSON'S position has not been touched by M. BOUTY'S experiments, and that the position which has been assailed is an imaginary one that never had any existence except in the mind of M. BOUTY.

Prof. JOHN PERRY has contributed an article to *Nature* on the interesting phenomena he described briefly in his speech at the Institution of Electrical Engineers on the 8th inst. (see *The Electrician*, March 16, p. 746). These phenomena relate to the connection, observed over a period of some 20 years by Dr. SCHLIEB, of Baden-Baden, between atmospheric electrification and human pathology. Neurotic patients, for example, are alleged to be depressed when the air is negatively electrified and abnormally stimulated when the electrification is positive. But we fail to discover in Prof. PERRY'S account of these important researches any conclusive evidence or even direct indication that the abnormal symptoms observed in the patients were actually caused by the electrical conditions of the atmosphere. Certain electrical conditions, or changes of those conditions, it is true, were observed to be accompanied by definite symptoms; but there is nothing to show that the symptoms were due to electrical causes. They may have been produced by the physical causes which led to the electrical conditions. Thus, for example, we are told that the positive or negative electrification of the atmosphere corresponded with changes in the barometric and hygrometric conditions of the atmosphere. "It is of no importance," writes Prof. PERRY, "whether the barometer is high or low, but whether it rises or falls. It is not important to know whether the moisture of the air is great or not; it is important to know whether the moisture decreases or increases, whether the process of condensation or of evaporation prevails."

PRECISELY; then why attribute our state of health and mental condition to electrification, any more than we attribute fine or wet days to the same cause? Most people are depressed by foggy or rainy weather and braced up by clear blue skies or brisk breezes; and it has been the popular custom to attribute their feelings to these palpable atmospheric conditions. Dr. SCHLIEB and Prof. PERRY now ask us to adopt a subtler explanation, in the changes of electrical condition which accompany the more obvious variations in the weather. We are unable to discover that their request is justified by their experimental evidence. What is mainly lacking, we think, in this evidence, is any experiment showing that electrical atmospheric changes *alone* will produce the same changes of symptoms. Under constant barometric and hygrometric conditions, has it been found that artificial electrification of the air in a patient's room produces the same change of symptoms as have been observed with varying barometer and dew-point? Prof. PERRY says nothing on this head; yet the result of such an experiment should be conclusive, or nearly so. We may remark, by the way, that, if Prof. PERRY'S theory is correct, there should soon arise a demand for small portable air-electrifying machines, for use by neurotic patients in depressing weather. This gives the question a practical turn.

AN article by Mr. ALTON D. ADAMS in the *Engineering Magazine*, entitled "The Future of Electrical Supply," relates to a subject fully dealt with by the late Mr. DENNY LANE nearly ten years ago. Mr. ADAMS considers that electrical supply works will in the future be replaced by gas generating plant, from which gas is to be distributed to sub-stations containing gas-driven dynamos. Apart from the fact that in Belfast, where steam-driven plant has been reverted to, the system has been tried and found wanting, and that other gas-driven stations have motor-generators and not gas engines as balancers in their sub-stations, Mr. ADAMS lays himself open to criticism on the basis of his own figures. Comparing the modern polyphase supply system with his gas scheme, he states that 90 per cent. is a high efficiency for rotatory converters, 95 per cent. for transformers; and he allows for 5 per cent. loss in the mains, bringing the whole efficiency down to 73 per cent. These figures can only be taken as relative, for it is not stated whether they are intended as full-load or all day efficiencies. On the other hand, he assumes the combined efficiency of the gas main and gas engine dynamos at the relatively high figure of $0{\cdot}95 \times 0{\cdot}90 = 0{\cdot}85$, and he further neglects batteries, as he is of opinion that batteries of the same size would be employed in either case. Nor does he compare the relative cost of attendance and repairs, which would be much greater in gas-driven stations. In view of the points quoted, and the fact that the capital cost is estimated, even by Mr. ADAMS, to be the same in the two cases, it is clear that, except in individual instances under more or less exceptional conditions, the gas engine sub-station system, if destined to be the electrical supply system of the future, will only be that of a future which is still indefinitely far distant.

WE referred in our issue of March 9th to the publication of a blue book containing "further correspondence relating to the proposed construction of a cable across the Pacific Ocean." In the "instrument" appointing a Committee to consider the scheme suggested by the Committee of 1896 it is laid down that the first duty of the committee will be to consider the following points: (1) The cost of (*a*) laying and (*b*) maintaining the line, and whether as a single or duplicated cable. In order to arrive at a conclusion on this point, the Committee will be at liberty, if they think proper, to advertise for tenders, on the understanding, however, that no tender can be accepted without reference to the several Governments concerned. (2) The rates to

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be charged for messages, and the revenue which the cable may be expected to earn therefrom. (3) The steps which should be taken in order to secure that all messages between this country and Australasia should be sent solely through British territory or through cables owned and worked by British companies. (4) The framing of a scheme for the permanent administration and working of the cable when laid. The conclusions arrived at by the Committee on these points will be laid before the several Governments concerned, who will then decide what further steps should be taken. All questions as to the mode of raising the capital necessary for the undertaking are reserved for the Imperial Government alone.

Erratum.—In the note at the bottom of the first column of page 747, for "megohms" read "milligrammes."

Institution of Mechanical Engineers.—The annual dinner announced to take place on April 25th has been postponed.

Obituary.—We regret to announce the death of Mr. Chas. T. Rittenhouse, on February 26th, at Denver, Colorado. The deceased was formerly editor of the *Electrical World*, which he resigned after filling that position for about 12 months, on account of his health. He was only 28 years of age at the time of his death.

Spanish-American War.—The Cuba Submarine Telegraph Co. has presented to the United States War Department a claim for $4,000 for damage done to the company's cables during the late war. The company also claim the subsidy of $10,000 per annum which was received from the Spanish Government, and which is due to be paid up to the year 1910.

Cable Interruptions:—	Date of Interruption.
Latakia—Cyprus	June 21, 1899
Cayenne—Pinhieros	Oct. 11, 1899
Tangier—Tarifa	Jan. 3, 1900
Paramaribo—Cayenne	Feb. 16, 1900
Ceara—Maranham	Feb. 20, 1900
Para—Maranham	Mar. 2, 1900
Môle-St. Nicolas—Cap Haitien	Mar. 7, 1900
Jeddah—Suakim	Mar. 13, 1900

The Institution of Civil Engineers.—The annual dinner of this Institution took place on Wednesday evening, at the Merchant Taylors' Hall. In the absence of the president, Sir Douglas Fox, owing to domestic bereavement, the chair was taken by Sir Wm. Preece, past president. During the evening the chairman announced that a visit had been arranged for the American Institution of Civil Engineers to England in July next, and that the Guildhall had been secured, by the kindness of the City authorities, for an entertainment on July 5.

Personal.—In connection with the bi-centenary celebrations of the Berlin Academy of Sciences, the Emperor conferred the Order of the Red Eagle, First Class, upon Prof. Mommsen; the star of the Royal Order of the Crown, Second Class, upon Prof. Auwers, the permanent secretary of the Academy; and the Order of the Red Eagle, Third Class, upon Prof. Karnack. Lord Kelvin and Prof. Max Müller were elected Foreign Members of the Academy; and Profs. Rowland, Sir John Burdon-Sanderson, William James, Mahaffy, and Maitland, Dr. A. S. Murray, and Mr. F. Llewellyn Griffiths were elected Corresponding Members.

Losses in Transformers.—An article by E. A. Wagner in the *American Electrician* describes under what circumstances it is preferable to use transformers with a high core-loss in preference to those having a low core-loss, the total losses at full load being in each case equal. When the transformer is to be used at full or partial load for only a few hours daily, then transformers with the lowest core-losses will have the highest efficiencies; whereas, if the transformer be nearly always worked at full or over load—as, for example, in the electrical furnaces at the Niagara works—a transformer having a high core-loss is to be preferred.

Embarkation of the Electrical Engineers (R.E.) Volunteers for South Africa.—The first detachment of the Electrical Engineers (R.E.) Volunteer Corps set sail from Southampton on Friday last, the 16th inst., on the royal mail steam packet "Tagus." Among the apparatus taken out by the detachment were two traction engines, four searchlights, and the necessary plant—including bicycles—for laying field telegraphs and telephones. The cycles have been specially designed by Major Crompton. They have 9in. cranks, and are geared up to 84. Every machine carries two drums, each bearing a spool of copper wire two miles in length. All the above stores were carried by the "Custodian," which sailed on Saturday.

City and Guilds of London Institute.—The committee have decided that in counties and county boroughs possessing an organisation for the promotion of secondary education, recognised by the Science and Art Department, such organisation may, on application through the secretary of the technical instruction committee or otherwise, be held responsible, under certain conditions, for the conduct of the Institute's examinations and for the establishment of new classes in technology, in accordance with clause VII. of the Science and Art Directory. The committee will, however, continue to require, as a condition for the registration of a class in any technological subject, the approval by the Institute of the qualifications of the teacher proposed to be appointed.

British Association.—The following are the names of the presidents of the various sections for the meeting of the British Association, to be opened at Bradford on September 5 next: Mathematical and Physical Science, Dr. J. Larmor, F.R.S.; Chemistry, Prof. W. H. Perkin, F.R.S.; Economic Science and Statistics, Major P. G. Craigie; Mechanical Science, Sir Alexander Binnie; and Corresponding Societies, Prof. E. B. Poulton, F.R.S. Dr. A. A. Common, F.R.S., will act as chairman to a separate department of Astronomy in Section A. The evening discourses will be delivered by Prof. Gotch, F.R.S., on "Animal Electricity," and Prof. W. Stroud, on "Range Finders." The lecture to working men will be delivered by Prof. S. P. Thompson, but the subject has not yet been announced,

Ventilation of Large Buildings.—In a Paper on this subject read before the Civil and Mechanical Engineers' Society on the 1st inst. by Mr. Mervyn O'Gorman, attention is called to the use of electricity for this purpose. The Paper, however, only incidentally touches on electrical matters. The author considers that where electric power is available, only ignorance of the value of perfect conditions of ventilation could lead to the neglect of provisions for these. The requisite conditions of the air supplied under ventilation are stated to be warmth, careful filtration, proper collection and delivery to avoid high velocity and dustiness, and a sufficient degree of moisture. The volume of air necessary is said to be 1,000 cubic ft. per hour per individual. The "Plenum" system of ventilation is recommended in preference to the "Vacuum" system.

Line Insulator for 60,000 Volts.—The *Western Electrician* of Chicago describes a new type of insulator which has just been brought out in America. It is designed for a 60,000 volts active line pressure, and is capable, it is stated, of carrying 81,000 volts in severe rainstorms without leaking. It is also said to be able to carry 100,000 volts without arcing. The insulator has a porcelain pin base, with a specially prepared quality of annealed glass at the screw. The upper part of the insulator is of vitrified china. The body and glaze are of simple earths fused together into a vitreous homogeneous mass at a high temperature. No lead or other metallic oxide is used in the making, and the body being of exactly the same material and fired at the same temperature as the glaze, has the same insulating qualities with or without the glaze. It is asserted that the insulators will not crack on the surface, or "leak" when subjected to varying temperatures.

The Manufacture of the American Pacific Cable.—Mr. J. A. Scrymser, President of the American Pacific Cable Co., gives reasons why the proposed new Pacific cable should not, and indeed cannot, be made in America. He points out that such work has never been done in America, and that the plant, the capital, and the experience required cannot be improvised at the touch of a Government undertaking. Practically all the

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ocean cables, from the first transatlantic line in 1857, have been made in England, and the English firms have practically a monopoly of the experience. To make the cable in America, a big plant, with a large number of experienced workmen, would be necessary. This would involve a preliminary large investment of some millions, with the risk of a possible failure in the line during laying, and thus leading to a dead loss. In addition, there must be ten ships, of at least 4,500 tons, specially constructed for the work, each ship having a complete outfit of apparatus and manned by men of experience. All this equipment is found only in England. When Germany wanted a cable she could be sure of, and wanted it quickly, connecting Germany to New York *viâ* the Azores, she had this cable made in England.

A Small Continuous-Current Transformer.—A continuous current transformer intended for charging small secondary batteries of three to five cells from the public supply mains is described in a recent issue of *l'Electricien*. Messrs. Legros and Meynier, the makers, employ a field magnet of the two-coil consequent pole type and an armature with two windings. The primary winding for 110 volts is on the ordinary drum system, but the secondary has only one turn and a simple two part commutator. The speed is 220 revs. per min., and it is stated that the stepped current serves quite well for charging the cells. Running light as a motor, the machine requires a current of 0·66 amperes. When used for charging four cells, in a series of tests that were made, 2 amperes at 110 volts were required in the primary, and a secondary pressure of 10·5 volts was generated, supplying a current of 10·5 amperes for charging. This works out to an efficiency of just over 50 per cent. In these measurements the secondary current and pressure were measured with alternating-current instruments. The makers propose to construct a similar machine with two collector rings added so that it can be run also as a synchronous motor from alternating-current mains, and to obtain continuous current from either of the two commutators. They suggest that the armature could be brought up to the speed of synchronism by starting it with a string in a similar way as a top.

Institution of Electrical Engineers.—At the meeting of the Institution on the 8th inst. the President (Dr. S. P. Thompson) announced that the secretary had received a formal request from the secretary of the Northern Society of Electrical Engineers for incorporation with the Institution of Electrical Engineers, thus forming a local section for Manchester and district. The incorporation would take place under the terms of article 67 of the present articles of association, and the application in terms of articles 65 and 66 would be approved subject to the settlement of the financial and legal details of incorporation, which would be gone into in due course by the secretaries. In making this announcement Dr. Thompson considered he was entitled to say that the Institution and the late Northern Society were both to be congratulated on the fact that the Northern Society had thought well to throw in its lot with the Institution; and while it ceased to exist in one capacity, it came to life in another. It had the effect of transferring some 90 persons who had not been in membership with them, but who were members of the Northern Society, into their ranks. By this incorporation he hoped that the hands of their friends in the Manchester district, as well as their own, would be strengthened for the work which they had carried on for seven years independently. He wished to congratulate them on the proposition they had made to the Institution, and at the same time to acknowledge that the Institution of Electrical Engineers were distinctly the gainers from their action in this matter.

The Bi-Centenary Celebrations of the Berlin Academy of Sciences.—On Monday last the Emperor Wilhelm opened the celebration of the bi centenary of the Berlin Academy of Sciences by receiving, in the White Hall of the Royal Castle, with full state and ceremony, the members of the academy and the deputations from other countries which have come to Berlin. In the course of the speech from the throne the Emperor recalled the close relations which had always existed between the Academy and the Imperial house. The Academy was originally founded by King Frederick I. of Prussia, on the initiative of Leibnitz, its first president. He referred next to the intimate connection between German science and the universities, and quoted Helmholtz's belief that academic teaching furnished abundant incentives to scientific research. The Emperor next intimated that he intended to found a number of new chairs in philological research, and also in the physical and mathematical section, on account of the importance of the technical sciences at the present day. At the second day's celebrations Prof. Karnack delivered an eloquent address on the history of the Academy, and concluded with the words: "May the light which was in the beginning and the word which was in the beginning continue to illumine the spirit of this institution in the third century of its existence." Addresses of congratulation were then presented by the representatives of foreign academies. Among the institutions represented were the Royal Society of London, Royal Irish Academy, Royal Society of Edinburgh, Smithsonian Institute, the American Academy of Arts and Sciences, and the Académie des Sciences de l'Institut de France.

Underground Telephone Wires in London.—We have previously alluded in these columns to the circular issued by the Postmaster-General to local authorities in London, asserting that the National Telephone Co. had no legal right to lay wires underground in this area, a statement contradicted by the National Telephone Co. It is interesting to note that the question, which evidently involves a nice legal point, besides being of immense importance to the telephone business of the two contending parties, is to be discussed before the proper tribunal on April 5th. A circular has been addressed by Mr. W. E. L. Gaine, general manager of the National Co. to the members of the London County Council with reference to the company's request for permission to lay underground wires. After referring to the protracted negotiations with the Council which have been going on since June, 1896, the circular says:—

> The company has pointed out to the Council that now that its demand for competition has been answered affirmatively, the company will be placed at great disadvantage with its competitor, the Postmaster-General, if it is denied powers to put down plant which the Postmaster-General possesses, and the Council has replied that it is ready to give the requisite consent on two conditions:—
>
> (1) That the company will supply the service on the same terms as the Postmaster-General, whatever those terms may be; and (2) that the company will permit the Postmaster-General's subscribers to have free intercommunication with those of the company.
>
> The company in answer has said that it will accept the first condition, but that the second is impossible of acceptance.
>
> On the 1st ult. I wrote to the clerk of the Council, stating that the company was willing to agree to the principle of intercommunication upon the lines which the Telegraph Act of last year and the Postmaster-General's order thereon imposes for the provinces. This letter was considered by the Highways Committee of the Council, and the answer I received was, "The committee is not prepared to recommend the Council to consent to the provincial terms as to intercommunication between the two systems being applied to London." The demand of the Council for free intercommunication by a competitor commencing business is equivalent to asking that a new railway a few miles long should have free running powers over the whole of the London and North Western system.
>
> There the matter now stands, except that the County Council has commenced an action against the company with the view of obtaining an injunction restraining the company from maintaining its existing underground wires, some of which have been laid down with the consent of the Council, and all with the consent and approval of the local authority.

MEETINGS OF SCIENTIFIC AND ENGINEERING SOCIETIES, &c.

(TO-DAY) FRIDAY, March 23rd.

PHYSICAL SOCIETY.

5 p.m. Meeting in the rooms of the Chemical Society, Burlington House. Agenda: (1) An Electromagnetic Experiment, by Prof. S. P. Thompson, F.R.S.; (2) Some Experiments illustrating Syntony, by P. E. Shaw; (3) An Electrical Micrometer, by P. E. Shaw.

SATURDAY, March 24th.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture III. on "Polarised Light," by the Right Hon. Lord Rayleigh, F.R.S.

MONDAY, March 26th.

SOCIETY OF ARTS.

8 p.m. Cantor Lecture IV. on "Photography of Colour," by E. Sanger Shepherd.

SATURDAY, March 31st.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture IV. on "Polarised Light," by the Right Hon. Lord Rayleigh, F.R.S.

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CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

Charge Conveyed by Becquerel Rays.—A highly interesting discovery has been made by P. and S. Curie in connection with the magnetically deflected rays of radium compounds. These rays resemble cathode rays rather than X-rays, not only in the matter of magnetic deflection, but also in the fact that they convey a negative charge. This has been proved by the authors in several ways. On account of the complication introduced by the fact that radiation makes the air or any other gas a conducting body, it was necessary to keep the electrode receiving the radiation sealed up in a non-conducting envelope, against one side of which the radium preparation was pressed. The preparation was contained in a thick-walled leaden box, and was covered with a piece of aluminium foil 0·01mm. thick. Even after traversing this, and an ebonite layer 0·3mm. thick, the rays conveyed a current of the order of 10^{-11} amperes through the galvanometer connected with the enclosed electrode. Conversely, when the radium preparation was embedded and the outer metallic envelope put to earth, an electrometer connected with the radium box showed a positive charge which is apparently maintained without loss, and would steadily rise if perfectly insulated.

[P. and S. Curie, *Comptes Rendus*, March 5, 1900.]

Magneto-Optic Reciprocity.—Since the discovery of an action of a magnetic field upon the orbits of luminous ions, the converse effect has been sought for, but so far without much success. The creation of a magnetic field by the propagation of a circularly polarised beam in an absorbing medium, predicted by Fitzgerald and Gray, cannot apparently be verified by present means. Sheldon recently announced the creation of a varying magnetic field by the rotation of the plane of polarisation of a mechanically rotated beam; but his interpretation of the results has been much criticised. As the effect should vary directly with the speed of rotation, O. M. Corbino has clinched the matter by increasing the speed from 300 to 2,000,000 per second. This he did by an optical instead of a mechanical contrivance. Two circularly polarised beams, reversed with respect to each other and of slightly different periodicities, were made to interfere. They produced a plane-polarised beam whose plane was in a state of rapid rotation. This beam was sent through a magnetising coil filled with carbon bisulphide. Although the effect in this case should have been 6,000 times the magnitude of Sheldon's effect, no magnetic effect of any kind was observed.

[O. M. Corbino, *Nuovo Cimento*, Dec., 1899.]

Flux of Energy.—Since Poynting's important work on the flux of energy in an electromagnetic field, the idea of the identity of energy and its continuous propagation in space has not been followed up with great zeal, if we except some general Papers on the subject by Lodge and Ferraris, and some mathematical investigations by Wien. So far, the field investigated has been confined to electromagnetism, elasticity, hydrodynamics, and heat, and Lodge is the only physicist who has endeavoured to follow the flux of energy into purely mechanical regions. An interesting attempt in the same direction has recently been made by V. Volterra, who makes straight for the most difficult point—that of gravitational attraction. It is just here that the difficulty of localising and "identifying" the energy is greatest, since there is no evidence of a finite velocity of propagation. The author shows that the flux of mechanical energy is represented by a system of three vectors, embodying the elastic, kinetic, and gravitational elements respectively. The latter is situated in open space, and is not attached to matter any more than a vector representing a magnetic field. He draws a diagram of the flux of gravitational energy, in which the lines of flux have the aspect of the lines of force of two magnets which repel each other.

[V. Volterra, *Nuovo Cimento*, Nov., 1899.]

Vibrations Produced by Vacuum Discharges.—J. Stark describes some novel phenomena obtained when a continuous discharge from a battery of accumulators is sent through a vacuum tube, and the exhaustion is such that the discharge is only just able to pass. A telephone introduced into the circuit then proves that the discharge is intermittent and has a more or less definite period. On placing the ear against the tube in the neighbourhood of the cathode, a note is heard, which the author terms the "cathode note." Sometimes there is a mixture of high and low notes. The note may be increased in intensity by laying a strip of tinfoil loosely round the tube in the neighbourhood of the cathode. It is then audible to a distance of some 20 yards. The electric oscillations here produced are of the frequency of several hundred per second, and are therefore intermediate between those due to alternators and those obtained in Hertzian wave experiments. If the electrodes consist of flexible wires or carbon filaments at right angles to the length of the tube, the cathode is put into a state of visible vibration, while the anode remains stationary. This indicates an effect of the charges on the walls upon the electrodes. The effect would be strongest at the cathode, where there is the greatest fall of potential.

[J. Stark, *Ann. d. Physik*, No. 2, 1900.]

Electrical Thermostat.—W. Duane and C. A. Lory have designed a thermostat of remarkable efficiency. It consists of an electrically-heated conducting liquid, whose temperature is regulated with the aid of a highly expansive liquid like alcohol. The liquid of the thermostat is a weak solution of common salt in water contained in a wooden trough. The ends of the trough are completely covered inside with sheets of zinc serving as electrodes, by means of which an alternating current from a 110 volt electric light circuit passes through the solution. The liquid is kept in rapid circulation by means of four stirrers operated by a small water motor. The tubes containing the regulating liquid are of thin brass, and form a rectangle. The alcohol ascends into the regulator, which consists essentially of an iron U-tube containing mercury. One of the openings of the U-tube serves for regulating the height of the mercury and thus the temperature, while the other contains a mercury contact which inserts or cuts out a resistance in the heating circuit. The action is so prompt that the temperature of the thermostat is maintained within $\frac{1}{2000}$th of a degree even when the surrounding temperature varies by some 15 degrees. The current is interrupted several times per second.

[Duane and Lory, *Am. J. Sc.*, March, 1900.]

Curvature of Becquerel Rays.—A comparison of the magnetic deflections of Röntgen, Becquerel, and cathode rays has been made by R. J. Strutt. He made a strong effort to obtain some sign of magnetic deflection of Röntgen rays, but entirely failed. He can assert with certainty that with a field of 3,270 C.G.S. units no perceptible deflection is obtained, and in view of the probable limit of sensitiveness of his apparatus, he says that to produce a curvature of radius 1cm. in Röntgen rays a magnetic field would be required of at least 60 million units. Thomson has found that to produce the same curvature in cathode rays a field of only 315 units is required. Becquerel rays stand between Röntgen and cathode rays in this respect. The author arrives at an estimate of their curvature by placing a little lead box containing a uranium preparation on its side on a sensitive plate in a magnetic field. The box is only half full, and he adjusts the magnetic field until the rays are so deflected away from the plate that they just graze its surface. It is then easy to draw the trajectory of the highest ray. A field of 1,680 units gives a radius of curvature of 3cm. Hence a radius of 1cm. would require 5,000 units.

[R. J. Strutt, *Proc. R. Soc.*, March 3, 1900.]

Electrical Engineers (R.E.) Volunteers and the War.—We understand that the War Office has agreed to accept a further detachment of E. E. Volunteers for service in South Africa. Another engine and dynamo, together with a couple of waggons, will be provided for the use of the corps.

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ELECTROMAGNETIC THEORY.—CXIII.*

BY OLIVER HEAVISIDE.

(*Continued from page 617.*)

§ 456. If a perfectly conducting sheet of metal be placed so that the axis of a plane wave lies in the sheet, it will usually interfere with the continuance of the wave in its simple state. The exception is when the sheet (infinitely thin) is turned round so as to be perpendicular to D in the wave. Then the wave will run on unchanged. It will run on to the sheet at P (Fig. 4), traverse the strip, and run off at Q, and go on as it was before. At the same time, it is to be remarked that the wave is really split into two waves, which are quite independent of one another save in the accident of being timed together. The upper side of the strip is positively electrified, the lower side negatively, and the electrifications cancel one another as the wave runs off.

Either of the waves may be abolished, so far as the possibility of existence of the other is concerned (Fig. 5). It will run along the strip by itself. But when it comes to the edge of the strip, what then? The wave goes right on. But since the electrification cannot leave the sheet, a new wave is generated, beginning the moment the wave reaches the edge. It is cylindrical, having its axis at the edge. It, together with the plane wave, form the complete new state of D. But this is too complicated for present discussion.

To simplify matters, we may prevent the generation of the cylindrical wave by convection. Directly the front of the wave reaches the edge, or at any rate not later than that moment, set the conducting sheet moving with the wave. Then the plane wave will go on unchanged. Fig. 5 will do for this case also, PQ being now imagined to move instead of

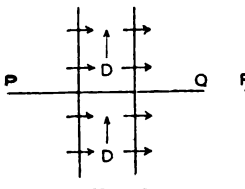

Fig. 4.

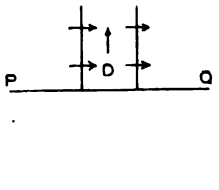

Fig. 5.

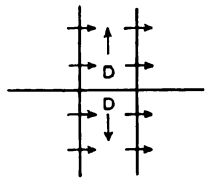

Fig. 6.

being stationary. The current on the strip is no longer a conduction current, but a convection current. Also, it no longer matters whether the sheet is conducting or non-conducting. It must be something that can be charged. In addition, there is the assumption that its motion does not disturb the ether. For merely descriptive purposes we may speak of the motion of electrification. The surface density being D, the convection current is Dv per unit area. It is continuous with the electric currents on the front and back of the slab wave. The current is the curl of the magnetic force, as usual.

We may have another wave below the one in question, and there need be no connection between their magnitudes. An extreme case is reached by letting D be of the same strength, but oppositely directed in the two waves, as in Fig. 6. As there is similar electrification on both sides of the strip, the electrification density is 2D if we ignore the strip. This example is of some significance, because the state represented is what would be tended to if the given electrification, initially at rest, were set in motion in its own plane along PQ at a speed which ultimately became v.

Instead of one plane of electrification, as in Fig. 6, there may clearly be any number. In the limit we come to any arbitrary distribution of electrification. For instance, D may be any function of y, the distance measured parallel to D. Its divergence is then the density of electrification, which must be moved with the wave of course, or it will break up.

Returning to Fig. 5, if the reader thinks, he may observe a curious thing. The current is the curl of H, both when the wave runs along the stationary conductor and when the conductor is carried along with the wave. In the latter case Dv is the surface current density, and it is a convection current.

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But when the conductor is stationary the electrification is there all the same, and it moves at the same speed. Why is it not a convection current in this case also? Because the conductor is not moved. This is not a mere matter of convention. To illustrate: Suppose the conductivity is not quite perfect, so that there is a thin film of conduction current near th surface. H is now continuous there, and there is no surface current, in spite of the transfer of electrification. The variation of H which measures the current is distributed throughout a thin film under the electrification belonging to the wave. This remains true however great the conductivity is made. In the limit, with perfect conductivity the current becomes a surface current. But there is not the slightest reason for supposing that it suddenly, in the limit, becomes a convection current. To obtain the convection current, abolish the conduction current by moving the material supporting the electrification.

In the true physics of the matter, the current in the conductor itself may be partly of the convective nature, of course, by the electrons being set moving by the wave penetrating

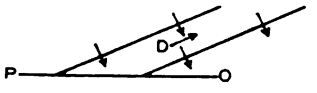

Fig. 7.

the conductor from its surface. But that is another matter. A theory of matter is now in course of evolution, but it is not made yet. In any case, however, the supposed interior convection currents represent a secondary action due to the electromagnetic wave running along the surface of the conductor.

§ 457. Returning to a perfectly conducting plane surface PQ at rest, let the H in a plane wave be tangential, and perpendicular to the plane of incidence, but let the D be no longer perpendicular to the conductor. Fig. 7 shows an unstable state of affairs, because E has a tangential component, which would be instantly destroyed by the generation of a new wave. Passing over the complicated details of the process, consider the ultimate result that is tended to, shown in Fig. 8.

Here we have a pure wave on the right side moving obliquely towards the conductor, and an exactly similar wave on the left side moving away from it. They are represented by plane slabs. They join together perfectly where they overlap, at PAQ and just above. If we consider a single tube of flux of

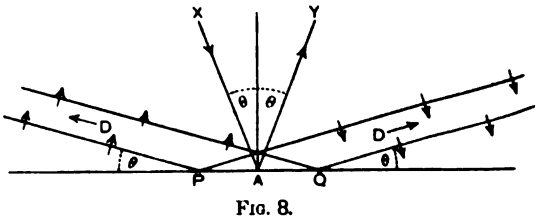

Fig. 8.

energy in the incident wave, with its continuation in the reflected wave, the two together make an incident and reflected ray (or thin beam). For instance, X is incident, and Y reflected, at the point A. The energy travels along XA in the right wave, and then along AY in the left wave. In the overlapping region H is doubled. It is up through the paper in both waves. Also, D is vertical. If θ is the angle of incidence, PAQ travels along the surface from left to right at speed u connected with v by $v = u \sin \theta$.

Thus, $u = v$ at grazing incidence. That is, when XAY is horizontal. The two waves then make one doubled simple wave, 2D being perpendicular. But at perpendicular ray incidence D = 0. This is the case of direct reflection of a plane slab striking flush against a perfect conductor. The electric force is destroyed, and H is doubled during coincidence of the incident and reflected waves. The reflected wave has the same H but reversed E. Five stages are shown in Fig. 9. Stage 1 shows E (by the ordinate) at the moment the front of the slab strikes the conductor; 2, when it has gone in one-fourth; 3, when half gone in; 4, when three-fourths gone in; and 5, all gone in, and replaced by a pure negative wave. "Gone in" does not here imply entrance.

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Now consider the case of oblique incidence, represented by Fig. 8. The density of electrification is $2D \sin\theta$, and its speed of transference is $u = v/\sin\theta$; so $2Dv$, that is, 2H, is the equivalent electric current per unit surface of conductor. Now 2H is the curl of **H** under the circumstances, but, as before explained, it is a conduction current. We may, however, easily turn the problem into one relating to convection. When, or before the electrification reaches the end of the sheet, move the sheet itself in its own plane along with the electrification. Then the two waves will go on behaving exactly as before. We may dismiss the idea of a conductor, and consider PAQ to represent a plane strip of electrification, density $= 2D \sin\theta$, moving in its own plane perpendicularly to its edges at the speed u, accompanied by the two electromagnetic waves. An upward pressure on the strip is required to maintain the state, but no work is done by it. Energy is being constantly transferred from one wave to the other. In fact, we may say that the one wave is being continuously turned into the other.

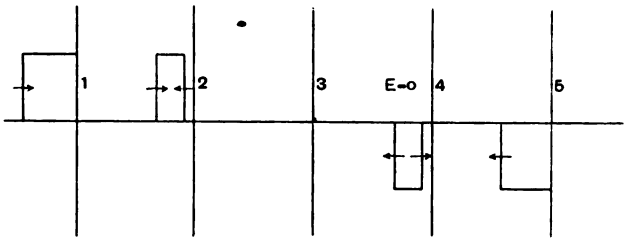

FIG. 9.

This state of things is obviously not that which could arise from putting the strip, given charged and at rest, into motion at the speed u, because there is a wave in advance of the strip, which is moving faster than the speed v of propagation of disturbances. But we may readily construct the proper solution of the new problem stated. In Fig. 8, keep the reflected wave in its place, but turn the incident wave over to the other side and start afresh, as in Fig. 10. The electrified strip PQ moves along the x-axis at any speed $u > v$. The final state that is tended to consists of two plane waves as shown, inclined backwards. D is away from the strip in both waves, which are exactly similar, and the angle between either D and the axis is the θ given by $v = u \sin\theta$. This solution is only true when $v < u$, or in the limit $v = u$. When $v > u$, the displacement spreads out over all space, obviously.

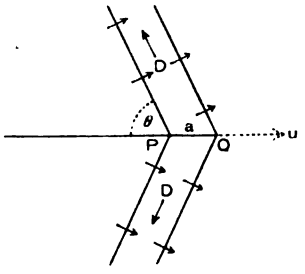

FIG. 10.

This is a very important case theoretically, in spite of its simplicity, so some more details may be given. There is no conversion of one wave into another, as in Fig. 8, but a real generation of the waves by the motion of the electrification. For the waves move normal to their planes, as usual, and additions are being continuously made to them at PQ. If the breadth of the strip is a, the depth of the two waves is $b = a \sin\theta$. The energy density is 2U; and the speed of elongation of the waves is $u \cos\theta$. Therefore the rate of increase of energy in the upper wave (per unit distance perpendicular to the paper) is

$$2Ua \sin\theta \times u \cos\theta = Uua \sin 2\theta,$$

and its double is therefore the rate of increase of the energy of both waves. Therefore, by the law of activity,

$$F = 2Ua \sin 2\theta$$

measures the applied force required to maintain the electrification in steady motion. This force **F** acts along x. That is, it is a push from behind or a pull in front. If it be removed, the electrification will at once begin to slow down, and this will continue until its speed is v. The state represented in Fig. 6 will be tended to.

As Newton is not yet superseded, we must have equal action and reaction. The companion to the impressed **F** is the force exerted on the electrification by the stress in the two waves. The stress in a pure wave is a pressure 2U acting along the ray. So $2Ua \cos\theta$ is the slanting back pressure upon PQ from above. Similarly in the lower wave. Their up and down components cancel one another. Their tangential components are additive, and together make $2Ua \sin 2\theta$, as before got by a consideration of the energy added to the waves.

It is not necessary for the waves to be externally unbounded. The displacement may be terminated upon stationary perfectly conducting plane surfaces. So we get the state of things shown in Fig. 11, where the two planes are AB and AC. Everything else is as before. Here the energy (per unit depth normal to the paper) is always finite, increasing at a uniform rate. To make more complete, we may show how to initiate the waves. Starting with zero displacement everywhere, let an impulsive voltage act in the direction of **u** all along the line A, generating the double charge $+\rho$ and $-\rho$ there, and let the line of $+\rho$ be immediately carried away at speed u. The line of $-\rho$ will then split into two halves, one of which will run along AC and the other along AB at the speed v. They will be joined to the $+\rho$ by two impulsive plane waves, as in Fig. 11, save that the waves there are slabs. To have slab waves, the initial voltage must continue for a finite interval of time,

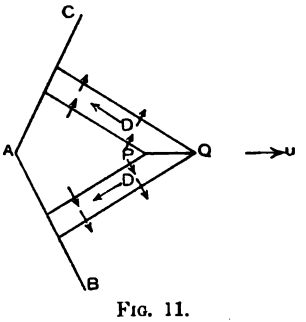

FIG. 11.

Now go back to Fig. 10. If the width of the strip PQ be reduced to nothing, whilst the charge upon it is maintained the same, we come to the case of an electrified line moving transversely at any speed greater than v, accompanied by impulsive plane waves. No separate figure is needed. But the force F, although it is finite when PQ is finite, becomes infinitely great by the concentration of electrification assumed. To show this, put F in terms of the total charge on PQ. If Q be this charge (per unit length along the strip), we have

$$Q = Da \sin\theta, \qquad \text{and } U = \tfrac{1}{2}ED = \tfrac{1}{2}cE^2.$$

These make F become

$$F = \frac{2Q^2}{ca}\cot\theta = \frac{2Q^2}{ca}\left(\frac{u^2}{v^2} - 1\right)^{\frac{1}{2}},$$

which increases infinitely with a^{-1} and also with u. It is, however, zero when $u = v$. This means that the two waves are in one plane. It is necessary, therefore, to have finite surface density of electrification, in order to be able to move the charge through the ether at speeds greater than light by the application of finite force.

Several modifications of these results will come in due course. One may be given here, being closely related to Fig. 10. In the arrangement there represented, reverse D in the lower wave. In order that the wave shall move the same way, H must also be reversed. The two displacements, in the upper and lower waves, are now continuous. PQ is therefore unelectrified. What then must it represent, in order that the problem may be really electrical, with growth of the waves by external work done on PQ? To answer this, observe that **E** is discontinuous tangentially at PQ. This means that the strip is a strip of f or curl e, the source which generates induction as before considered, § 453, whilst generating dis-

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placement positively on one side and negatively on the other. Remembering that E is towards the f surface below and from it above, whilst H is up through the paper in both, we have

$$H = \frac{f}{2\mu v \cos\theta} \qquad E = \frac{f}{2\cos\theta}$$

and the total displacement is

$$Q = \tfrac{1}{2}cfa \tan\theta.$$

In the case of a filament, put $af = f_o$. That is, f_o is the line source. Then we have two impulsive waves, in which

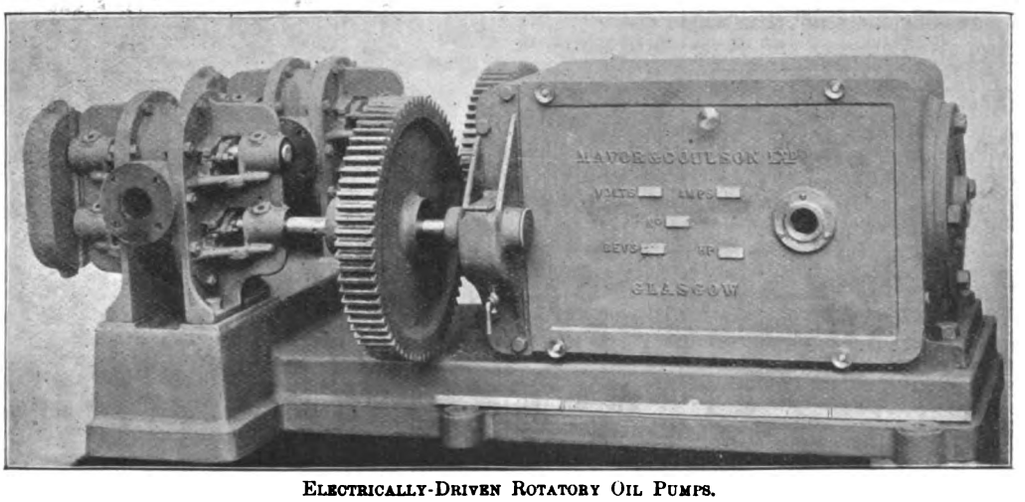
$$Q = \tfrac{1}{2}cf_o \tan\theta.$$

But if f_o is finite, there is the same infiniteness of applied force involved as previously.

(To be continued.)

ELECTRICALLY-DRIVEN ROTATORY OIL PUMPS.

The accompanying illustration shows a pattern of electrically-driven rotatory pump recently brought out by Messrs. Mavor and Coulson, of Glasgow. The plant has been specially designed for pumping heavy oils, and the illustration shows two pumps of the drum type geared to one of Messrs. Mavor and Coulson's electric motors. The pumps run at 250 revolutions, being driven through raw hide pinions and cut steel spur wheels by the motor, which runs at 700 revs. per min. The motor is of the well-known steel-case enclosed type made by this firm, and has a slotted drum-wound armature and



ELECTRICALLY-DRIVEN ROTATORY OIL PUMPS.

self-lubricating bearings, the bearings being carried by flanges bolted to the ends of the casing. The design is adapted so that, if the motor has to be bolted to a wall or to the under side of a ceiling or beam, the flanges carrying the bearings can be moved through 90deg. or 180deg., the oil wells being thus kept at the bottom of the bearings. The drum pump consists of a revolving piston sweeping out the cylinder every revolution, this revolving piston dipping into a revolving valve. When the piston moves round away from the valve a vacuum is formed into which the oil or water to be pumped flows, the fluid in turn being forced forward by the front face of the piston. The advantage of this type of pump is that it provides a continuous flow together with the positive thrust of a ram pump.

Electrical Machinery in U.S.A. Government Works.—In the new mint of the U.S.A. Government at Philadelphia, now rapidly approaching completion, electricity is to be used throughout for driving the presses and milling machines. The electrical equipment includes four direct-connected engines and dynamos, in addition to the following motors installed in the coining departments: 14 motors of 45 H.P. each, 16 of 5 H.P. each, 6 of 25 H.P. each, 30 of 5 H.P. each for the presses, and 15 of 5 H.P. each for the milling machines. There is also to be an electro-refining department, and electric power will be used in the engraving department.

CABLE-REPAIRING STEAMSHIP "JOHN PENDER."

Messrs. R. Napier and Sons (Ltd.), of Govan, launched, on the 18th inst., a twin-screw cable steamer of about 2,400 tons for the Eastern Telegraph Co. (Ltd.). This is the sixth cable steamer that Messrs. Napier have built for the Eastern and associated telegraph companies, but is much larger than the others, and has been specially designed by the telegraph company, who have also prepared the detailed specifications for the vessel and all machinery to meet the requirements up to date for laying and repairing submarine cables. The general dimensions are: Length between perpendiculars, 305ft.; breadth, 41ft.; and depth moulded, 26ft. 8in. to spar deck. The vessel has been built to class 100 A1 at Lloyd's, under special survey, and is fitted in accordance with the Board of Trade regulations for a passenger certificate. The upper deck is flush all fore and aft, to obtain an unobstructed lead from the four cable tanks and a portable tank to the picking up and paying out machines at the bow and stern; the spar deck is of teak, and the most modern appliances have been provided for the difficult and delicate service on which the vessel is to be employed. These include the cable gear with two pairs of compound engines, dynamometers, turning over gear, sounding machines, searchlight, and a very complete installation of electric lighting with duplicate dynamos. Amidships on the spar deck is a large chart-house, captain's cabin, and testing room; abaft the engines there is commodious accommodation on the main deck for the captain, principal officers, and electricians, which consists of a handsome dining saloon in wainscot oak and spacious state-rooms with the most recent improvements for comfort. The engineers' quarters are near the machinery, and the petty officers, cable hands, crew, and firemen farther forward. There are numerous store-rooms for the cable plant, a large engineers' workshop, refrigerating room, dynamo space, and everything that experience could suggest for the peculiar service on which the steamer is to be employed.

While having a full boat equipment, which includes steel lifeboats, the vessel has also a 28ft. steam cutter. The propelling machinery consists of two sets of triple-expansion engines, having cylinders 22in., 35in., and 58½in. diameter respectively by 3ft. stroke, and three single-ended boilers for a working pressure of 175lb., with the most modern appliances for efficiency and economy, including Howden's system of forced draught, manganese-bronze propellers, &c. Being built with a cutwater stem and graceful lines, the new steamer is a very handsome craft, and looks like a large yacht. Her appearance will be enhanced by a smart schooner rig. Miss Jessie Fleming Hamilton cut the lashing, and named the new steamer "John Pender." After a successful launch, the vessel was towed up the harbour to receive her machinery, which has been constructed at the builders' Lancefield engine works, and the company adjourned to the model room, where the usual toasts were duly honoured. Mr. James Hamilton, in the course of a short address, said he hoped the vessel would be a success, and would long perpetuate the memory of the man who had done so much for ocean telegraphy.

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POLYPHASE DEVELOPMENTS AT NIAGARA.*†

BY J. E. WOODBRIDGE.

(*Concluded from page 654*).

The Niagara-Buffalo Transmission Line and its Protective Arrangements.—Some interesting detail changes have recently been made in the overhead transmission line from Niagara Falls to Tonawanda and Buffalo. As readers of the electrical papers may remember, this line consists of six uninsulated stranded cables, each with a cross-section of 350,000 circular mils., the three cables of one three-phase circuit being on one side of the poles, while those of the other circuit are on the other side of the poles. Originally these six cables were supported on one six-pin cross arm, with a distance from pin to pin of only 18in. between centres. On account of the mischievous interference of the ubiquitous small boy, this arrangement has been changed: the centre wire of each three-phase line has been dropped to a lower cross arm, giving a triangular arrangement of the three wires of each circuit. With the old arrangement, boys, and perhaps other mischief makers, improved the opportunity to throw pieces of wire, barrel hoops, or other metal objects over the line, starting violent 11,000 volt arcs, which often held between the wires 18in. apart and were blown by the wind along the pole line, to the delight of those who started the arc but to the distress of both the generating and receiving stations. With the new arrangement the minimum distance between the wires is 36in., across which an 11,000 volt arc would probably not hold, and across which it is more difficult to lodge a short piece of wire. The lines are spiralled in the same places that they were formerly.

Another detail change on the line is the removal of the guard wires, which were intended to serve as lightning arresters. These have been taken down, as the trouble they caused through falling over the line wires proved greater than any probable benefits. There are no line arresters on the circuit—*i.e.*, lightning arresters are only in use at the transmitting end at the Tonawanda sub station (which taps the line), and at the Buffalo terminal house, where the line goes underground.

The line is still worked at a pressure of 11,000 volts, the contemplated change to 22,000 volts not having been made as yet. At present, owing to the lack of sufficient generating equipment to meet all demands for power, the Buffalo end of the system is limited to about 10,000 H.P., which can be carried over the present line without excessive drop. When more power is available, and is utilised in Buffalo, more copper or a higher voltage will be necessary. Present plans contemplate installing, during the coming summer, another independent pole line between Niagara Falls and Tonawanda to reinforce the present line up to that point, the load on that part of the line being heavier than on the rest of the line into Buffalo owing to the fact that the Tonawanda station absorbs no small amount and the Lockport line is tapped off at Tonawanda. A new and separate line of poles will be run, to avoid an interruption of the supply through the fall of a pole on either line. The new line will be erected on the other side of the 30ft. right-of-way, one side of which is now occupied by the present pole line.

To further provide for the expected increase of loads in Buffalo, it is proposed to raise the line pressure to 22,000 volts, but it is not considered advisable, on account of static, to introduce this high pressure into the extensive underground network which has gradually been developed and connected to the 11,000 volt system in Buffalo. On this account another transformation will probably be made at the terminal house in Buffalo, where the overhead line ends and the underground lines begin. This transformation will be from 22,000 volts to 11,000 volts. The power will then, between the dynamos and the consumer's premises, undergo an unusually large number of transformations, which are necessitated by the peculiar conditions of the case, but warranted by the low cost and high efficiency of the large transformers which can be used in work on this scale. In the power house there will be one step-up transformation from 2,200 to 22,000 volts, in the terminal house in Buffalo the pressure will be stepped down from 22,000 to 11,000, and at sub-stations in Buffalo it will be further stepped down from 11,000 to 2,200 for distribution to consumers who take it in the 25 cycle form. At the premises of these consumers there is a further reduction to 440 volts, 220 volts, or whatever is adopted as most suitable for use under the particular conditions of the installation.

On account of the large number of extensions and ramifications which this transmission system will undoubtedly possess within a few years, and on account of the enormous amount of power ready to concentrate itself upon any fault and cause serious trouble, the problem of protecting the lines by means of circuit-breaking devices has been studied out with unusual care and developed on an entirely new basis. The problem has been rendered still more difficult owing to the use of a large number of synchronous motors and rotary convertors. These machines, when loaded, will fall out of synchronism should the supply be interrupted or the voltage fall seriously during only a few seconds' time. When the supply returns after such a brief interruption the machines are running too slowly to lock in step again, and promply blow their fuses and stop, causing considerable interference with regular working before the normal condition can be restored. On this account it becomes necessary to maintain at all hazards the continuity of the supply without the slightest risk of an interruption

There are two complete three-phase transmission circuits running from the power house at the left to the various centres of distribution. Each sub-station or large consumer of power may be tapped into both these lines, so that in case one fails the other will continue to deliver power. In case a short-circuit occurs on one of two lines cross connected in this way at several points, the current will tend, of course, to come over the cross connections, where the sub-stations are tapped out, from one line to the other, thus throwing out the circuit breakers supplying both lines at the generating end. To avoid this contingency there are inserted in the cross connections what are termed reverse-current circuit breakers. These circuit breakers are so designed that when power flows through one of them in the normal

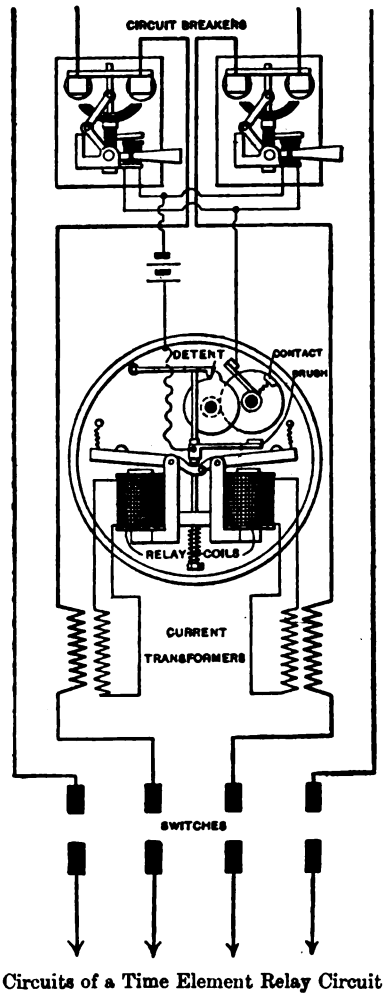

FIG. 8.—The Circuits of a Time Element Relay Circuit Breaking Set.

direction from the transmission line toward the common connection into the sub-station, the breaker will not operate, no matter how heavy the load may be. In case, however, the power tends to flow back through any one of them in the reverse direction from the sub-station connection into the transmission line, the circuit breaker is immediately affected and opens the circuit. Incidentally it might be noted that if any sub-station contains a large storage battery connected with the system through rotary converters or motor-generators, and the power is cut off on both lines, leaving this storage battery and its transforming machines loaded with all the other sub-stations, the reverse-current circuit breakers between the storage battery sub-station and both lines will operate, cutting that station off from both lines and allowing the battery to drive the machines in its own station by means of its stored power. Detailed descriptions of two quite different forms of reverse-current circuit breakers will be given further on in describing the stations of the Cataract Power and Conduit Co. and of the Tonawanda Power Co.

The system is further protected by what is known as the time-element feature, which has already been mentioned in connection with the Carbide transmission. At the risk of repetition, the

* Abstract from the *American Electrician*.

† Articles on this subject also appeared in *The Electrician*, Vol. XLII., pp. 565, 600.

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general scheme of the time-element devices will be again pointed out. Referring to the general diagram of the lines (Fig. 8), it will be seen that the feeders running out from the sub-stations, as well as the sub-stations themselves and the transmission lines in turn supplying them, are all protected by circuit breakers. To prevent a short-circuit on a feeder from tripping the circuit breakers operating the whole station, or even the circuit breakers supplying the whole transmission system, before the breaker on the feeder can open the circuit and blow out the arc, the time-element feature has been adopted. This feature consists of an arrangement of the parts so that a breaker does not open instantaneously upon the occurrence of a short-circuit, but only opens in case a short-circuit continues for a certain predetermined and adjustable length of time. This time is so adjusted that the circuit breakers most distant from the generating plant open first—let us say in one second—while those further back towards the plant, and hence covering a greater number of lines or machines, do not operate as quickly, but only after the short lasts three seconds; and those at the plant itself, and covering the whole network, operate most slowly, only after a continuance of the short for perhaps five seconds. Thus, if a short-circuit occurs upon a feeder running out from one of the sub-stations, the circuit breaker in that feeder operates at once and before the breakers covering the whole sub-station or the breakers in the transmission lines can be tripped. If a short-circuit occurs in a sub-station, it continues until the breakers protecting the station are tripped, but those protecting the transmission lines, having a longer time interval, remain unaffected.

Two quite distinct forms of time-interval apparatus have been devised and put in service on these lines, one made by the Westinghouse Co. and the other by the General Electric Co. The former was described above in connection with the Carbide transmission. The latter is in use on the Buffalo transmission line, and may be described as follows: The time-element feature is not incorporated in the construction of the circuit breakers themselves, but is brought into their action by means of a relay principle; that is to say, the overload currents, or rather the derived currents from series transformers in the main lines, are not introduced into the breaker tripping coils, but are introduced into a separate time-element mechanism, which in turn acts as a relay closing a local circuit through the tripping coils and thereby operating the breakers.

In appearance the breaker resembles in form the General Electric railway breaker with the magnetic blow-out attachments removed. The live contacts on the movable part are insulated from the mechanism by a large disc of mica and hard rubber. The breaker only opens a short distance, and depends upon a fuse shunted around its contacts to take and destroy the arc which follows this opening.

The time-element device consists of a clockwork and two magnets enclosed in a cylindrical case with a glass cover, all of which is mounted on the front of the panel containing the breakers. The two magnets are connected respectively with the secondaries of two series or current transformers in the two phases of a two-phase circuit or two legs of the three-phase circuit to be protected. In case a short-circuit occurs on any phase, the current flowing to it must pass through one or the other or both of these legs, so that there is no necessity of a series transformer and coil for the third leg. If either coil becomes energised by an overload, it releases the clockwork of the instrument, and if the short-circuit continues, this clockwork closes a local circuit which connects with both the tripping coils of two circuit breakers which open two legs of the circuit to be protected. In case the system is three-phase, there is no circuit breaker in the third leg, since if two legs are open the load is certain to be thrown off no matter what phase it may be on.

The Work of the Cataract Power and Conduit Co.—The work of distributing, transforming, and selling the power transmitted by the Niagara Falls Power Co. to Buffalo is carried on by an associated corporation known as the Cataract Power and Conduit Co. This company assumes control over the transmission line, where it enters the Buffalo city limits, and handles the power from that point to the consumer's premises. The property of this company consists altogether of a distributing network, largely underground, and several sub-stations containing transformers, switchboards, and regulating apparatus, but with no running machinery except small auxiliary apparatus such as blowers.

The company's work is so largely of a concealed nature that but few realise the extent of the underground network that is already distributing 25 cycle power throughout the city of Buffalo. Beginning at the city line, the company operates a section of the overhead pole line running in from the city limits 3,740ft. to a new terminal house, where the overhead pole line ends and the underground cables begin. This terminal house contains simply lightning arresters and switchboards for cutting out either one of the overhead transmission lines or any one of the various cables that start from it. The cables from this point to the various sub-stations are of course operated at 11,000 volts. These 11,000 volt cables aggregate a total length of 151,000ft. They are three-conductor cables, mostly of sizes No. 000 and No. 1.

In addition the company operates about 20,000ft. of three-conductor cable on its 2,200 volt distribution lines from the sub-stations to consumer's premises, as well as some 27,000ft. of overhead pole line on the 2,200 volt system. For its underground cables the company now has about 65,000ft. of conduit, nearly all Camp vitrified tile with concrete manholes. This conduit aggregates about 825,000 duct feet, in addition to which the company occupy other conduits, in common with the Buffalo General Electric Co., and has some of its cables drawn into conduits belonging to the International Traction Co. With both these companies the Cataract Power and Conduit Co. is associated through its delivery of power for their use.

Referring again to the map, it will be seen that three cables are used to supply the three sub-stations of the Cataract Power and Conduit Co., one cable running to sub-station No. 1 only, one other to sub-stations Nos. 2 and 3, and the other to all three sub-stations. The fourth, which was only drawn in during the last year, is used for supplying four new rotary converter sub-stations of the International Traction Co., located at points designated by Figs. 5, 6, 7, and 8 on the map. This cable forks to two branches, one running to two of these sub-stations and the other to the other two. The total length of the cable is some 14 miles. This long cable is of the Habirshaw make, manufactured by the India-Rubber and Gutta Percha Insulating Co., Glenwood Works, Yonkers, N.Y.

On account of its length, this cable will be divided into sections by junction boxes located in manholes. Each of these 11,000 volt junction boxes will consist of a small marble panel carrying three switches mounted on hard rubber bushings, and separated by barriers, the whole arrangement being similar to the switches used in the sub-station work. This little switchboard will be enclosed in a cast-iron box, with removable covers both front and back for reaching either the switches themselves or the back connections. The covers will be bolted on watertight rubber gaskets.

The general scheme of this company's distribution comprehends transformation in sub-stations from the line pressure of 11,000 volts three-phase to 2,200 volts three-phase, with distribution at this pressure to consumer's premises, at which points the pressure is again reduced to that required by the apparatus driven. In the case of very large consumers this scheme is departed from by locating the sub-stations immediately adjacent to the premises and transforming direct from the transmission line pressure to the voltage desired by the consumer. For instance, sub-station No. 1 is located in the structure of the International Traction Co.'s famous steam-power plant on Niagara-street. In this sub station 2,000 H.P. is transformed from 11,000 volts to 360 volts three-phase, at which pressure it is taken by the railway company's rotary converters. The station also contains 11,000 volt to 2,200 volt transformers for supplying motor loads in the vicinity.

Sub-station No. 2 is located down in the dock district, in the midst of large grain elevators, shipyards, &c. Power is transformed at this point only to 2,200 volts three-phase, but with arrangements for a considerable range of voltage by means of induction regulators or boosters. These were provided on account of the heavy induction-motor load taken off from this station and the drop liable to be caused by the lagging currents of such a load.

Sub-station No. 3 is a wing of the Buffalo General Electric Co.'s central station, which is driven entirely by means of Niagara power. The Buffalo General Electric Co. takes all its power at 352 volts three-phase on account of this pressure being suitable for the 500 volt rotaries of its power service, and also on account of the fact that this pressure is a convenient one for the many synchronous motors driving arc and other central station dynamos: 352 volts is high enough to avoid excessive cost of copper in the station distribution, and low enough to avoid difficulties in the insulation of motor windings or physical danger in operation. On this account sub-station No. 3 of the Cataract Power and Conduit Co. delivers most of its power at 352 volts three-phase, something over 3,000 H.P. being demanded by the Buffalo General Electric Co. at times of heaviest loads. The sub-station also contains 11,000 volt to 2,200 volt transformers for large motor loads in adjacent territory, small motor loads being carried by 500 volt direct-current motors run from the Buffalo General Electric Co.'s power circuits.

The power taken in by the four new rotary converter sub-stations of the International Traction Co. is not transformed by the Cataract Power and Conduit Co., the traction company taking the power in the 11,000 volt form and doing its own transformation.

There are now connected to the circuits of the Cataract Power and Conduit Co. alternating-current motors or rotary converters with an aggregate capacity of 13,000 H.P. Owing to the present lack of sufficient generating equipment at Niagara Falls to meet the increasing demand, the Cataract Power and Conduit Co. has been limited—as was mentioned above—to about 10,000 H.P. On this account and until additional installation at the Falls, now under construction, is completed, the company will be unable to take on new loads except small ones with peaks not coinciding with those of its daily load curve. The Buffalo General Electric Co. alone has contracted for 3,000 H.P., and the International Traction Co., as soon as its new rotary stations are finished, will take 5,000 H.P.

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The other loads are comparatively small, but by no means insignificant either in size or in number. Two large grain elevators are supplied from sub-station No. 2, one requiring 1,000 H P. The Union Dry Dock Company operates extensive machine shops by means of induction motors. These shops are unique in that individual motors, one for each machine, are used—probably the first instance of individualisation of alternating-current motors to any considerable extent in this country. Owing to the high speed of induction motors, they are not direct geared to the tools, but are belted. In the yard of the same company the polyphase currents drive a mammoth crane serving the building berths. This crane, the individual motors in the shop, and the motors of the elevators mentioned above, are a standing refutation of all arguments against the use of alternating-current motors on account of their alleged inability to drive loads requiring high starting torques or variable speeds.

A few figures as to the efficiency of the transformation and transmission from Niagara Falls to Buffalo may be of interest. The total loss between the primary or 2,200 volt side of the step-up transformers at Niagara Falls, and the secondary or 352 volt side of the step-down transformers in sub-station No. 3 in Buffalo, amounts to about 25 per cent. of the power delivered throughout the entire day. This is a transmission of 28 miles with two transformations. The efficiency is maintained at a high point under light loads by cutting out step-up and step-down transformers, and taking all advantage possible of the increased efficiency of the line at low loads.

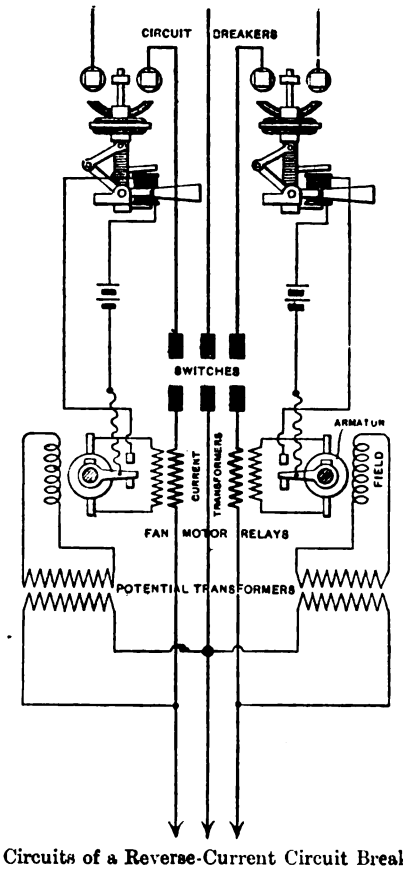

FIG. 9.—The Circuits of a Reverse-Current Circuit Breaker Set, showing how a direct-current motor is used with alternating currents to indicate direction of current passing in the line.

In the sub-stations of this company Nos. 1 and 2 we find the first reverse current circuit breakers, the general purpose and principle of which were outlined above in the general discussion of the protection of the transmission line. They open but a short distance, as the right-hand one indicates, the arc being taken and blown out by means of a shunt fuse exactly like that used with similar breakers fitted with the time-element feature described above in connection with the Niagara Falls end of the transmission line.

The tripping coils of the breakers are connected with relays, which consist simply of General Electric fan motors. The two motors may be seen on the sub-base of the panel. These fan motors are provided to distinguish between power going through the circuit in one direction and power going through in the other direction in order to operate the breakers only when the direction of transference of power reverses. Obviously in alternating-current work the current itself is constantly reversing, and no polarised apparatus can be used to distinguish between a flow of current in one direction and that in the other. The fan motors have their fields connected to potential transformers, giving them a constant and strong alternating magnetisation. The armatures are connected through the brushes with series or current transformers, as indicated in the general diagram of circuits, Fig. 9.

The reaction of the current in the field upon that in the armature of one of these fan motors sets up a torque in one direction on the motor shaft, because the currents in both armature and field reverse simultaneously. If, however, the direction of flow of power in the main circuit reverses, the armature of the fan motor gets what may be called a positive current while its field is getting a negative, whereas formerly both armature and field received positive currents simultaneously; the torque of the armature is reversed and a crank mounted on the motor shaft rotates from a back stop to a front contact closing a local circuit through the tripping coil of the circuit breaker. This local circuit may be, and is in most cases, excited by a potential transformer, or it may be excited by means of a battery, as indicated for simplicity sake in the diagram. The local circuit passes through a contact on the breaker (not shown in the diagram) designed to cut off the battery power as soon as the breaker is tripped.

It is of course desirable that there should be no difference of phase between the currents in the armature and the field of the fan motor when the load is non-inductive; then a considerable lag or lead of the load will not cause a reversal of the torque. This can be realised in several ways well known in alternating-current work, such, for example, as connecting in Y the primaries of the potential transformers supplying the fields of the fan motors; or the self-induction of the motor field may be depended upon. In actual practice at Niagara a small three-phase transformer is used, so built and connected that proper phase relation is obtained.

STORAGE BATTERY PROBLEMS.*

BY E. J. WADE.

PART I.

Everyone who has given any thought to the principles underlying the chemical storage of electrical energy must at some time or another have been struck by the extraordinary fact that in spite of the theoretical reversibility of every galvanic combination—and their name is legion—yet one and one only out of the whole number is commercially feasible; so that at the present day storage cells may at once be classified thus:—Practical: Lead—sulphuric acid—lead peroxide cells. Unpractical: All others. Such, however, being the state of affairs, it appears a fairly safe inference that this special combination must possess distinctive features not shared by any other, or at least by any other whose cost is not prohibitive; and on examination this soon proves to be the case.

Several noteworthy features, each contributing towards its success, might be cited; but the really unique characteristic of the combination as a whole lies in the fact that the electrodes, the active materials, and the compounds produced from them are, under every normal condition of use, all insoluble in the electrolyte employed. In every other galvanic combination with which commercial storage has been attempted, one or both of the electrodes or active materials have been soluble, and this solubility has in the long run invariably proved fatal. If a soluble negative is used, and the majority of the attempts made have been in this direction by substituting zinc for lead, the metal can only be redeposited effectively under certain conditions and for a limited number of times. If the positive is soluble, as for instance in the early attempt of Messrs. Thompson and Houston to adapt the Daniell cell to storage purposes, there is the additional trouble that its soluble salt inevitably reaches sooner or later to the negative electrode, where it is also deposited and sets up destructive local action. The latter objection of course applies to all kinds of fluid depolarising agents. For these amongst other reasons the difficulties in the way of constructing successful storage cells with soluble electrodes have up till now proved insurmountable; while a second combination, which follows the lines of the lead accumulator and only forms insoluble compounds at both poles, yet remains to be discovered. So advantageous, however, to the electrical industry might be the results attending the introduction of an altogether new type of cell, possessed of greater capabilities than those now in use, and so considerable should be the reward of its inventor, that the subject well merits further investigation and experiment in both directions; but I incline to the apparently paradoxical opinion that the solution of the problem, if any, willbe an insoluble one. Also I think that, considering the extent to which the field has already been worked over, success is most likely to be attained by the utilisation of some of the less studied and more obscure reactions into which the metals enter.

On turning our attention again to the lead—sulphuric acid—lead peroxide combination, the storage cell of commerce, a second remarkable fact encounters us. We find that although these cells have now been manufactured and used on a large commercial scale for

* Paper read before the Institution of Electrical Engineers, March 22.

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close upon 20 years, and during that time have been the subject of frequent laboratory investigations, it is not yet definitely settled what are the exact physical and chemical changes taking place in them. Now, this is a most unsatisfactory state of affairs. If, as is not impossible, we may always have to depend on this one combination for all practical electric storage, it becomes of the greatest importance to determine whether its capabilities have already been developed to their utmost limits; or, if not, in what directions further advances are possible: but how can this be done without any certain basis to work from? The last 15 years have witnessed more improvements in lead accumulators than might at first sight be apparent from an inspection of the cells themselves, for they have consisted not so much in any radical alterations of type as in a better understanding of the methods of treatment, the processes of manufacture, and the proper proportions and relations of the various component parts. A general readjustment, in fact, of many details all tending towards one common end, and resulting in an apparatus far better able to meet the requirements of its users. On the other hand, there are indications that empirical experimenting has nearly reached its limits, for I do not think that many of these improvements have been made very recently. It is true that within the last few years there have been numerous attempts, as the Patent Office records bear eloquent witness, to reduce the weight of the cells in order better to adapt them for traction purposes generally, but more especially for use in electric automobiles. Time and trial have already pronounced their judgment on most of them. A few survive, but whether their *sum total* of usefulness shows any increase over earlier types appears to be doubtful. It has of course long been known that weight could be considerably reduced at the expense of life and durability, if circumstances rendered it desirable to do so; but unless the one factor is improved without depreciating the other, that in itself hardly constitutes any real advance. On this question of weight versus durability, however, the views of members who have had actual experience with the later and lighter types of cells would be of much use and value.

The preceding considerations must be my excuse for devoting a considerable portion of this Paper to a discussion of some of the theoretical and chemical questions connected with lead cell, for if I can help to throw light, or be the means of getting any further light thrown on this part of the subject, I may after all be doing the most practical service possible. Personally I have no doubt that, as far as any explanation based solely on the results of chemical analysis can help us, the "double sulphation" theory gives the nearest approximation to what does or should take place on discharge. Put shortly, this theory maintains that on discharge lead at the negative and lead peroxide at the positive react with sulphuric acid in the electrolyte and are both converted into normal lead sulphate, water being eliminated at the positive; and the reactions are expressed chemically in the following well-known equations:—

At the negative electrode: $Pb+SO_4=PbSO_4$; at the positive electrode, $PbO_2+H_2+H_2SO_4=PbSO_4+2H_2O$; and the sum of the reactions at both electrodes: $Pb+2H_2SO_4+PbO_2=2PbSO_4+2H_2O$. I have advisedly said that this is the "nearest approximation" to the discharge reactions, for the above statements, if taken literally and without considerable mental reservations, especially with regard to the very definite facts embodied in the equations, are probably inaccurate, and certainly open to question in nearly every particular. In the first place, it is doubtful whether negative active material is simply lead, Pb, using the word and symbol without any qualification and in their usual sense as applied to the ordinary metallic form of that substance. If for a negative electrode of spongy metal electrolytically prepared we substitute one containing metallic lead in as fine a state of subdivision as it is possible to procure it by purely mechanical means, such, for instance, as lead dust or lead wool, no practical storage capacity can be obtained. The evidence seems to show that the spongy lead at the negative, in addition to its extreme porosity, possesses distinctive chemical properties, and is a true allotropic modification which enters into combination somewhat differently to how lead does in its normal condition. M. Darrieus, who was, I believe, the first to propound this view of the nature of the negative active material, has shown that the E.M.F. of various galvanic combination in which electrolytically prepared lead is employed is 0·3 to 0·4 volts higher than that obtained by substituting ordinary sheet metal. This proves that the former must be in an abnormally active state; and the same fact is shown chemically by the extreme readiness with which negative active material oxidises when exposed to the action of the air, the combination taking place so rapidly that the heat liberated very considerably raises the temperature of the electrode.

Secondly, there is some reason for believing that the positive active material is not normal lead peroxide, PbO_2, if we adopt as our standard for that compound the residue left after treating red lead with dilute nitric acid, which certainly has a proportional composition agreeing with this formula. Mr. FitzGerald drew attention to the point in 1890, the evidence being of a somewhat similar nature to that just adduced in the case of the negative active material—namely, a difference in the E.M.F.s generated by the two substances. The probability is therefore suggested that the crystalline electrolytically prepared peroxide of a positive electrode is also an allotropic modification, and not identical with the amorphous anhydrous peroxide obtained by chemical means; but in this case the matter is complicated by Mr. FitzGerald's further observation that, as far as his experience goes, the electrolytic peroxide is always hydrated. While then, for lack of more definite knowledge, still using the formula PbO_2, it must be considered only provisionally correct.

Thirdly, the usual equations are very misleading as to the nature and composition of the discharge products. Quite apart from the confirmation afforded by analysis, the most casual examination shows that the active materials are never fully sulphated by the time the discharge is completed, no matter under what conditions it is taken nor how small the quantity of active material employed. Even with the merest films of spongy lead and lead peroxide the same fact is patent to the eye. This is indeed only one aspect of the more general objection which has been urged by Mr. FitzGerald for many years past, that the very definite discharge equation must have some equally definite E.M.F. corresponding to it, no matter what may be its absolute value; whereas the E.M.F. of a discharging cell is a constantly varying one. Even granting that the small but rapid drop of E.M.F. generally observed during the first few minutes of a discharge is the result of special reactions not allowed for in the equation, and that the complete and sudden loss of voltage which ends the discharge is also brought about by causes beyond its scope, yet the fact remains that throughout the normal and useful portion of the discharge lying between these two the E.M.F. is slowly but steadily falling all the time. Even the assumption of the partial conversion of either of the active materials into normal lead sulphate, $PbSO_4$, under ordinary discharge conditions, is not to be reconciled with their observed behaviour, which is in many respects incompatible with the presence of large percentages of that substance. To instance one. Normal lead sulphate is probably quite irreducible if not unperoxidisable in a dilute sulphuric acid electrolyte of the strength ordinarily used in storage cells, *provided all the materials are absolutely pure*, for the smallest traces of impurities make a remarkable difference in this respect. But however that may be, there is no doubt as to its being acted upon with extreme slowness, under the most favourable conditions in admixture with other materials of a more conductive nature, and then only with an excessive outlay of energy in proportion to the result obtained; whereas both the active materials can be brought back to their original states of lead and lead peroxide with great rapidity and the expenditure of very little more current than is theoretically necessary. This discrepancy, as well as the almost complete masking of other properties of the normal sulphate, can hardly be explained as due to its state of extreme subdivision and intimate admixture with unaltered active material, for under certain well-known conditions of treatment it does appear in full possession of its distinctive colour and with its non-conductivity and irreducibility aggressively in evidence. A good deal more might be said as to these and other reasons which forbid our accepting the double sulphation theory in its simplest form except as a purely provisional statement; but without stopping to discuss them further, I will give a very brief summary of what I believe to be the real nature of the various changes that go on in the cells.

Commencement of Discharge.—The active materials of fully charged negative and positive electrodes consist of lead and lead peroxide respectively, but *both in allotropic or polymeric states, and possessed of a molecular structure far more complex than is represented by the formulæ* Pb *and* PbO_2.

Normal Discharge.—On discharge no molecules of lead or lead peroxide are wholly and directly converted into normal lead sulphate; but, *still maintaining their complex molecular structure*, they pass through a long series of true compounds containing SO_4 in gradually increasing proportions. In this way no portion of the active materials loses its conductivity nor is cut off from electrical connection with the remainder, and its easy and rapid desulphation on recharge is thereby provided for.

End of Discharge.—This absorption of SO_4 does not and cannot go on until the molecules are fully sulphated, because at some intermediate stage their electrical resistance, which previously has only been increasing slowly, commences to go up with extreme rapidity. This change is necessarily accompanied by an equally sudden and rapid fall in the cell's potential difference, which soon passes below the usual limiting value; but if the circuit is still maintained the internal resistance goes on rising, and in a short time the potential difference is reduced practically to zero. Most probably the rapid acceleration of resistance sets in when the molecules of active material have attained the respective proportional compositions $Pb_2O_2SO_4$ and Pb_2SO_4.

Reversal.—If the current is kept flowing through the cell by means of an external E.M.F., reversal now commences. No further sulphation of the active materials takes place, the proportion of SO_4 present in the molecules remaining constant throughout this stage, but lead

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gradually passes over to peroxide at the negative, and *vice versa* at the positive, until their composition, as given above, is exactly reversed. Here again the change is only effected through a whole series of intermediate compounds, and *the molecules retain their complex structure intact.*

Recharge.—The recharge of a cell, whether in continuation of the reversal or as the normal charge following on a discharge, consists essentially in the gradual withdrawal of SO_4 from the molecules until allotropic lead and lead peroxide are again reproduced. Other reactions on charge are only incidental so far as the active materials are concerned.

"*Sulphating*"—Using this word in its well-understood technical sense, sulphating consists in the breaking up of the complex molecules, containing more or less SO_4, into a number of simpler and independent molecules of normal lead sulphate and of lead or lead peroxide. This rearrangement of structure destroys the continuity and conductivity of the active material, and at the positive, if not at both electrodes, is accompanied by an increase in bulk which may lead to the breaking up of itself and its support. Nothing further is needed to bring about this change than rest on open circuit; but the instability of the compounds appears to be largely proportional to the percentage of SO_4 present either in the active materials or in the electrolyte—that is to say, it increases with the extent to which the cell is discharged and with the strength of acid used in it. Probably local action, due to impurities and other causes, plays an important part in facilitating the same result; and a still more favourable condition is the excessive weakening of the acid electrolyte in the pores of the active materials during discharge.

It will be observed that the foregoing views are entirely based on the possibility of the active materials existing in two distinct molecular states: an allotropic one involving a complex structure and, although unstable, corresponding to the normal and healthy working condition of the cell, and a simpler and more stable one, but identical with the undoubtedly deleterious condition known as "sulphated." From its very nature direct proof of this assumption is almost impossible, and as the indirect arguments are mostly theoretical and require a consideration of some of the purely chemical characteristics of the lead compounds, I have dealt with them separately in the second part of this Paper. In it I have also traced out in more detail the different changes that must ensue in the cell according to this hypothesis, for the way in which it enables us to furnish a consistent and reasonable explanation of the cell's behaviour in every respect appears to me to furnish one of the strongest arguments in its own support. One obvious objection to the theory may be referred to here. Involving, as it does, the formation of numerous sulphated lead compounds of infinite composition, it runs counter to the usual text-book chemistry, which draws an absolutely hard and fast line between chemical compounds and mechanical mixtures. In recent years, however, the rapid advances made in our knowledge of physical chemistry have provided much evidence obtained from very different sources, such as the properties and behaviour of alloys and of aqueous solutions, all tending to prove that substances may exist whose components do not apparently follow the law of combination in multiple proportions, and yet must in other respects be regarded as true molecular and chemical compounds. Of this nature are the compounds normally formed during the discharge, reversal, and recharge of a lead cell.

From this basis of theory we can now proceed to the consideration of some points of more direct practical importance. In the first place, it it is true that the molecules of active material *inevitably* cease liberating electrical energy when they are about 50 per cent. sulphated (giving on analysis 44 per cent. by weight of unaltered peroxide at the positive and 40·5 per cent. of uncombined lead at the negative), owing to a sudden and large increase in their electrical resistance at that stage, then the actual performance of commercial storage cells approaches far nearer to the theoretically possible maximum than has hitherto been supposed. If it *could* be effected electrically, the complete sulphation of 1lb. of lead would liberate 118·5 ampere hours, and the complete reduction to sulphate of 1lb. of lead peroxide 102·5 ampere-hours; but I consider that the real standard of perfection should be just half these values—that is, 59·25 and 51·25 ampere-hours respectively. (The figures for the peroxide are based on the assumption that its proportional composition is PbO_2; if it is hydrated its possible output will be slightly less.) The active materials of well-designed and properly formed Planté type electrodes do, I think, often approximate to these outputs when discharging at low rates, say in nine to twelve hours, and, judging from the analyses of the positive paste in the E.P.S. cells tested by Prof. Ayrton in 1890, the active material of Faure type electrodes is also capable of doing so; but in this special instance the previous treatment of the cell was exceptionally favourable, and as on a 12 hour discharge rate its capacity came out about 33 per cent. above its listed value, it had evidently been worked up to a state of efficiency but seldom attained, still less maintained. In practice, pasted electrodes hardly ever give more than 30 to 40 ampere-hours per pound of positive or negative active material, while about half these values is probably a more usual figure, for, although the specific output of the active materials in new electrodes is often high, yet in many cases it decreases considerably with use; and if the electrodes are of faulty design or manufacture, or the cells not properly looked after, it may drop to almost any extent. However, with all electrodes, whether of the Planté or Faure type, there is a very considerable falling off in the specific output of the active materials as the discharge rate is increased. The exact amount and curve of decrease varies with every different make of cell, but the best of them do not, at a three-hour rate, give more than two-thirds to three-quarters of their output on a nine to twelve-hour rate; while if discharged in one hour their output is only about one-half or even less. After all, then, there is still some considerable margin left for improvements in the ratio of output to weight, especially when rapid discharges are required; and these are often precisely the cases where a reduction in weight would be of the most importance and use, provided it were not effected at a sacrifice of durability.

It is evident that to obtain the maximum output from any active material the electrolyte must have access to each of its individual molecules, so as to include them all in the electrolytic circuit; and its porosity therefore must be thoroughly molecular. That is to say, in addition to the spaces that exist between the small visible particles of material, each of these particles must itself be porous throughout. Most negative active material necessarily fulfils this condition, as the electrolytic reduction of the oxide or other insoluble salt employed must leave each molecule of lead surrounded by a space, also of molecular proportions, previously occupied by the other elements in combination with it.

The case of positive active material is somewhat different. If it is prepared from salts, such as lead sulphate or lead chloride, possessing about twice the bulk or half the density of lead peroxide, its molecular porosity is initially provided for just as it is in negative active material; but if it is obtained from litharge or minium or other compounds whose density is about the same as that of the peroxide itself, it is not at first sight evident how it can possess any porosity beyond the spaces between its visible particles; while if it is produced from solid metallic lead by a formation of the Planté type, no porosity of any kind seems to be provided for. In all these cases, however, the materials, before being peroxidised, no doubt pass through an intermediate stage of partial sulphation accompanied by a proportional increase in bulk, so that in this respect the conditions are to some degree the same as if lead sulphate had been the original raw material. That some such growth of the positive active material does take place during its first formation is shown by the expansion of its support which almost invariably attends this process, whether the electrodes be of the formed or pasted variety. But although the pores and spacing are there, they are quite inadequate to contain anything approaching the amount of electrolyte required for the full discharge of the active material surrounding them. Negative active material sufficiently porous to hold its own volume of liquid will have what is sometimes incorrectly called a "density" of 5·7 (half the density of solid lead, 11·4) or, as I prefer to term it, a 50 per cent. porosity; and this is a good average figure for the spongy lead in commercial cells. Lead peroxide being bulkier than lead, positive active material is, as a rule, not nearly so porous, and a good average material will certainly not have more than a 33 per cent. porosity, or a so-called density of about 6·3 (two-thirds that of solid PbO_2, 9·45), and it will only contain one-half its own volume of electrolyte. Now, solid lead requires about 24 times and solid peroxide about 16 times their own volumes of dilute sulphuric acid, sp. gr. 1·200, for their 50 per cent. sulphation, with a fall of acid strength to sp. gr. 1·150; so that negative and positive active materials of good average porosity can only contain about $\frac{1}{24}$th and $\frac{1}{32}$nd respectively of the quantity of electrolyte necessary for their complete discharge under these conditions. Even if the whole of the acid were abstracted from the solution in the pores, leaving nothing there but water, then the negative and positive active materials could respectively contain only about $\frac{1}{8}$th and $\frac{1}{11}$th of the necessary amounts of 1·200 acid, or about $\frac{1}{4}$th and $\frac{1}{10}$th if 1·300 acid were employed.

These figures show very clearly how entirely the output of a lead cell is dependent on the diffusion of acid from the main body of the electrolyte into the depleted solution in the pores of its active materials. As long ago as 1889 Messrs. Duncan and Wiegand called attention to some of the results that must ensue if proper diffusion were not provided for; and Messrs. Gladstone and Hibbert, in their communication to this Institution in 1892, also indicated some of the effects probably due to this cause. In the latter instance, however, they were considering the matter chiefly in its relations to the E.M.F.s of cells under various conditions; and I think it yet remains to be recognised how far-reaching are the consequences of defective diffusion, and how many of the faults and shortcomings of the cells may be attributed to it. Rightly to comprehend the scope of its action, it is advisable to consider in some little detail just what takes place in the active materials of a cell when discharging at some rate sufficiently high to bring the effects of imperfect diffusion well into play; that is, at a rate which reduces its output considerably below what can be obtained at slower rates.

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It is impossible to say the exact proportions in which the different parts of the active materials will contribute towards the discharge current on first closing the external circuit, for this largely depends on the relative resistances of the electrolyte and the active materials themselves—a very problematic question. Lead in a solid state has only about one-twelfth the conductivity of copper, and in the porous condition its specific resistance is almost certain to be very much higher, but even then it is no doubt considerably less than that of the electrolyte; so, as regards the negative electrodes, the layers of active material nearest to the opposing positives will tend to supply more than their due share of the total current. On the other hand, although lead peroxide is one of the best conductors of electricity of any solid compound substance not entirely metallic, its specific resistance is of the order of a fluid electrolyte, and is probably higher than that of the ordinary acid solution in a cell; therefore at the positive electrode it is possible that at first the inner layers of active material may discharge a little more rapidly than the others. At both electrodes, however, the distribution of the work is also affected by other conditions, such as the nature and position of the conducting support; and, on the whole, it will be simpler and not much amiss to assume that the initial contribution of every molecule of active material to the discharge is approximately equal, provided that sufficient time has elapsed since the previous charge for the strength of the acid thoroughly to equalise itself throughout the pores. But this state of affairs begins to alter immediately after the discharge has commenced. The diffusion not being sufficiently rapid to supply acid to all parts of the electrolyte as fast as it is being withdrawn by the active material, the solution becomes graduated into a series of layers or strata (assuming the active materials are of uniform porosity throughout) of different strengths, those layers directly adjacent to the surface undergoing practically no alteration, while the innermost layers will be the most weakened. This change must necessarily be accompanied by a variation in the E.M.F.s acting at different parts of the active materials, for it has been demonstrated by several researches, notably those of Messrs. Gladstone and Hibbert and of F. Streintz, that the E.M.F. of a lead-lead peroxide couple in dilute sulphuric acid depends on the strength of the electrolyte Roughly speaking, it slowly decreases from 2·05 volts in 1·200 acid to 1·85 volts in about 1·030 acid, and then drops away rapidly to 1·45 volt, the E.M.F. of the couple in pure water. Consequent in its turn upon the variations in the E.M.F., the relative rates at which the molecules generate current are correspondingly affected throughout the active materials, for only by that means can a uniform potential difference be maintained between every portion of the opposing electrodes. In this way, too, the inequalities in the strength of the electrolyte are prevented from passing certain limits, because just as fast as the acid in solution diminishes so does the rate of sulphation which brings about this diminution decrease also, until at all points in the active material the absorption of acid and its replenishment by diffusion just balance each other, the net result being that the outer layers supply considerably more and the inner layers considerably less than their due share of the current.

This unequal distribution of the work is not only maintained throughout the discharge, but becomes more pronounced towards the end, for the conditions which regulate the rate of diffusion are steadily growing worse the whole time. The active materials gradually increase in bulk as they sulphate, thereby reducing their porosity, and it is just those portions through which the whole of the diffusion to the interior has to take place that choke up soonest and most thoroughly. As the discharge proceeds, the E.M.F. falls fastest when the sulphation is most rapid, and a more equitable proportion of the work would then be thrown on to the other parts of the active materials, were it not that their output is limited by the rate of diffusion, so they can only draw on the surrounding electrolyte till its strength and their E.M.F. is correspondingly reduced. Thus the potential difference between all parts of the opposing electrodes falls gradually and uniformly, and the variations of acid strength, small at first, slowly increase, until by the time the E.M.F. of the outermost layers working in the strongest acid has dropped to about 1·85 volt, solely by reason of their advanced state of discharge, the specific gravity of the solution round the inner layers will be 1·030 or thereabouts, and their E.M.F. also only about 1·85 volt, although they may not have done a tithe of the work of which they are capable. At this stage the specific conductivity of the active materials becomes the chief factor in controlling the further course of the discharge. The resistance of the outer and most sulphated layers goes up rapidly, and for a short time the burden of the discharge is probably taken up by the layers immediately beneath them. These, however, soon follow suit, and the resistance of the inner layers of the electrolyte, from which by now almost the whole of the acid has been abstracted, also being very high, the potential difference between the electrodes very quickly drops below the normal limit.

It is now apparent why the output of a cell decreases so much on heavy discharges, and also why little or no increase of capacity can be obtained by using masses of active material of more than a certain thickness. The higher the rate of discharge or the more impeded the diffusion, the less is the interior of the active material drawn upon for the maintenance of the current; while if either of these conditions is pushed to an extreme, nearly the whole of the work is done by a very thin outside layer, and by the time this is exhausted hardly any acid will be left in the electrolyte surrounding the remainder. Of course, as soon as the discharge is stopped fresh acid begins to diffuse in, and after a little while a further discharge is obtainable. By repeating this proceeding a sufficient number of times, the larger proportion of the deficiency on the first discharge may be made up.

Recharging is seldom effected at such extremely high rates as are sometimes used for the discharge, but they must often be quite sufficient to liberate acid in the pores of the active material considerably faster than it can be dissipated; and, although in this case the effects of imperfect diffusion are not so evident and the details of the procedure which brings them about are still more complicated, yet, following the same line of reasoning as has just been applied to the discharge, certain general conclusions may be drawn. The outer layers of active material will absorb more than their due proportion of the current, and by the time they are fully desulphated the inner layers, as yet only partially charged, will be surrounded by abnormally strong acid to enable them to maintain an equivalent voltage. Unless, therefore, the current is prolonged for a time after gassing has commenced and the end of the recharge only determined by a sufficiently high potential difference being attained, there is some likelihood of the inner layers not receiving their proper charge at all; and in any event the gassing, by expelling some of the electrolyte from the pores and destroying its continuity, must itself greatly retard the process.

Not only, then, is the *output* of a cell materially diminished through insufficient diffusion, but its *durability and life* must also be more or less seriously affected owing to the injurious conditions to which portions of the active materials and their metallic supports are thereby subjected—conditions favourable to the breaking up of the molecular structure of the former with "sulphating" and all its attendant evils, and to the destruction of the latter by local action. These effects are chiefly experienced by the innermost layers of active material, which work in abnormally weak acid towards the end of the discharge and abnormally strong acid towards the end of the charge, and in addition do not undergo that thorough desulphation on charging necessary to help to bring them back to their normal state. The outermost layers also suffer, however, inasmuch as they are liable to be over-discharged to the point of reversal every time the full output is required from the cell. At the positive electrodes, wherever the layer of peroxide in immediate contact with the support is broken up from any of the preceding causes, the metal itself will become exposed to electrolytic action and its sulphation and corrosion greatly facilitated.

A third effect of imperfect diffusion is to reduce the electrical efficiency of the cell. In part it acts by lowering the average E.M.F. of discharge and raising that of recharge, the missing electrical energy appearing as heat generated at the end of both processes when the outside electrolyte diffuses in and mixes with that of unequal strength contained in the pores of the active materials. But when this takes place the conditions of equilibrium previously existing as regards E.M.F. between all parts of the active material are disturbed; local currents flow, more heat results, and consequently the ampere hours available on discharge are also somewhat diminished, and those necessary for recharge somewhat increased. The loss of energy due to these causes was pointed out and demonstrated by Messrs. Duncan and Wiegand in 1889. It follows, and is indeed found to be so in practice, that the best efficiency of a cell is obtained by commencing its discharge immediately the recharge is finished, and *vice versâ*. When the discharge rates are high or the diffusion poor, the difference may be considerable. Undoubtedly the abnormal sulphation is the most serious result of impeded diffusion, for not only does it directly depreciate the electrodes and bring about a permanent reduction of their capacity in proportion to the quantity of active material affected, but also, by choking up the space available for the electrolyte, it aggravates the causes through which it was itself started, and so increases the temporary losses of capacity due to high discharge rates, besides reacting unfavourably on the cell's efficiency. The only practical method of determining the extent to which diffusion into the pores of the active materials is provided for in a cell is to compare its outputs at different discharge rates. There have been cells on the market of the Faure type, and possibly are still, which show a steadily increasing capacity down to a 30-hour or 40-hour rate. Such inadequate diffusion is due either to the masses and layers of active material being too thick, or to the free access of the electrolyte to their surfaces being too much impeded, or to their porosity being insufficient; often it is brought about by a combination of these causes. The two former conditions can easily be improved by proper mechanical design. To compensate for the latter special devices are sometimes employed, such as perforating the active materials, or providing channels through their interior or enclosed spaces in their midst to

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act as reservoirs of electrolyte; but the more usual plan has been to mix various substances, such as magnesium sulphate, salt, sugar, carbon, and so forth, with the lead compound used for pasting, and to remove them afterwards by solution or the action of the forming current. Still, when all these precautions are taken they will not increase the diffusion beyond a certain degree. That this is so is shown by those commercial cells of Planté type in which extremely thin layers of active material are employed with a very free access of electrolyte to their surfaces, for even these do not attain their maximum output at more than a 12-hour discharge rate, although there is very little diminution at about a nine-hour rate, but above this it falls off with increasing rapidity. The fact is, to go to the root of the trouble, the *molecular porosity* of the active materials, whether of the Faure or Planté type, needs to be considerably increased. If an ordinary active material prepared from a paste of litharge or red lead could be enormously magnified, it would be seen that the minute spaces between the individual grains are very caverns in comparison with those that penetrate the grains themselves, and it is these latter which appear to prevent the diffusion from proceeding at more than a certain rate, no matter how large the former may be. The total porosity of an active material is in itself therefore but a very partial guide as to its capabilities. For instance, its molecular pores might be almost stopped up with irreducible sulphate resulting from improper treatment during its first formation or afterwards, and yet it could possess a very open structure as judged by a microscopic examination or by the quantity of liquid it was capable of absorbing. Devices such as those just now mentioned may, within limits, improve the total porosity of the active materials, but they leave their molecular porosity unaltered, for this depends almost entirely on the lead compound used as raw material, and is rigidly fixed by its chemical composition and specific gravity. The only exception is in the case I have already referred to, where the partial sulphation of dense materials, such as Pb, PbO, or Pb_3O_4, at an intermediate stage of their first formation, leads to growth and expansion and a consequent increase in their ultimate porosity. The molecular porosity of active materials of the Planté type, and of all those of the Faure type prepared from litharge or minium, is probably only about 25 per cent. and can hardly exceed 40 per cent., even assuming that a very heavy preliminary sulphation takes place. A more porous material is obtained by the electrolytic reduction of lead chloride which has had a small proportion of zinc chloride fused with it. The two form a molecular compound that sets to a crystalline mass of low specific gravity; and when the zinc chloride and the chlorine of the lead chloride have been removed, *every molecule* of the lead remaining is surrounded by a space of about twice its own size. It possesses therefore a true molecular porosity of 65 to 70 per cent., and is capable of holding about two-thirds of its own apparent volume or twice its actual volume of electrolyte.

This active material perfectly fulfils the proper conditions as regards the quality of its structure, but as regards the degree of porosity it is only a step in the right direction. *In the ideal active material every one of its molecules should be surrounded by space sufficient to hold enough electrolyte for its complete discharge, so that no diffusion has to take place either from outside or between different parts of the active material itself.* To achieve this result it must be able to contain not merely twice, but ten to twenty times its actual bulk of electrolyte, corresponding to a molecular porosity of 90 per cent. to 95 per cent.

It is of course one thing to indicate the ideal conditions, and quite another to show how they are to be attained. The problem is to prepare an active material possessed of an extremely high molecular porosity without too much reducing its cohesion and mechanical strength generally. There are, at any rate, no fundamental difficulties in the way. Many substances exist, such for example as carbon in the form of charcoal, which prove that porosity and strength can go together. A remarkable instance is furnished by "block magnesia," a basic magnesic carbonate, which has a 90 per cent. to 95 per cent. porosity and can take up about nineteen-twentieths of its own nominal volume of liquid, and yet will withstand a crushing strain of more than 80lb. per sq. in. Given an active material with similar qualities, practically the full theoretical output corresponding to a 50 per cent. sulphation could, I believe, always be obtained from a cell, no matter how high the rate at which it were discharged. But what is of still more importance, the durability of the cell should be immensely increased and its life proportionately lengthened; and most of the causes that give rise to abnormal sulphation being eliminated, there would be little permanent loss of capacity or electrical depreciation. Then, too, an exceedingly high electrical efficiency should be realised, for the dissipation of energy in the form of heat would be reduced to an almost negligible quantity.

If all these improvements are possible, there is yet hope that lead cells may eventually fill their unique position as the sole practical means of storing electrical energy far more adequately than they have hitherto done; but whether or no this comes about, I feel assured that no substantial advance remains to be effected except in the direction I have indicated, and the only other alternative will be to discover a new combination altogether.

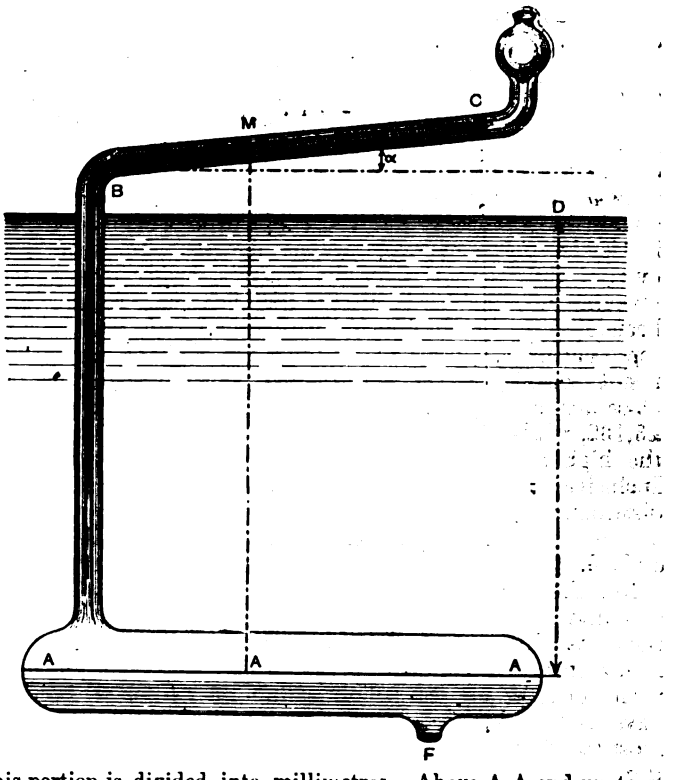
(To be continued.)

AN ACCUMULATOR CHARGE-INDICATOR.

No. 3 of the *Centralblatt für Accumulatoren- und Elementenkunde* gives a description, by Prof. Bellati, of Padua, of an apparatus which has been designed for the purpose of showing the amount of charge which has been put into or withdrawn from an accumulator, so that its condition at any period of its working can be seen at a glance, and losses due to over-charge or to over-discharge may be avoided.

After dealing with the early methods for the purpose which were tried by Crova and Garbe, and the instruments of Parker and Roux, which depend on the change of density in the electrolyte, Prof. Bellati says that these instruments were found unsatisfactory in practice on account of their costliness, and that they could not be used continuously, as the metal portions of them were corroded by the acid.

There is, however, another method for the determination of the density of a fluid which, so far as he knows, has not been employed in the case of accumulators. It is based on the principle that, in the case of two vessels communicating with each other, the height of the fluid in each above the dividing layer is in the inverse proportion to their density. An apparatus constructed on this principle may be constructed as shown in the accompanying diagram. A A is a glass cylinder which has an opening, F, on its lower side. On its upper side it is prolonged into a tube, A B C, which at first rises vertically, and then in the portion B C slopes towards the horizontal.



This portion is divided into millimetres. Above A A and up to a certain point, M, the apparatus is filled with a liquid which is lighter than the electrolyte, and does not mix with it, such as petroleum. The electrolyte surrounds the apparatus up to the level D, and also fills the lower half of the cylinder below A A, so that there is a condition of equipoise when the column of the electrolyte D A weighs as much as the column of petroleum M A of equal section, and as the density of the electrolyte varies the height of the column of petroleum also changes. As the area of the layer which separates the two fluids is great in proportion to the sectional area of the tube, the changes in the height of the petroleum column only show in its upper end. The slight bend B C greatly increases the sensitiveness of the apparatus, because the change of place of the meniscus M is greater than would be the case with the employment of a vertical tube in the proportion of 1 : sin α. If the apparatus is firmly attached to the cell of a discharged accumulator whose E.M.F. is 1·80 volts to 1·85 volts, and the position of the meniscus marked, then, and when it is fully charged, the interspace on the scale can be marked in divisions which will give the amount of charge in the cell on an arbitrary scale; or the interspace between the position of the meniscus on full charge, and full discharge, may be graduated in ampere hours. If it is desired to do this, the tube must be suitably bent, which may be effected by slipping in a horizontal connection whose axis is perpendicular to the axis of the tube. The point of intersection of these two axes will be zero, and will always remain at the same height whatever the inclination of the tube. When the accumulator is discharged, the apparatus can be raised or lowered so as to bring the meniscus of the petroleum to zero. To prevent the zero point coming

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on the bend of the tube, the first part of the bent portion may be given an U shape.

The sensitiveness of this indicator is very great, but certain precautions must be observed in using it. In the first place, it is necessary to be able to observe accurately the position of the meniscus, even when the tube is very little bent, and this can be effected by the employment of capillary tubes, as in this case the meniscus shows very plainly. Further, the level of the surface of the electrolyte must not alter by evaporation, which may be prevented by covering it with a layer of heavy oil; or the original level may be maintained by the addition of water. Another source of error is caused by change of temperature, the liquids inside and outside the indicator having different coefficients of expansion; and this error is best avoided by maintaining the temperature of the battery room as constant as possible.

ELECTRICITY WORKS ACCOUNTS.

Chelsea Electricity Supply Co. (Ltd.).

The accounts for 1899 of the Chelsea Electricity Supply Co. show excellent results of operations during the year. Additions to the lamp connections have raised the total equivalent to 129,000 8 c.p. lamps, or by nearly 14 5 per cent. Still more satisfactory is the advance made in the output, which at 1,428,322 units sold indicated an increase of 17 per cent. over the 1898 figure.

In October the company introduced the maximum system of charging for supply—fixing the initial charge at 6d. per unit for 1½ hours and at 3d. per unit consumed afterwards. In view of the fact that previously the charge was a uniform one of 6d. per unit, except to a few large consumers, this innovation means a material reduction in the average price, and to it is probably due the slight drop which even now is visible in the average revenue figures. In spite, however, of the diminution in the receipts, owing to a general lowering of the costs items the financial results have been more than maintained. The working profit was £20,107, representing 5·57 per cent. on the mean capital—an excellent result, considering the large capital expenditure which took place during the year. The depreciation fund was allocated £3,132, while £1,096 was set aside to reserve as provision for the high cost of coal which is prevailing this present year. Inclusive of the balance from 1898, there was available for distribution £12,000, out of which dividends of 6 per cent. per annum on both the preference and the ordinary shares were divided.

Not the least interesting or satisfactory feature of these accounts of the Chelsea Co. is the very general reduction of the costs which has been effected. At the rate of output and load factor (10·3 per cent.) prevailing, all the important items without exception present figures uniformly below what might have been expected. The fuel item at practically 0·7d. is a most satisfactory result under the conditions which obtained during last year in the coal trade.

To facilitate comparison we repeat the following table:—

Year.	No. of consumers	Equiv. lamp connections.	Output. Units sold.	Revenue.	Working profit.	Ord. div. %	Plant capacity. KW.	Max. supply d'mand'd KW.
1889	93	8,730	...	...	...	...	...	...
1890	252	19,580	...	£6,079	£543	...	2t6	...
1891	...	27,500	290,458	10,173	1,750	...	449	...
1892	...	34,876	357,162	12,523	4,319	2½	...	...
1833	...	40,665	402,848	13,732	6,269	5	885	...
1894	...	47,286	469,515	15,486	8,0t6	5	885	476
1895	715	57,354	577,770	17,165	9.890	5	1,205	638
1896	972	80,460	813,764	21,355	10,362	5	1,310	980
1897	1,190	96,638	1,061,970	27,382	14,555	6	1,860	1,3:0
1898	1,416	112,700	1,220,198	31,363	16,662	6	2,260	1,390
1899	1,690	129,000	1,428,323	34,988	20,107	6	3,100	1,580

Brompton and Kensington Electricity Supply Co. (Ltd).

Evidence of excellent progress is contained in the accounts of the "Brompton and Kensington Electricity Supply Co."—formerly the "House-to-House Electric Light Supply Co."

During 1899 335 new consumers, with the equivalent of 15,002 additional lamps, were connected to the mains, thus raising the total lamp connection by nearly 19 per cent. The output has now reached the enviable stage when the number of units sold has to be expressed in seven figures. The actual increase was about 27 per cent.

Owing to a substantial reduction of 0·3d. per unit in the aggregate costs, in conjunction with the increase in the output, the working profit shows the gratifying return of 10 per cent. on the mean capital. This compares well with the 8·4 per cent. of the preceding year, and is the more worthy of commendation in view of the large capital expenditure which has taken place during the year, as well as of the material reduction in the average revenue received per unit. A large amount of substitution of plant has been effected in the station, and in order to meet the net cost of the plant removed £2,500 was appropriated from the net revenue account, together with £7,000 from the depreciation fund. In addition to this £2,500, £4,500 of the working profit was placed to the depreciation fund, which now stands with £11,500 balance.

Interest charges absorbed another £1,013, and there was available for distribution £10,327, out of which were paid dividends of 7 per cent. and 6 per cent. respectively on the cumulative preference and the ordinary shares.

With the exception of the fuel item, all the costs have been reduced, and, even considered in relation to the high load factor of 12·8 per cent. which characterised the load, they show very satisfactory values indeed—the fuel item not excepted.

Perhaps the management and property charges still slightly exceed the normal, but they have shown a good movement in the right direction.

The following table indicates the progress made since 1889:

Year.	No. of consumers.	Equiv. lamp connections.	Output.	Plant capacity. KW.	Max. demand. KW.	Revenue. Total.	Working profit.
1889	78	4,520	...	...	...	..	...
1890	248	13,665	...	300	...	£5,010	£385
1891	373	19,388	247,861	300	250	8,328	2,250
1892	471	23,700	313,484	450	306	10,689	2,837
1893	599	28,429	358,506	550	351	12,064	4,231
1894	755	35,858	400,911	550	410	13,696	6,264
1895	933	44,162	476,714	930	520	15,395	6,841
1896	1,164	55,265	643,693	1,325	658	17,442	9,032
1897	1,416	66,364	811,255	1,410	809	20,811	12,033
1898	1,777	80,301	974,618	1,460	917	24,907	14,065
1899	2,112	95,303	1,241,369	1,810	1,105	30,417	18,181

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

Aberdeen (Municipal)	Jan. 12, 1900	Kingston-on-Thames (Mun.)	April 21, 1899
Ayr (Municipal)	Sept. 22, 1899	Lancaster (Municipal)	Jan. 19, 1900
Bath (Municipal)	Feb. 9, 1900	Leeds (Municipal)	Dec. 1, 1899
Bedford (Municipal)	May 19, 1899	Leicester (Municipal)	Jan. 26, 1900
Belfast (Municipal)	Sept. 15, ,,	Leyton (Municipal)	Sept. 8, 1899
Birmingham (Company)	Sept. 15, ,,	Liverpool (Municipal)	June 9, ,,
Blackburn (Municipal)	Jan. 19, 1900	Londonderry (Municipal)	Feb. 16, 1900
Blackpool (Municipal)	Sept. 29, 1899	Manchester (Municipal)	Aug. 11, 1899
Bournemouth (Company)	April 28, ,,	Newcastle and District (Co.)	Oct. 6, ,,
Bolton (Municipal)	Nov. 24, ,,	Newcastle-upon-Tyne (Co.)	April 14, ,,
Bradford (Municipal)	April 14, ,,	Newport (Mon.) (Municipal)	Dec. 15, ,,
Brighton (Municipal)	May 12, ,,	Northampton (Company)	Oct. 20, ,,
Bristol (Municipal)	July 14, ,,	Norwich (Company)	Nov. 17, ,,
Burnley (Municipal)	Aug. 25, ,,	Notting Hill (Company)	Mar. 16, 1900
Burton-upon-Trent (Mun.)	April 21, ,,	Nottingham (Municipal)	July 21, 1899
Bury (Municipal)	Sept. 22, ,,	Oldham (Municipal)	Dec. 1, ,,
Cambridge (Company)	Mar. 10, ,,	Oxford (Company)	May 19, ,,
Cardiff (Municipal)	Dec. 15, ,,	Pontypool (Company)	May 5, ,,
Charing Cross (Municipal)	Mar. 9, 1900	Portsmouth (Municipal)	July 14, ,,
Chelsea (Company)	Mar. 31, 1899	Prescot (Company)	Dec. 8, ,,
Cheltenham (Municipal)	Nov. 10, ,,	Preston (Company)	Sept. 29, ,,
Chester (Municipal)	June 23, ,,	Reading (Company)	Oct. 13, ,,
City of London (Company)	May 12, ,,	Richmond (Company)	Oct. 15, ,,
Clerkenwell (Company)	Aug. 18, ,,	Salford (Municipal)	Feb. 23, 1900
Coventry (Municipal)	Feb. 23, 1900	Scarborough (Company)	Nov. 3, 1899
Croydon (Municipal)	Feb. 9, ,,	St. Helens (Municipal)	Dec. 8, ,,
Derby (Municipal)	Jan. 26, ,,	St. James' & Pall Mall (Co.)	Feb. 16, 1900
Dewsbury (Municipal)	Nov. 24, 1899	St. Pancras (Vestry)	May 26, 1899
Dover (Company)	June 2, ,,	Sheffield (Municipal)	Dec. 29, ,,
Dundee (Municipal)	Jan. 12, 1900	Shoreditch (Vestry)	Oct. 27, ,,
Eastbourne (Company)	Feb. 2, ,,	Southampton (Municipal)	Nov. 10, ,,
Edinburgh (Municipal)	Nov. 17, 1899	Southport (Municipal)	July 7, ,,
Exeter (Municipal)	Aug. 5, 1898	South Shields (Municipal)	July 7, ,,
Glasgow (Municipal)	Sept. 1, 1899	Stafford (Municipal)	Dec. 29, ,,
Guildford (Company)	May 5, ,,	Sunderland (Municipal)	July 28, ,,
Halifax (Municipal)	July 21, ,,	Taunton (Municipal)	June 16, ,,
Hammersmith (Vestry)	May 26, ,,	Tunbridge Wells (Mun.)	Sept. 1, ,,
Hampstead (Vestry)	Aug. 25, ,,	Wakefield (Municipal)	Dec. 1, ,,
Hanley (Municipal)	April 28, ,,	Walsall (Municipal)	June 23, ,,
Harrogate (Municipal)	Oct. 20, ,,	Wandsworth (Company)	Aug. 18, ,,
Harrow (Company)	June 16, ,,	Westminster (Municipal)	Mar. 9, 1900
Hast'gs & St. Leonards (Co.)	Feb. 2, 1900	Whitehaven (Municipal)	July 28, 1899
H'use-to-H'use Co. (K'ns'gt'n)	Mar. 31, 1899	Windsor (Company)	Dec. 22, ,,
Hove (Company)	Mar. 10, ,,	Woking (Company)	Dec. 22, ,,
Huddersfield (Municipal)	Oct. 6, ,,	Wolverhampton (Municipal)	June 30, ,,
Islington (Vestry)	Oct. 27, ,,	Woolwich (Company)	Jan. 12, ,,
Kens'gton & Knightsbr'(Co.)	Mar. 16, 1900	Worcester (Municipal)	April 7, ,,
Kingston-upon-Hull (Mun.)	June 9, 1899	Yarmouth (Municipal)	Nov. 3, ,,

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	BROMPTON & KENSINGTON.		CHELSEA (LONDON).	
Undertaking Worked by	The Brompton and Kensington Electricity [Supply Co. (Ltd.)		The Chelsea Electricity Supply Co. (Ltd.)	
Date of Commencement of Supply	January, 1889.		September, 1889.	
System of Supply	Alt.-curr. trans. feeding low-pressure network.		Continuous-curr., with dynamotor sub-stations.	
Chief Engineer	H. W. Bowden.		Percy Still.	
YEAR ENDED	DEC. 31, **1898.**	DEC. 31, **1899.**	DEC. 31, **1898.**	DEC. 31, **1899.**
QUANTITIES—				
Units generated	—	—	—	—
„ SOLD (TOTAL)	974,618	1,241,369	1,220,198	1,428,323
„ sold to consumers	—	—	1,220,193	1,428,323
„ sold for public lighting, &c.	500	—	nil	—
„ used on works	—	—	—	—
UNITS SOLD PER 8 C.P. LAMP CAPACITY	21·4	21·9	17·3	14·7
Maximum supply demanded	917 kilowatts	1,105 kilowatts	1,390 kilowatts	1,580 kilowatts
Number of public lamps	2 arc[a]	7 arc[a]	nil	nil
Number of consumers	1,777	2,112	1,416	1,690
Connections to mains in 8-c.p. lamps	80,301	95,303	112,700	129,000
CAPACITY OF PLANT IN 8-C.P. LAMPS	45,600	56,600	70,650	96,900
CAPACITY OF PLANT IN KILOWATTS	1,460	1,810	2,260	3,100
CAPITAL—	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.
AUTHORISED (TOTAL)	£249,500 / £171	£249,500 / £138	— / —	— / —
Share	199,500 / 137	199,500 / 110	£200,500 / £83·7	£400,500 / £129
Loan (including Debenture charges)	50,000 / 34·2	50,000 / 27·6	—[a] / —	—[a] / —
RECEIVED (TOTAL)	190,635 / 131	203,305 / 115	292,620 / 129	338,430 / 109
Share	140,635 / 96·4	158,305 / 87·4	200,500 / 83·7	200,500 / 64·7
Loan (including Debenture charges)	50,000 / 34·2	50,000 / 27·6	92,120 / 40·8	137,930 / 44·5
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	58,865 / 40·3	41,195 / 22·8	— / —	— / —
Share (unissued)	58,865 / 40·3	41,195 / 22·8	nil / —	200,000 / 64·5
Share (uncalled)	— / —	— / —	nil / —	— / —
Loan (including Debentures)	— / —	— / —	— / —	— / —
REPAID (TOTAL)	— / —	— / —	— / —	— / —
RESERVE OR SINKING FUND	— / —	— / —	46,818 / 20·7	48,605 / 15·7
DEPRECIATION FUND	14,000 / 9·59	11,500 / 6·35	8,670 / 3·84	10,270 / 3·31
EXPENDED (TOTAL)	177,533 / 122	186,212 / 103	332,291 / 147	389,835 / 126
Lands and buildings	19,099 / 13·1	20,294 / 11·2	94,829[b] / 41·9	114,960[b] / 37·1
Plant	91,507[b] / 62·7	94,401 / 52·2	135,085[b] / 59·7	157,659[b] / 50·9
Mains	64,556 / 44·2	68,113 / 37·6	87,375[b] / 38·7	102,135[b] / 32·9
Miscellaneous	2,375 / 1·63	3,401 / 1·88	15,002 / 6·64	15,081 / 4·86
BALANCE OF CAPITAL ACCOUNT	+13,097 / 8·97	+22,093 / +12·2	−39,671[c] / −17·6	−51,405[c] / −16·6
REVENUE—	Total. / Per unit sold.	Total. / Per unit sold	Total. / Per unit sold	Total. / Per unit sold.
TOTAL	£24,907 / 6·138d.	£30,417 / 5·885d.	£31,363 / 6·171d.	£34,938 / 5·881d.
Revenue from supply	23,379 / 5·760d.	28,912 / 5·595d.	29,474 / 5·800 l.	33,449 / 5·624d.
„ meters, &c.	1,480 / 0·365d.	1,491 / 0·288d.	1,215 / 0·239d.	1,440 / 0·242d.
„ public lighting	— / —	— / —	— / —	— / —
„ sale of lamps, &c.	— / —	— / —	— / —	— / —
„ miscellaneous sources	47 / 0·012d.	13 / 0·003d.	674 / 0·133d.	99 / 0·017d.
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	£10,841 / 2·670d.	£12,237 / 2·368d.	£14,701 / 2·893d.	£14,881 / 2·500d.
WORKS COSTS	6,510 / 1·603d.	7,689 / 1·487d.	9,860 / 1·940d.	10,104 / 1·697d.
Generation of electricity	*6,222 / 1·532d.*	*7,241 / 1·400d.*	*8,324[d] / 1·638d.*	*8,336[d] / 1·401d.*
Fuel (including cartage, &c.)	2,784 / 0·686d.	3,648 / 0·705d.	4,495 / 0 884d.	4,152 / 0·698d.
Oil, waste, water, stores	439 / 0·108d.	434 / 0·084d.	661 / 0·130d.	594 / 0·100d.
Wages at station	2,398 / 0·591d.	2,645 / 0·512d.	1,752 / 0·345d.	1,709 / 0·287d.
Repairs and maintenance at station	601 / 0·148d.	513 / 0·099d.	1,218 / 0·240d.	1,296 / 0·218d.
Distribution of electricity	*288 / 0·071d.*	*448 / 0·087d.*	*1,536 / 0·302d.*	*1,768 / 0·297d.*
Wages, &c.	224 / 0·055d.	349 / 0·068d.	949 / 0·187d.	860 / 0·145d.
Repairs, renewals of mains, &c.	65 / 0·016d.	99 / 0·019d.	585 / 0·115 l.	903 / 0·153d.
Public lighting	— / —	— / —	— / —	— / —
Attendance	— / —	— / —	— / —	— / —
Renewals	— / —	— / —	— / —	— / —
MANAGEMENT AND PROPERTY CHARGES	4,331 / 1·067d.	4,543 / 0·880d.	4,841 / 0·953d.	4,777 / 0·803d.
Royalties	— / —	— / —	7 / *0·001d.*	7 / *0·001d.*
Rent, rates, taxes	*1,367 / 0·337d.*	*1,498 / 0·290d.*	*1,859 / 0·366d.*	*1,936 / 0·325d.*
Management	*2,964 / 0·731d.*	*3,059 / 0·590d.*	*2,975 / 0·586d.*	*2,834 / 0·476d.*
Salaries	1,892 / 0·466d.	1,988 / 0·385d.	2,233[e] / 0·439d.	2,137 / 0·359d.
Stationery, &c.	149 / 0·037d.	131 / 0·025d.	145 / 0·029d.	140 / 0·024d.
Establishment charges	308 / 0·076d.	300 / 0·058d.	266 / 0·052d.	260 / 0·044d.
Law charges, &c.	615[c] / 0·151d.	631[e] / 0·122d.	332[f] / 0·065d.	297[h] / 0·050d.
FINANCIAL RESULTS—	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded
WORKING PROFIT FOR YEAR	£14,066 / 8·39%	£18,181 / 10 0%	£16,662 / 5·50%	£20,107 / 5·57%
Sum carried to Depreciation Fund	4,000 / 2·383%	7,000[f] / 3·85%	2,500 / 0·825%	3,132 / 0·867%
Sum carried to Reserve or Sinking Fund	— / —	— / —	12,780[g] / 4·22%	1,096[i] / 0·303%
Net interest on loans (incl. Debenture charges)	1,507 / 0·898%	1,013 / 0·558%	2,736 / 0·903%	4,802[j] / 1·33%
BALANCE FROM LAST ACCOUNT	226 / 0·135%	159 / 0·088%	1,652 / 0·545%	923 / 0·256%
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	8,785 / 5·23%	10,327 / 5·69%	12,923 / 4·26%	12,000 / 2·32%
Deficit	— / —	— / —	— / —	— / —
ORDINARY DIVIDEND PAID	6% / —	6% / —	6% / —	6% / —
PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE	43·5%	40·2%	46·9%	42·5%
Expenditure per kilowatt capacity	£7. 8s. 7d.	£6. 15s. 2 l.	£6. 10s. 2d.	£4. 16s. 0d.
REVENUE PER KILOWATT CAPACITY	£17. 1s. 0d.	£16. 16s. 0d.	£13. 17s. 2d.	£11. 5s. 7d.
Expenditure per 8-c. lamp capacity	4s. 9d.	4s. 3¾d.	4s. 2 l.	3s. 0¾d.
REVENUE PER 8-C.P. LAMP CAPACITY	10s. 11d.	10s. 9d.	8s. 10½d.	7s. 2½d.
REVENUE PER 8-C.P. LAMP CONNECTED	6s. 2½d.	6s. 4½d.	5s. 6¼d.	4s. 5d.
Price charged for lighting, per unit	6 l.[d]	6d.[d]	6d.	6d. to 3d.[k]
Price charged for power, per unit	3d.	3d.	3d.	3d.
Price charged for public lighting	2½d.	2½d.	—	—

BROMPTON AND KENSINGTON.—REMARKS—*a* Trial lamps run free of charge for 12 months. *b* Includes £7,000 for patents and patent rights. *c* Includes £83 to auditing, £146 law, and £165 to insurance. *d* Subject to discounts. *e* Includes auditing £83, law £112, and insurances £213. *f* Includes £2,500 applied in reduction of renewals suspense account.

CHELSEA (LONDON).—REMARKS—*a* To extent of subscribed share capital. *b* These items do not include any fraction of £10,238 paid for works, machinery, and mains of the Cadogan Co. and included under "miscellaneous." *c* Over-expended. *d* Includes "sundry costs" £198 in 1898 and £585 in 1899. *e* Includes directors' remuneration £1,000. *f* Includes £53 to auditing, £34 law expenses and £246 to insurance. *g* Paid out of balance of premiums on new issue of ordinary shares. *h* Includes auditing £53, law £6, and insurance £232. *i* Provision for extra cost of coal in 1900. *j* Including £100 fees to trustees of debenture stock-holders. *k* On maximum demand system, 1½ hour scale.

The Electrician.

The Oldest Electrical Journal (established as a weekly Journal 1861—1878

Published every Friday, Price Sixpence; Post Free, Sixpence-Halfpenny.
Editorial Publishing and Printing Offices,

1, 2 & 3, SALISBURY COURT, FLEET ST., LONDON,

Telephone: 949 Holborn. *Telegrams:* "Electrician Newspaper London."

All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher "The Electrician," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "The Electrician" *Printing and Publishing Company, Limited, and be crossed* "Coutts and Co."

All Editorial letters to be addressed to The Editor.

All letters for insertion in "The Electrician," *or containing questions, must be accompanied by the name and address of the writer as evidence of good faith. No notice whatever is taken of anonymous communications.*

"The Electrician" *is published every Friday morning, in time for the morning mails. It is on sale at the railway bookstalls throughout the Kingdom on Friday morning, and can be obtained of all Booksellers and Newsvendors; or direct from the Publishing Offices, as above*

Subscription Rates.—The Rates for Subscriptions to "The Electrician" are as under:—

	Year	Half-Year	Quarter	
United Kingdom	26s. 0d.	13s. 6d.	7s. 0d.	Post free, payable in advance.
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THE IMPORTANCE OF THE STORAGE BATTERY.

The Institution of Electrical Engineers was engaged last night in considering various problems in storage battery practice and theory, as set forth in remarkably clear and logical language in a Paper contributed by Mr. E. J. Wade. As an author Mr. Wade is not unknown to our readers, who will remember the instructive and thoughtful series of articles on "Storage Batteries" which he commenced in our pages in September, 1897 (see *The Electrician*, Vol. XXXIX., p. 716), and will form the nucleus of a forthcoming work on "Secondary Batteries" in *The Electrician* series of books. Part I. of his present Paper will be found in our issue this week. It is not our purpose to enter upon a discussion on this Paper at present; we shall defer comment of this description until our readers have had an opportunity to read the entire Paper as well as our report of the discussion at the Institution. We wish, however, at this early stage to introduce the main subject of the Paper to the special notice of our readers. The storage battery runs some danger of being ignored, or of receiving but scant attention from such electrical engineers as are not brought directly into contact with its manufacture or use. There is, of course, a large community of electricians who fully appreciate its advantages, and who are constantly employing storage plant for numerous purposes; but it is undeniable that an extensive section of the electrical profession fails to realise the potential influence of the storage battery upon their professional practice.

The importance of the storage battery is immense. Regarded not so much as to what it can now accomplish as in respect of what its substantial perfecting would render practicable, this item in the electrical engineer's stock-in-trade stands second only to the dynamo. The advent of a storage cell with a degree of perfection that, while it does not seem hopelessly unattainable by experts, would far surpass the best existing cell in every important respect, would speedily revolutionise the bulk of our practice in electrical supply for lighting and power, as well as for traction; and it would render obsolete, not only the use of animal power, but even the latest and most improved forms of mechanical and electrical traction, whether for vehicles on railways and tramways or on common roads. It would open up applications of electric power now commercially impossible, and probably other applications now scarcely even imagined. A cheap, light, efficient, and durable

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cell, simple in its construction and use, ready in its action: that is the problem to be solved.

The prize lying in the immense fortune that awaits the individual who solves this problem, and who produces a battery of this degree of perfection, might reasonably be supposed to be tempting enough to command the entire energies of the best inventive skill in the chemical and electrical professions. Beyond question it has already done so; yet consummate skill and untiring energy have hitherto been baffled, if not completely, at any rate to a very large extent. Progress, indeed, has been made; difficulties have been surmounted; the storage battery of to-day is vastly superior in most respects to that of five or ten years ago, although it is substantially composed of the same essential parts and of unchanged materials. Difficulties remain; and the nature of these suggests that their removal can only be effected by radical changes in the essential components of the cell. With this crucial difficulty Mr. WADE deals thoughtfully and suggestively in his Paper, more especially in the portion we print this week. Lead has been hitherto the element common to all successful storage cells—lead, sulphuric acid, and lead peroxide. Mr. WADE suggests that the pre-eminence of this element, and of this one and only successful combination, lies in the condition of insolubility in the electrodes throughout the entire cycle of their normal changes. If this lucid suggestion really contains the secret of successful storage battery design, a rational line of research lies in seeking out those metallic elements which, in combination with selected electrolytes, would behave analogously when used as a storage cell. The ground has been well searched already, though largely empirically and without any such guiding principle to afford a clue. It remains to be seen whether a more rational comprehension of these less prominent chemical and electro-chemical conditions will lead to a more successful solution of the problem. Mr. WADE points aspiring inventors to "the less studied and more obscure reactions into which the metals enter." But we must not follow this line of thought further just now; we have already reserved it for a later date, when it can be discussed in relation to the entire Paper and the discussion evoked.

We may conclude with a few reflections upon the effects which the advent of an improved storage battery, such as we have described, might be expected to produce in electrical engineering practice. With regard to electrical generation, its effect would be to give continuous-current plant an enormous advantage over single-phase alternating currents, and even in the majority of cases probably over polyphase transmission. Wherever transformation would be a serious disadvantage, continuous-current plant would be preferred to all other for generation, transmission, and distribution. For long-distance transmission, however, polyphase systems would in all probability be preferred, owing to the difficulties of generation at high voltage with continuous currents; but sub-stations would almost invariably distribute continuous currents to the consumers. It is also probable that storage plant would be more largely used, not only in central and sub-stations, but also on consumers' premises. A great impetus would be given to the use of what may be termed portable electric energy, by which we mean small detached batteries capable of working lamps, for mining and other purposes, and small motors, for vehicles, &c., and for use on all occasions when small power might be required. To the changes in electric and other forms of traction we have already alluded, but we may add that neither the overhead trolley system nor any of the open or closed conduit systems would stand any chance of general patronage if it were possible to construct a cheap, light, efficient, and durable battery car. Electric railway traction would probably undergo similar revolution, the battery locomotive taking the place of existing line equipments. In all departments of electric power supply and utilisation there would be an enormous reduction in the costs of production and the price of sale of electric energy, owing to the more economical conditions as to capital and revenue expenditure which would be introduced with efficient and cheap storage plant. Increased cheapness would react upon the demand, and the wholesale rate of production and sale would still further reduce costs and prices. Without exaggeration we might say that a satisfactory storage battery would speedily inaugurate a very general "Age of Electricity." It is unnecessary to enlarge further on this theme—attractive because of its possibilities, depressing on account of the immediate outlook. Sufficient has been said to indicate the immense importance of the storage battery as an electrical engineering implement of the future.

DEVELOPMENTS IN LEAD ACCUMULATORS.

In No. 5 of the *Centralblatt fur Accumulatoren- und Elementenkunde* there is an article by A. Heinemann on "Lead Accumulators," in which he points out that until quite recently all the research work and experiments which have been carried out on the chemistry and physical properties of lead accumulators have had very little influence on their manufacture. They are still made, broadly speaking, either on the Faure or the Planté system, very much as they were in the early eighties, and the principal improvements which have been introduced have been mechanical rather than chemical. Within the last few years, however, there has been a change, and attempts have been made to employ organic instead of inorganic lead salts in the preparation of the active material for the plates. In spite of the claims which have been advanced on their behalf, it is clear that the plates of the simple Faure type cannot have the durability which has been claimed for them, or the working expenses for batteries of this type employed on tramways would not be as high as they are. Although the Planté type of plate is to be preferred theoretically, the practical manufacturer has directed his attention to the improvement of the block, or rather of the pasted plate, and this has given rise to the introduction of two types of plates—those in the preparation of which organic lead compounds are employed, and those in which lead salts are employed either pure or mixed with some other inorganic substance. Plates of this latter type may give very good results at first, especially as regards capacity, from their great porosity, but they have a short life; and this has led to the employment of organic substances, whose introduction was so bitterly opposed when they were first suggested. On the expiration of the Faure patent numbers of persons attempted to manufacture accumulators who had no knowledge of chemistry or of the practical working of batteries, with the result that most extraordinary methods and substances were proposed for the manufacture of the active material for the electrodes; but that was only a passing phase, and now there are many engaged in the attempt to produce a good plate who have a sound knowledge of organic chemistry. Some organic compounds, such for instance as glycerin and butyric and lactic acids, have the property of forming quickly-drying compounds with lead oxides, and this renders them useful to the manufacturer, even though on electrolysis they do give rise to the formation of by-products, for the experienced man can deal with these latter. The organic paste has the advantage that it can be greatly compressed, which also improves its durability, for the loss of active material caused by the wash of the electrolyte between the plates is thereby diminished. According to the material employed, the most various products are formed in the production of the lead oxide paste, amongst

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others some of a resinous nature, which are not unlike caoutchouc in their stability, and undergo no further change. These serve to unite the highly compressed lead oxide particles, and offer very little resistance to the passage of the current, on account of the extreme thinness of the film which separates and retains the particles. Glycerin has many advantages, but on oxidation it yields no resinous body, and disappears entirely from the plate during the process of formation. Those plant oils which have already undergone a certain degree of oxidation in the air, and which, like turpentine, will yield an oxidation-product by atmospheric oxidation alone, are best suited for the formation of this caoutchouc-like body by electrolysis. The exact chemical constitution of this body is not thoroughly understood at present, but it is neither reducible nor oxidisable. As it is an insulator, it could not be employed by itself for the formation of the paste for the plates, and so the parent body from which it is formed by oxidation must be used for this purpose, which results in the particles of oxide being cemented together without their being insulated from each other. The oils of the cypress, birch, and pine species have been suggested for the purpose by Heinemann in his German patent 107,726, 1898, and accumulators constructed by his process have been made by Messrs. C. Kliemt, of Berlin.

The following table gives a comparison of the results obtained with a battery constructed by this process, and with batteries made by a German company and by the Fulmen company :—

	I. Deutsche accumulatoren-gesellschaft.	II. L'accumulateur Fulmen S. a. Paris.	III. Accumulator according to patent 107,726.
Type	C.	B.	P.
Dimensions of electrode in mm.	175 × 130 × 5	175 × 100 × 5	180 × 100 × 5
Surface of electrode in sq. dm.	2·275	1·75	1·8
Weight of positive electrode in grms	680	475	520
Discharge in amperes	2·3	3·5	2·5
Capacity in ampere-hours	13·8	17	20
Weight per sq. dm. in grammes	300	272	344
Capacity per sq. dm. in amp.-hours	6·1	9·7	11
Capacity per kg. of positive electrode in ampere-hours	20·3	35·7	32·3
Capacity per kg. of plates in amp.-hrs.	11·6	16·0	17
Capacity per kg. of cell in amp.-hrs.	7·5	10·6	13
Capacity per kg. of plates at a discharge rate of 1 ampere pr sq. dm. in ampere-hours	8·3	18	21·2

After five months' continuous daily use for traction purposes by the Berlin post office, the electrodes of No. III. battery were in perfect order, whilst the positive plates of No. II. (Fulmen) battery were worn out after a hundred charges.

ARE RAREFIED GASES ELECTROLYTES?*

BY M. E. BOUTY.

1. To investigate the electrical properties of rarefied gases, the usual method consists in observing the luminous effects produced when a tube of the rarefied gas, containing two metallic electrodes, is connected externally to a source of continuous or alternating potential difference. The appearances observed under these conditions vary at different portions of the tube. If the electrodes could be dispensed with and the discharge produced by induction, one might reasonably expect phenomena of a simple character. In his book on "Recent Researches in Electricity and Magnetism," published in 1893, Prof. J. J. Thomson briefly summarises a number of remarkable experiments made by him on such electrodeless discharges. The tube, filled with the rarefied gas, is placed inside a coil of wire, through which a rapidly oscillating discharge from a Leyden jar is passed. Under these circumstances, and if the pressure of the gas be about $\frac{1}{200}$mm., a very brilliant luminosity is observed. If the vessel containing the gas consist of two concentric portions, the experiment may be adjusted so that the external vessel alone is illuminated ; it then acts like an electric screen, and the induction in the inner vessel becomes too small to excite luminescence.

Prof. J. J. Thomson interpreted these effects by supposing a rarefied gas to possess a conductivity like that of electrolytes. The magnitude of this conductivity was obtained by substituting for the gas in the outer vessel a solution of sulphuric acid, and varying the concentration of this until it had the same screening effect as the original rarefied gas. The conductivity is found to be a function of the pressure, passing through a maximum at about $\frac{1}{200}$mm. If, instead of the volume of the gas, the mass be taken and the specific conductivity be calculated, it is found that the molecules of a gas at its maximum of conductivity conduct as well as the molecules of a solid metal. Thus, gases which at ordinary pressures are dielectrics become, merely by a change of pressure, really excellent conductors; a change which is so very considerable that it is generally attributed to dissociation or to ionisation of the molecules.

If rarefied gases are such excellent conductors, how are we to explain the very considerable difficulty for a discharge to pass in a tube having electrodes? We can only assume the existence of a special resistance of enormous magnitude in passing from the surface of the electrode to the gas, or conversely. Prof. Thomson does find, in fact, that if the discharge tube be divided into two parts by a continuous metallic diaphragm, two flattened luminous rings are formed in the two portions of the tube, the spaces near the diaphragm remaining dark. The appearances are unaltered if the metal partition be replaced by mica. These very curious facts lead Prof. Thomson to regard a rarefied gas as an electrolyte.

Now, all electrolytes obey Faraday's laws. If, then, the analogy of a rarefied gas to an electrolyte be complete, a compound gas submitted to the action of a large number of discharges should deposit on its electrodes the products of its decomposition, and in quantity proportional to the total quantity of electricity which has passed.

M. Eilhard Wiedemann* has examined, from this point of view, gaseous hydrochloric acid and the vapours of the chloride, bromide, and iodide of mercury ($HgCl_2$, $HgBr_2$, HgI_2). Using the latter three bodies he found at the electrodes only a small quantity of the products of decomposition, about 3 per cent. or 4 per cent. of the amount which would be present if Faraday's laws were completely fulfilled. Further, the products are found almost indifferently at either electrode. These are sufficiently explained by secondary actions (thermal, &c.) of the discharge. M. E. Wiedemann rightly concludes that it is impossible to consider a rarefied gas as a true electrolyte.

Using an absolutely independent method, I have arrived at the same conclusion, by observing the effect of a constant electrostatic field on a rarefied gas contained in a tube without electrodes.

2. If between the plates of a condenser an insulated metallic conductor be placed, there occurs an increase in the capacity of the condenser. I found also that in this respect all known electrolytes behave like metallic conductors. The question naturally arises, Does a tube filled with a rarefied gas behave in a similar manner?

The necessity for introducing such a tube between the plates of a condenser requires that the plates be separated by at least a few centimetres, and hence gives rise to very small capacities, of the order say of $\frac{1}{100000}$ microfarad. If such a capacity be discharged through a capillary electrometer having a capacity of say $\frac{1}{2}$ microfarad (near the zero of the electrometer), the potential difference to which it will be raised will be of the order of $\frac{1}{100000}$ that between the two plates of the condenser. Now, the electrometer can detect easily $\frac{1}{10000}$ volt; hence with about 100 volts the measurements become fairly reliable.

In my preliminary experiments I introduced between the plates of the condenser a spherical glass vessel coated inside and out with paraffin and filled with air at atmospheric pressure. The increase in capacity is due only to the walls of this tube, the volume of which is merely a small fraction of the whole bulb. The increase in capacity was, however, observable on the electrometer when a sufficiently large potential difference was used, and amounted in general to about 1 per cent. or 2 per cent. of the whole capacity. Filling the globe in turn with mercury, an electrolyte, distilled water, absolute alcohol, petroleum, &c., and taking care to renew the coating of paraffin each time in order to remove all surface conductivity which might have been acquired, it can be shown that the globe filled with air produces always an increase in capacity of 2 per cent, while when filled with any of the above liquids, or with mercury, the increase in capacity amounted in every case to 50 per cent. In these experiments the charge and discharge were obtained with a commutator worked by hand, and the condenser remained in contact with the accumulators for some seconds. The better dielectrics are thus found to behave, in increasing the capacity of the condensers, like perfect conductors. A trace of moisture either on the outside or inside coatings of the globe has the effect of increasing the capacity, and may cause it to have any value between 2 per cent. and 50 per cent. Experiments of this kind are thus capable of indicating conductivities at least 100 times as small as that of the best liquid dielectrics.

3. Convinced of the sensitiveness of the method, I next used tubes containing rarefied gases: I used at first those nearest to hand—incandescent lamps, Crookes tubes, radiometers. In spite of the presence of the insulated metallic portions—the carbon filament in

* Paper read before the Société Française de Physique.

* E. Wiedemann, *Wied. Ann.*, Vol. LXI., p. 737; abstracted in *The Electrician*, Vol. XXXIX., p. 535

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the lamp, the electrodes in the tube, the vanes in the radiometer—all behaved like a tube filled with air at atmospheric pressure. The increase in capacity was never as much as 5 per cent. Crookes tubes containing no electrodes, which I made of various forms, showed increases in the capacity of but 1 per cent. or 2 per cent., even when the distance between the plates was reduced to 2cm. and the potential difference was 2,000 volts.*

It is therefore impossible to assume for the rarefied gas in a Crookes tube (at pressures of $\frac{1}{100}$mm. to $\frac{1}{500}$mm.) a conductivity even so small as one-hundredth of the conductivity of a solution of sulphuric acid or of rectified spirits of turpentine.

4. Among the tubes experimented upon were included accidentally two Geissler tubes (pressure of gas of the order of 1mm.). So long as the electrostatic field did not exceed a certain value, about 300 volts per cm., these behaved like Crookes tubes—that is, like tubes filled with air at atmospheric pressure; but for fields sensibly higher than this they behaved like a globe filled with mercury. The capacity increased almost instantaneously from 2 per cent. to 50 per cent. With the field strength equal to this critical value, the capacity increase varied with the different experiments. Sometimes it was 2 per cent., at other times it was 50 per cent., according to circumstances, which I did not specially investigate, but which are probably the same as those relating to the passage of a spark between two metallic spheres in air when the potential difference is maintained near the critical value. I next substituted for the Geissler tubes others without electrodes, connected directly with a mercury pump, by which I could vary the pressure from say 5mm. by steps of 0·2mm. I always obtained the same result. For every pressure there is a critical value for the field strength such that for any less intensity the globe behaved like a dielectric and for any higher value like a conductor.

It is clear that in these experiments nothing was changed at the surfaces of the condenser plates, which remained immersed always in air at atmospheric pressure. The observed discontinuity cannot therefore be traced to the gas-metal layer; it is due entirely to the gas inside the insulated glass vessel. If the experiment be made in a dark room, it is seen that in the case of strong fields there is a sudden glow both at the instant of charging as well as of discharging. In weak fields the gas remains always dark. *The apparent conductivity of a rarefied gas is therefore essentially connected with its luminosity. The gas glows each time there occurs a passage of electricity.*

5. I insist, then, that, according to the preceding observations, it is impossible to compare a rarefied gas with any known electrolyte. I have previously shown† that the conductivity of an electrolyte can only be regarded from the point of view of its ability to permit of the passage of an electric current. However small be the electromotive force applied at any point in the mass of an electrolyte, or (when inductive methods are not employed) however small the potential difference between any two planes situated in the liquid, the conductivity is invariable. It is impossible to discover any critical strength of field, however small, below which an electrolyte will cease to conduct.

The apparent conductivity of a gas is seen to be related to another phenomenon essentially sudden and violent, which succeeds the condition of dielectric equilibrium, just as the breaking of a stretched wire follows immediately on its condition of elastic equilibrium when the applied weight exceeds a certain limiting value. Under the influence of a strong electric field the gas breaks down at some point in the same manner as a sheet of paper or of glass; but on account of its greater homogeneity a gas yields at a number of points simultaneously, and becomes illuminated not along any straight line, or even any definite curve, but along a path spread throughout the entire mass. Fundamentally there is no difference between the discharge between two metallic electrodes and the luminescence produced in electrodeless tubes, which has just been studied.

Just as the breaking load gives an estimate of the *cohesion* between the two neighbouring portions of a loaded wire, so also the minimum field strength sufficient to break down the electrical equilibrium of the gas measures, what may be called, the *dielectric cohesion*. The ether—that is, a vacuum—has a perfect *dielectric elasticity*. Its dielectric cohesion cannot be broken down, and discharges cannot be passed through it. But gaseous molecules give rise to weak points, and the dielectric cohesion then becomes measurable. I am at present engaged in determining how this cohesion depends on the nature of the gas, its pressure, &c.

6. Every rational experiment on the electrical properties of gases should in future be conducted along the following lines:—

(*a*) The dielectric equilibrium should be first investigated in fields of strength less than that of the critical field menioned above. This requires a knowledge of only one or more characteristic constants of the gas—*i.e.* dielectric constant and its variation with pressure, temperature, &c.

(*b*) In fields greater than that of the critical field. The internal changes undergone by the gas subjected to the action of discharges (*i.e.*, nature and amount of products of decomposition, polymerisation, dissociation; temperature attained, radiations emitted), or the electromagnetic field produced by the discharges, or what is equivalent, the mean intensity of the currents equivalent to these discharges (*i.e.*, J. J. Thomson's screening effects) should be examined. Only in this sense may we speak of an *apparent specific conductivity* of the gas. This would be the conductivity of an electrolytic medium of equal volume, allowing the same quantity of electricity to pass under the same circumstances as the discharges.

(*c*) The boundary between the opposed phenomena occurring in the same gas placed in strong or weak fields should be determined. Among these investigations would be included the determination of the minimum potential difference required to produce a spark between metallic electrodes placed in air at various pressures, as also the laws of the dielectric cohesion of gases, which I am at present investigating.

* This potential difference was obtained from 1,000 small accumulators.

† Bouty, *Journal de Physique*, 2e serie, T. I., pp. 346–364, 1832.

THE ACTION OF ELECTRIC TRAMWAY CURRENTS ON SUBMARINE TELEGRAPH CABLES AND OTHER ELECTRIC CIRCUITS.

BY PROF. ANDREW JAMIESON, F.R.S.E.

The following is an abstract of the discussion on this Paper which took place at the Institution of Engineers and Shipbuilders in Scotland, on February 20th:—

Mr. W. M'WHIRTER said that what was technically known to electricians as earth conductivity must be exceedingly high at the Cape. He remembered, probably 25 years ago, having a similar trouble with an earth fault on a section of a railway in the English lake district near Coniston. Anyone who had been there knew that the geological formation was largely of slate. Much trouble was experienced with the telegraphs, and wires had to be run a long way to get good earth. On one occasion a breakdown occurred at the next station to Coniston Lake, which gave great trouble. To his mind, the fault as explained was clearly a bad earth connection. The currents he granted were much heavier than they ought to have been, and such as the Board of Trade would not allow to exist. No doubt the leakage currents spread right out into the bay, getting into the salt water and the sheathing of the cable, which everyone knew acted as a good conductor; then, largely following the cable route for a distance of a mile or more, they returned through the sea and earth to the tramway power station. He did not think there was any question of induction from the trolley wire. It was purely a case of leakage along the sheathing, thereby inducing, at every change of strength or direction, currents in the insulated core of the cable. He once had a case in Glasgow which threw a good deal of light on this point. Shortly after the North British Railway introduced their system of train lighting between College and Finnieston stations, a telephone circuit gave a great deal of trouble. Occasionally it worked all right, and he wondered where the fault occurred, till one day the assistant in charge said, "I cannot understand it, Mr. M'Whirter, but the telephone is always right on Sundays." The wires ran parallel to the North British underground railway, at a distance of probably 100 yards from the train lighting currents on the low-level line. Listening carefully at the telephone, he could hear the intermittent connection between the collector and the rail as the trains moved along the line. He then cut away the wires and put up a return wire, and the trouble disappeared. He was certain that Prof. Jamieson's proposed remedy would be a perfect one whatever the fault was, let it be induction or conduction, but he believed it was due to the latter. Mr. Trotter brought this same matter before the Institution of Electrical Engineers in 1897, and suggested a twin cable; but he said nothing about twisting the cores, and he (Mr. M'Whirter) felt sure it would not be satisfactory unless the core wires were twisted as recommended by the author.

Prof. JAMIESON in reply said he was glad to hear Mr. M'Whirter's remarks regarding bad "earths," for it reminded him of several mysterious and defective circuits with which he had to deal in connection with land line work in South America. He was also pleased that Mr. M'Whirter agreed with him in considering that the greatest cause of the interferences was due to the return stray currents from the rails passing along the cable sheathing, and thereby inducing currents in the insulated conductor.

Mr. W. B. SAYERS questioned if there would be any inductive effect due to the leakage current, seeing that in the part of the cable circuit affected one conductor was completely enclosed in the other. He thought Mr. M'Whirter was right in contending that the effects were due to the direct action of the stray currents, which would certainly produce a difference of potential in the circuit, and that the inductive disturbances must practically be zero. No magnetic field would be set up inside the sheathing due to stray currents flowing in it, and apparently the effective induction would act equally and opposite in the two parts of the cable circuit—viz., the core and the sheathing and sea water—as these would be cut simultaneously by the magnetic lines of force generated.

Prof. JAMIESON: Mr. Sayers is evidently under the impression that the interferences were due to these stray currents finding their way along the sheathing directly to the receiving instruments by the earth connection of the latter.

Mr. SAYERS again requested the attention of the meeting, but owing to the lateness of the hour the chairman suggested that the point raised by Mr. Sayers should be submitted to experiment, and that the report of the result should be embodied in the proceedings.

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Correspondence.

Prof. JAMIESON: Mr. M'Whirter kindly placed his works and instruments at our disposal for purposes of experiment, and joined up some 70ft. of well-insulated core sheathed with iron, as shown by Fig. 10.

1st Experiment.—The two conducting wires from the storage cell and key were securely bound to the iron sheathing about 50ft. apart, leaving about 10ft. of the sheathing free at each end of the cable. The ends of the core of this cable were connected to a telephone and a sensitive D'Arsonval mirror galvanometer, as shown. Each time the cell circuit was closed a click from the telephone was heard and a deflection of the galvanometer observed. The proved conclusively that currents were induced in the central insulated conductor by the primary currents sent along the surrounding sheathing. The experiment was varied by substituting alternate currents from an alternator, with similar results.

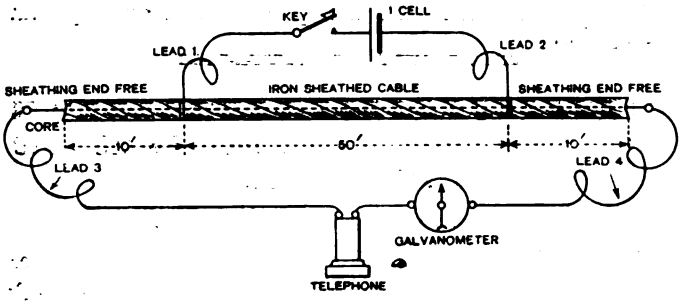

FIG. 10.

2nd Experiment.—The previous cable was now replaced by one having a twin twisted core with similar iron sheathing and connected up as indicated by Fig. 11. In this case neither sound from the telephone nor any movement of the galvanometer was observable, thus proving the efficacy of the twin core as an anti-inductive protection against interferences from intermittent currents passing along the outside sheathing.

3rd Experiment.—Since Mr. Sayers considered that the first experiment (Fig. 10) did not truly represent the case at Cape Town, the single-core cable was connected up in the manner shown by Fig. 12. Here a condenser was introduced between the central conductor and the telephone, and the

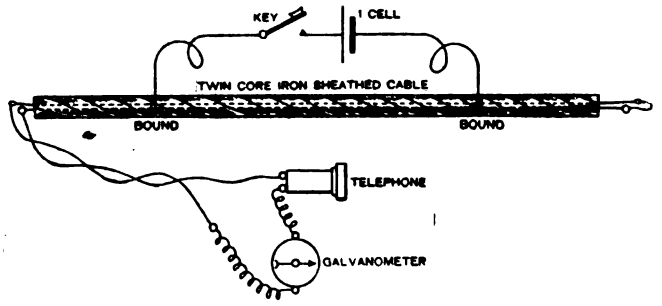

FIG. 11.

other terminal of the latter was connected to the outside sheathing, which was duly earthed. The cable was laid on the workshop floor, and the farther end of the central conductor was connected through 10,000 ohms to the sheathing, as represented in Fig. 1 of the Paper, with the exception of a condenser at the farther end. In this case, when intermittent currents were sent along the 50.t. of sheathing from the storage cell, the telephone immediately responded. But Mr. Sayers said that in this case these effects were not produced from induction solely, for he thought that the battery current split at the point of attachment to the sheathing. If it did, the portion of current which came from

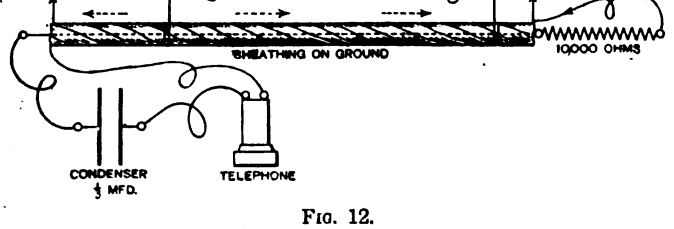

FIG. 12.

this attachment along the sheathing to the telephone was opposed to the induced current from the central core, and so it was in the case of the Cape cable. It should be observed, however, that the resistance of the 50ft. circuit along the sheathing was only ⅓ of an ohm, since 6 amperes was registered there from the 2 volt cell when the key was down; whereas the telephone circuit, which truly represented the Kelvin siphon recorder circuit at the Cape in miniature, had almost infinite resistance owing to the condenser and the 10,000 ohms. No apparent difference was experienced whether the sheathing was earthed or not at its ends.

4th Experiment.—The conditions in Fig. 13, as proposed by Mr. Sayers, introduced an entirely different problem from that under discussion.

5th Experiment.—On a subsequent occasion, in the presence of Mr. E. H. Parker, Mr. David Robertson, and myself, Mr. M'Whirter repeated *Experiment 1* with a cable having only a lead sheath, in order to avoid any effect due to the lay or twist of iron armour. In this case the sounds in the telephone and the deflections of the galvanometer were even greater than in the first experiment. This proved conclusively that intermittent currents in a tube did induce currents in an insulated conductor within it.

Mr. W. M'WHIRTER: In order to test the difference of opinion brought out in this Paper, I arranged, in my works at Holm-street, two lead-covered and armoured cables to represent as nearly as possible the conditions at Cape Town as explained by Prof. Jamieson. The cable used in the first and third experiments had an insulated core, lead-covered, taped, and armoured. In the second experiment there were twin tested cores laid up together, lead-covered, taped, and armoured.

1st Experiment.—The cable was suspended so that it was practically insulated from earth; connections were made to two points on the armour 50ft. apart, by means of twin twisted cable, thus avoiding any interference from the connecting wires. The battery connections were joined together at the farther end, and strong currents were sent through without producing any effect on the telephone. Further, currents from an alternating dynamo were sent through these connections and gave a negative result. The insulated core was joined up through a delicate galvanometer and a telephone. Every current sent through the sheathing or armour was distinctly heard in the telephone and was plainly indicated by the galvanometer, which proved conclusively that the stray leakage currents along the cable sheathing were capable of inducing currents in the insulated core of the submarine cable.

2nd Experiment.—Currents were now sent, under similar conditions, through the sheathing of the cable with twin twisted cores, the cores being joined together at one end and to the telephone and galvanometer at the other end. In the telephone there was perfect silence, and the galvanometer was unaffected, thus proving that any inductive effect upon one core was met by an equal but opposite effect in the other, and also that the adoption of a cable with a twisted twin core earthed out at sea would remove the interference caused by the electric traction.

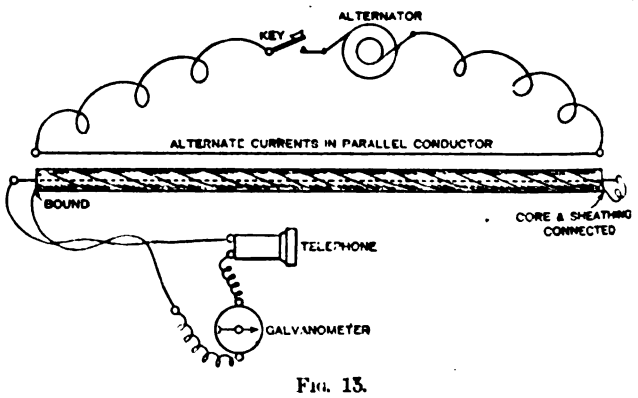

FIG. 13.

3rd Experiment.—The first cable was now laid out on the floor, so that the sheathing was practically earthed along its length: while in this condition one end of the sheathing was connected to the gas pipes, thus being *fully* to earth. The insulated core at one end was connected to the sheathing through 10,000 ohms. The other end of the core was connected through a condenser (½ microfarad) to the telephone and to the sheathing. Currents were now sent through the sheathing exactly as in the first experiment, and the induced currents were heard in the telephone as at first.

Mr. W. B. SAYERS: In accordance with the apparent desire of the meeting, I witnessed the experiments arranged by Prof. Jamieson and Mr. M'Whirter.

1st Experiment.—The arrangement in Fig. 10 did not fulfil the conditions, because the sheathing did not form part of the telephone circuit, and the inductive effect on the core of the cable was therefore unbalanced.

2nd Experiment.—Here there was naturally no effect.

3rd Experiment.—Here the effect was obtained, and was, in his opinion, due to the direct action of the battery circuit. In order to eliminate direct action from the battery circuit, he suggested the arrangement represented in Fig. 13.

4th Experiment.—Here the sheathing and core of the cable both formed parts of the telephone circuit, Fig. 13, and thus reproduced so far the conditions of cable working. The concentric conductor was subjected to the inductive effect of a conductor laid alongside of it and conveying alternate currents, without effect on the telephone.

Mr. DAVID ROBERTSON, B.Sc.: With reference to Prof. Jamieson's remarks: Did the fact that the cable sheathing exhibited no sign of electrolysis not show that the stray currents in it must be exceedingly small? And in connection with the shielding of the underground cable by iron pipes, it would be interesting to know in what way these pipes were jointed, as the value of shielding against change of induction depended very much on their conductivity.

Prof. JAMIESON: With regard to Mr. Robertson's communication, he might state that Mr. Wilkinson, the Eastern Telegraph Co.'s electrician, found a maximum of 5 amperes from the cable sheathing at certain times; and further, he (Prof. Jamieson) observed that the underground pipes were jointed with driven metallic lead.

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CORRESPONDENCE.

ELECTRIC TRAMWAYS AND SUBMARINE CABLES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: From the discussion and the correspondence on my Paper, which now appears in this month's *Proceedings* of the Institution of Engineers and Shipbuilders in Scotland, you will observe, that it was questioned if there would be any inductive effect on the submarine cable conductor at the Cape, due to the leakage or stray currents from the tramway rails passing along the cable sheathing, seeing that the sheathing *entirely* encloses the cable core.

To test this point, I carried out several experiments at Mr. M'Whirter's electrical works in Holm-street, Glasgow (as indicated by Figs. 10 to 13 and as detailed in the correspondence), whereby it was conclusively proved that electromagnetic induction *does take place* in an insulated conductor wholly surrounded by another one, when varying currents are passing in the latter. For example, if varying currents are passed through the lead tube sheathing of an ordinary electric light leading wire, which is joined in circuit with a telephone and a galvanometer (as in Fig. 10), then these instruments at once respond to the fluctuations of the current in the sheathing.

Since this is a *special* case of electromagnetic induction, which I cannot find explained in any text-book or paper, and since it is thoroughly well known, that under such conditions no resultant magnetic field is observable within the space

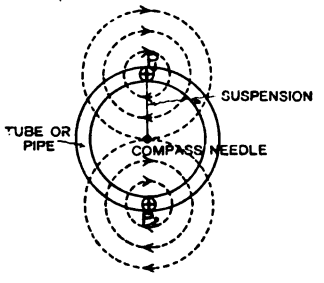

FIG. 14.

surrounded by a tube conveying steady or variable currents, perhaps you will permit me to state my opinions regarding the nature of the action.

1. It is proved by mathematics, that no resultant magnetic field exists anywhere within a hollow conductor of circular section, through which a current is passing at the same intensity in each part of its cross section.

Further, this may be proved experimentally by suspending a short, light piece of soft iron wire or a tiny magnet in the centre of a circular tube, having the axis of the latter in the magnetic meridian and passing currents along the tube, when the iron will be unaffected. This arises from the fact, that each diametrically opposite element of current produces an equal and opposite effect on the iron or magnet, as shown by the cross section (Fig. 14). This experiment may be extended to show that no field exists *anywhere within* the tube due to these currents.

2. If we now replace the iron or magnet by an insulated conductor, having a closed circuit through any delicate current detector and pass currents through the tube as before, then we immediately detect the presence of induced currents in the interior conductor. The interesting problem therefore arises: Why, and how, are these currents evoked, if there is no apparent field or change of field anywhere within the space surrounded by the tube?

3. Suppose we have a closed conductor, S (Fig. 15), and place near and parallel to it a primary conductor, P_1. Then, on starting a downward current in P_1 an upward or contrary current will be induced in S.

Let a primary conductor be now placed in *any* other position P_2 at the same distance from S (Fig. 16). On starting a downward current in P_2 we have the *same* effect in S as before.

4. Let both primary currents in P_1 and P_2 act simultaneously on the same conductor at the same distance. We have just seen that they each affect the secondary in the *same* way; hence their joint effect must be the *sum* of their several effects.

5. Consider now the special case (Fig. 17) in which the two elementary primary currents P_1 and P_2 are diametrically opposite. In accordance with the above statement, *they must assist each other in inducing currents* in the secondary; but it is evident that if they are equal, they *cancel each other's magnetic fields* at the central point.

6. In the general case (Fig. 18), the primary currents P_1 and P_2 do not cancel each other's fields at the centre of S, although of course they do assist each other's inductive action on the conductor, as shown above.

7. We may imagine a current flowing in a tube to be made up of a number of small parts, of which we may consider P_1 and P_2 (Fig. 18) to be any two. Every one of these

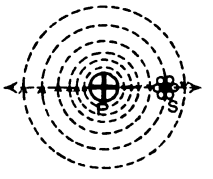

FIG. 15.

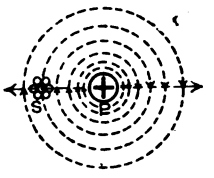

FIG. 16.

elements will affect the secondary in the same way as P_1. Hence they will all assist one another in inducing currents in S.

8. Another way of looking at this problem, is to take into account the total number of magnetic lines of force *linked* with the secondary circuit. Evidently all the electromagnetic lines of force which exist at any instant *outside of the tube* are linked with the central conductor S, since each is a complete circuit in itself. Hence, whenever the current in the tube alters, the number of these lines will correspondingly alter, and a current must be induced in S in accordance with Faraday's Law.

The above conclusions are the result of discussions with Mr. David Robertson, B.Sc., and I shall be glad to learn if our views agree with yours.

Some electricians expressed the belief, that the induced currents in the cable were due to the lay or twist of the

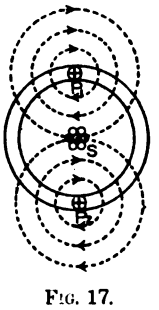

FIG. 17.

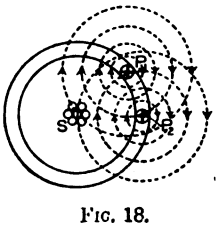

FIG. 18.

sheathing, but my Experiment 5 disproves this theory. If such had been the case, it would have been possible to kill all induction by having two separate sheathings, the one with a right-handed and the other with a left-handed twist or lay. Or, to have supplemented one of them with the necessary number of turns of conductor around the core. Mr. Wilkinson's elaborate and accurate experiments carried out at the Cape on behalf of the Eastern Telegraph Co. proved that the sheathing and the cable core interference currents were simultaneous. I venture however to think, that the above-mentioned experiments and arguments, have led us one step farther in connection with this interesting problem.—Yours, &c.,

Glasgow, March 19. ANDREW JAMIESON.

[We print an abstract of the discussion and official correspondence on pp. 787–8 of our issue this week. We also comment on the question raised by Prof. Jamieson, in our editorial notes.—ED. *E.*]

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PARLIAMENTARY INTELLIGENCE.

LONDON TRAMWAYS BILL.

On Monday the Select Committee of the House of Commons, presided over by Sir Samuel Hoare, commenced the consideration of the London County Council (Tramways) Bill, No. 2, by which power is sought to employ electricity as a means of traction on the tramways which they at present or may hereafter control.

Mr. S. Pope, Q.C., Mr. Freeman, Q.C., and Mr. Du Cane appeared for the London County Council; Mr. Castle, Q.C., for the South Metropolitan Gas Co.; Mr. C. Baggallay, Q.C., for the Lambeth Water Co.; Mr. Reader Harris, Q.C., for the East London Railway Co.; Mr. Erskine Pollock, Q.C., for the Hackney Vestry; Mr. Pembroke Stephens, Q.C., and Mr. Vesey Knox for the Wandsworth Board of Works; Mr. Vesey Knox for the Battersea Vestry; and Mr. F. Dodd for the Vestry of St. Saviour's, Southwark.

Mr. POPE said there are at present 115 miles of tramway laid in London, 72 miles of which had been acquired by the Council at a cost of £1,704,000, and 30 additional miles of tramway would fall into the hands of the Council in 1903. The northern section, 48 miles in length, is leased till 1910 to the North Metropolitan Company. By the bill the Council sought powers to work the tramways electrically. They proposed to adopt either the conduit or the surface-contact system, but retained the power to use the overhead system, which might be economical in suburban districts. The Council agreed, however, that they would not adopt the overhead system without the consent of the local authorities. The cost of equipping a portion of the line in the control of the Council would be £850,000, and, allowing 47 per cent. for interest and sinking fund, they anticipated an increased profit of £81,000 by the adoption of electric traction. The Council were about to lay an experimental line between Westminster Bridge and Tooting, half of which would be on the conduit and half on the surface-contact system.

Mr. J. W. BENN, Chairman of the Highways committee of the Council, supported the opening statement.

Dr. A. B. W. KENNEDY, F.R.S., said he was asked last year to report as to the use of electric traction in London. He examined electrical tramways in all parts of Europe and the United States. He reported that it would be quite possible to carry out electric traction even in the crowded streets of London in a practically successful manner without the use of overhead poles and wires. He was in favour of the underground system, which would be effective and fairly cheap, and he advised that that should be adopted in all the central streets. The overhead system could probably be used without injury to property in places where the traffic was smaller. He had prepared plans. His proposal was that the lines should be laid exactly like the ordinary cable line which was more familiar in London. The electrical appliances would be entirely out of reach, so as to secure the safety of the public. In the streets where there was much traffic he thought it would be of great advantage that overhead working should be entirely dispensed with. The conduit system had been tried in a number of large cities and was a practical success. It had never been found to cause any inconvenience to the ordinary traffic. They proposed to make an experimental line from Tooting to Westminster, one-half of which would be worked on the conduit system and the other half on some system of surface contact. The surface-contact system did not involve the use of two insulated conductors, which were required by the conduit system. He had advised the Council that by one of these systems he could devise a scheme for working the tramways efficiently and economically. The effect of the surface contact was that certain earth currents would be set up, which might take possession of the iron pipes. It was a peculiarity of electricity that it separated elements otherwise chemically combined. Passing through moisture it separated the oxygen from the hydrogen, and the oxygen was free to combine with the iron of the pipes, and rust was set up. This electrolytic action had occurred in America, but it was a thing that ought not to occur, of course. The operation on the mains would be a silent operation, and could not readily be discovered; but he could not agree that it was at all likely to occur. He was opposed to the overhead system for all central parts, but he was aware that power was reserved in the bill to adopt the overhead system if the Vestry gave permission. In his opinion the best system to adopt was the insulated return, as by that system the possibility of electrolysis due to leakage currents and electrical disturbance was completely obviated. There was undoubtedly a possibility of electrolysis due to leakage occurring from an insulated return. In his opinion the leakage could be, and under the Board of Trade regulations it must be, found out at once. He believed there was not a record of a tramway line working under those regulations where electrolysis had been found.

By Mr. CASTLE, Q.C.: In how many cases are the lines working with an earth return under those regulations?—Every case in this country. There is, I think, no case with an insulated return.

How many cases (not overhead wires but underground connections) are there in this country?—None.

What leakage would take place from the powers of the County Council to have earth returns if they chose?—They have not power to use earth returns.

You say that the advantage of the conduit system is that it gets rid of the possibility of electrolysis?—Yes, that is one of the advantages.

Continuing, Witness said the mode of constructing these tramways for the use of electricity was different from the mode of constructing tramways for horse traction. They had to dig a culvert along the centre of the road and would cause a larger disturbance to the mains and pipes. They would go a foot deeper under the road. He had suggested a new variety of surface-contact system, which he thought was suitable for the needs of London.

By Mr. VESEY KNOX: That is an experiment altogether?—Yes.

Nothing exactly like it is used anywhere else?—Probably not.

What size are the ducts which are to be in the road between the two lines?—About 8in. square or circular, and set in a concrete or bitumen block about 8in. square.

This is projecting above the surface of the roadway?—Yes, about seven-eighths of an inch.

And they will be placed at various intervals along the road?—Yes, at intervals of about 8ft. to 10ft.

Continuing, Witness agreed that as the system was something quite new, the Wandsworth Board should have power to require it to be removed after a certain lapse of time. It was reasonable that the Wandsworth Board should have some control over the experimental scheme, but if it was to be carried out all over London and become a uniform scheme, he did not see, from an engineering point of view, how every road authority could be allowed to have a vote on the question. His objection to giving a special clause to Wandsworth was simply that they would be asked for the same by other authorities. They contemplated the generation of electricity at one large central station for the whole of South London, and they would take the current by high pressure-mains to several stations, where they would transform it down to low pressure. By sec. 7 of the bill the Council took power to make agreements with companies for the supply of electricity in bulk, but they did not contemplate supplying electricity to any outside company. Their working would be subject to certain restrictions of the Board of Trade, the object of which was to detect any leakage and so prevent the possibility of electrolysis.

By the Committee: As to leakage, if there really were great leakage it would be a serious matter. It had been found in America, where leakages were very great, to be a most serious question. His view was that practically there was no difficulty in preventing any such leakage, and none whatever in discovering the leakage. The Board of Trade would, under the bill, have power to make regulations; and under the existing regulations he had not heard of any case of electrolysis taking place within the last six years.

Sir ALEXANDER BINNIE, the engineer-in-chief of the London County Council, said he had advised that the Council should work the tramways as a whole and, if possible, by one uniform system. In conjunction with Prof. Kennedy he had considered the question, and he entirely supported his evidence. When they had the complete system worked electrically they would be able to work more expeditiously and more cheaply. As to the claim of the gas and water companies to do the work of altering their mains and pipes by their own workmen, he said as a matter of practice they had always allowed the work to be thus done, but they considered that the carrying out of these works should all be under the control of the Council's engineer.

Mr. CASTLE, Q.C., on behalf of the South Metropolitan Gas Co., said there were two points which raised very important questions. The London County Council were seeking to introduce into London to an unprecedented extent electricity as a motive power, and one of the effects of introducing electricity, unless it was under perfect control, was that there was a liability of leakage which might produce a vast amount of damage to underground gas and water pipes and mains. In this country we have not sufficient experience of what electricity can and may do with regard to electrolysis, but there was sufficient doubt for them to ask Parliament for a protective clause. Electrolysis must be a concealed fact until the damage has actually taken place. The second point which he pressed was that they should have confirmed by Parliament what was the practice at the present time—they should have the opportunity of themselves doing the work which the County Council might require in dealing with their gas mains. The accident at Manchester made it desirable that the gas company should retain that control in their hands.

Mr. CHARLES CARPENTER, chief engineer of the South Metropolitan Gas Co., said that since the Tramways Act of 1870 there had not been a single occasion on which a tramway company had attempted to carry on the alterations to any of the pipes of the company. The question of electrolysis had been brought under his notice by experience abroad—especially in America. It was not that the regulations were not effective, but that they had not been tested. He did not know any case in which a clause with reference to damage by fusion had been given.

Mr. CLAUDE BAGGALLAY, Q.C., for the Lambeth Waterworks Co., said there were only two questions: (1) Should there be a liability on the part of the County Council to pay compensation in the event of damage being done? and (2) Should the work of altering the mains be done by some foreign body? The whole question was: Are the regulations sufficient protection? If they are sufficient, and if they are complied with by the parties working the tramways, there would be no harm done. If the regulations are sufficient and are not complied with an action would lie under the general law. But if the regulations were insufficient, and yet the Council complied with them, a compensation clause was absolutely necessary. The Board of Trade regulations in force were those of 1894. All he put was the contingency of the Board of Trade regulations proving insufficient having regard to the particular system adopted.

Mr. JAS. SWINBURNE, examined by Mr. Castle, Q.C., said he had had great experience in electrical engineering, and had gone into the question of damage that was likely to arise to gas and water mains from electric tramways being carried over them. In his opinion, in a small town, the Board of Trade regulations that were intended to deal with small systems would protect gas and water pipes sufficiently, but when you get into a large system like this there is no saying how far the pipes may be attacked. They certainly would be attacked to some extent: it was a matter of degree. But as the attack was a very insidious one it was very difficult to tell how much damage may be done before it was found out. Insulated returns would get over the difficulty, completely or practically completed; but any other system

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than that would be liable to the danger. As regarded the evidence of Dr. Kennedy as to the discovery of electrolysis, he was afraid Dr. Kennedy was reading the wrong paragraph of the Board of Trade regulations. These provided that there shall not be more than 7 volts on the one hand, and it also provided that near the station there shall not be more than either 2 amperes or 4 amperes or certain earth plates. That was quite right for a small system, but there is no way of making sure that there is no leakage. Seven volts were quite enough to give very serious electrolysis indeed. There was no machinery provided for by the regulations of the Board of Trade which would ensure the discovery of electrolytic action. They could not tell whether there was any electrolytic action until the mischief was done. It was silent, secret, and continuous. It was true that the Board of Trade had consulted the council of the Institution of Electrical Engineers before drawing up the rules, and he was on the council at the time.

Dr. KENNEDY, re-called, said he had prepared estimates for the cost of applying electric traction to the tramways of the Council. He found that the total length of line in London, if it were entirely doubled, would be 207 miles of single line. He estimated the cost of conversion to the conduit system, the cost of altering pipes and mains, putting down the rolling stock and building a power station, and the necessery plant would be £14,450 a mile. By the overhead system there would be a saving of £3,000, and by the surface-contact a saving of £1,500 per mile. That was for reconstruction only. The 72 miles of tramway would cost £1,170,000.

Yesterday, after a short consultation, the CHAIRMAN announced the decision of the committee. He said: By this Bill the London County Council applies for powers to use electric power for traction on its tramways. As the estimated amount of the expenditure contemplated by the bill is £3,000,000, the proposal is by far the largest and most important of its kind which has yet been before this House. Of the 40 vestries whose districts are represented on the County Council all have agreed to the provisions of the bill with the exception of Hackney, Wandsworth, Battersea, and, possibly, on clauses, Southwark. The committee are satisfied that if London is to have the full advantage of electric tramways it will not be desirable that special provisions should be introduced into the bill for the protection of the three vestries which have petitioned. The committee are influenced in this decision by the fact that Hackney has six members, Wandsworth two, and Battersea two on the County Council, so that if any grievance arises in their districts they have equal opportunity with other districts represented on the County Council of bringing that grievance before the County Council. In reference to the petitions of the gas and water companies, no evidence has been placed before the committee as to any cases of loss in this country sustained by fusion of or electrical action on gas and water pipes. The committee are satisfied that the provisions of the present bill and the enactments of the Tramways Act, 1870, with the fact that the London County Council is subject to the Board of Trade, both as to the approval of their system of traction and as to regulations that may from time to time be laid down, make every reasonable provision to meet the contentions of the two companies. With reference to the question raised by the Vestry of Battersea as to fares, especially with reference to working men's trams as well as other fares, no evidence has been put before the committee that would enable them to form an opinion as to the reasonableness of existing fares, though they considered that should the profits of the County Council materially increase owing to the introduction of electrical power the question of the reduction of fares should be taken into consideration. The committee with these remarks find the preamble of the bill proved.

Mr. PEMBROKE STEPHENS said, as the question was a very important one to Wandsworth, they would take no further part in the discussion.

The committee then proceeded to consider the various clauses of the bill.

ELECTRIC POWERS BILLS.

On Friday the House of Commons resumed the consideration of the motion by Lord Balcarres "that the Committee of Selection do appoint a committee, not exceeding seven members, to whom should be committed the following private bills":—

Lancashire Electric Power Bill;

Durham (County of) Electric Power Supply Bill;

South Wales Electrical Power Distribution Bill;

Tyneside Electric Power Bill (read a second time on Thursday, March 1).

Mr. GALLOWAY moved to leave out the words "the Committee of Selection do appoint a committee, not exceeding seven members," in order to insert the words, "a Select Committee be appointed."

The PRESIDENT OF THE BOARD OF TRADE (Mr. C. T. Ritchie) agreed with the mover of the amendment that these bills were so important in character that they ought not to be referred to an ordinary Private Bill Committee, but he differed as to the character of the committee by which the measures should be considered. To the proposal of a Select Committee he had two objections. One objection was that if the bills were sent to a Select Committee they would, in addition to passing through that committee, have also to pass through another committee, a course which would inevitably mean delay and probably the loss of the bills this year. The other objection was that a Select Committee was a committee nominated by the House and selected from both sides of the House; and that, he contended, was not at all the kind of committee to consider bills of the important character here concerned. What was required was a perfectly independent committee, selected by the ordinary tribunal, the Committee of Selection, composed of gentlemen who had no interest in the bills except to hear and judge the evidence put before them. He therefore supported the original motion.

Mr. BRYCE said the House had to choose between three kinds of committees to which these bills, involving far greater principles than ordinary private bills, could be referred—viz., the ordinary Private Bill Committee the Hybrid Committee, and the Select Committee. There was a fourth possible cause which, but for one objection, would probably be the best of all—that of a joint committee of both Houses. The objection was that the promoters of the bills might feel that in the event of the report being against them they would lose the opportunity of bringing the measures before a committee of the House of Commons. Clearly an ordinary Private Bill Committee could not deal with the matter. It was admitted on all sides that the magnitude and gravity of the question was such that it should be referred to a committee of very great strength. A Select Committee would not necessarily be the partisan committee suggested by the President of the Board of Trade. It was only right that there should be one partisan of each side, to see fair play, but the rest of the members should be absolutely impartial. It could not be doubted that the Committee of Selection would take pains that no interested persons were appointed.

Mr. GALLOWAY offered to withdraw the amendment if the proposal that three should form the quorum were withdrawn.

Sir HENRY FOWLER felt that of late years the character of the House of Commons had been imperilled by the nomination of gentlemen on committees as representatives of the interests concerned. If the House was to keep the confidence of the country as a just and impartial body, the time had come for that representation of interests to cease. In the case of these bills there should be no such thing as a quorum, but all the members of the committee should be bound to hear and judge the evidence. He agreed with the President of the Board of Trade that this should be a strong committee of seven members, and that in all other respects it should fulfil the obligations and liabilities of the ordinary Private Bill Committee.

Lord BALCARRES was willing to withdraw the words objected to by Mr. Galloway.

The amendment was, by leave, withdrawn.

Sir JOHN BRUNNER moved to omit the words "not exceeding" and to insert in their place "of," and this was agreed to.

On the motion of Lord BALCARRES it was also agreed, "That the committee have power to send for persons, papers, and records."

Mr. MONK (Gloucester) moved, and the House agreed, "That the committee be subject to the standing orders relative to the proceedings of committees on opposed bills (except that fixing the number of members)."

The entire motion, as amended, was then approved.

SOUTHPORT EXTENSIONS AND TRAMWAYS BILL.

This bill has been passed by a House of Commons committee. It is proposed to construct and electrically equip new tramways, and the bill empowers the purchase by the Corporation of the undertaking of the Southport and Birkdale Tramways Co., the leasing of tramways outside the borough, the reconstruction or alteration of existing tramways, the adaptation of the lines to the use of mechanical power, and the supply of electricity for traction purposes. The Corporation have already acquired the undertaking of the Southport and Birkdale Tramways Co. and have leased it to the company, and also wish to add to their own lines. The committee assented to the insertion of a clause for the repayment of the £40,000 to be borrowed for the construction of the tramways being spread over 40 years instead of 30 as laid down by the Local Government Board.

DUBLIN ELECTRIC LIGHTING BILL.

The consideration of the Dublin Electric Lighting Bill on second reading in the House of Commons yesterday was further postponed until April 13. Mr. W. Redmond has given notice of his intention to move the rejection of the measure.

COST OF TELEGRAMS TO SOLDIERS AT THE FRONT.

In the House of Lords last week the Marquis of Lansdowne (replying to the Earl of Lichfield) said the Eastern Telegraph Co. had agreed to make very important concessions in regard to the charge for telegrams to the troops in South Africa. All messages to soldiers and sailors were to be sent at the reduced rate of 2s. per word, instead of the full rate of 4s. In the case of an officer, the rank, and in the case of non-commissioned officers and men, the name might, at the sender's risk, be omitted, the regimental number alone being given in the latter case. The remainder of the address (including Cape Town) would be charged as only one word. Thus "3,383, Second Battalion Wiltshire Regiment, Cape Town," would be charged as two words only.

TELEPHONING CABLE MESSAGES.

In the House of Commons yesterday (Thursday) Sir EDWARD SASSOON asked the Secretary to the Treasury whether a considerable grievance existed among the commercial communities, notably in Liverpool, owing to the regulation requiring the transmission to their destination of cable messages received from America through the Post Office, and that this system necessarily involved delay and waste of time, entailing loss of transactions, especially in cases where the messages were received about the closing hours of business; and if he would undertake to modify the regulation so as to permit the cable companies themselves to send the messages through the telephone direct to their destination.

Mr. R. W. HANBURY said arrangements had already been made in Liverpool for telephoning these American cable messages direct to subscribers of the National Telephone Co. for the Exchange branch post office, which immediately adjoins the offices of the cable companies. The suggestion made would involve a modification of the terms of the National Telephone Co.'s licence, and it is obviously undesirable to take such a step to meet a limited local requirement.

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BRIGHTON CORPORATION BILL.

The committee of the House of Commons presided over by Mr. Schwann had under consideration on the 15th inst. the measure promoted by the Brighton Corporation, which contains some important electrical proposals. The bill contemplates the construction of tramways and the acquisition of land for purposes connected therewith at a cost of £200,000, and the erection of a generating station at Southwick at a cost of £400,000. The tramways, which are to be laid down in a connecting network, are to be away from the frontage of the town, none of them actually facing the sea, though the whole will be inside the borough boundary. It was explained to the committee that the demand for tramways was very strong in the town, and that there was practically no opposition from frontagers. The Corporation had decided to adopt the over-head trolley system.

On Friday last evidence was given to show that the scheme would be of great convenience, was widely desired, quite practicable, and that little if any injury would result to the surrounding property.

Mr. F. J. C. MAY, engineer and surveyor to the Corporation, said there were some steep gradients, but none worse than about 1 in 10. One of the particular points on which the committee of the Corporation inquired was as to the working of the overhead system on steep gradients, and they were told by all the engineers they had consulted that there was no difficulty, some engineers referring to gradients of 1 in 9 where the system worked with ease. The conduit system had also been considered; indeed, the committee started out rather prejudiced in favour of it, but they were converted to the overhead system.

Mr. KINCAID (Kincaid, Waller and Manville) who in conjunction with Mr. May had planned the tramway system, gave particulars of the overhead trolley system of working.

Mr. A. CHIPPERFIELD, a frontager in Dyke-road who opposed the bill, said the overhead wires would constitute a great danger in case of fire. He could not understand how a fire-escape could get to the houses with them. He had not thought that perhaps the wires were purposely placed high enough to meet this very point.

On Monday Mr. MAY, recalled, said it was not proposed to use the cog system on the cars, as on some of the mountain railways in Switzerland; the Corporation would depend entirely on the brakes for safety.

Mr. R. BALLARD said the hill in Dyke-road was so steep there that he should regard a tram coming down as he would a bullock—it might or might not become dangerous. If a vehicle ran away there would be nothing to stop it. When heavy rain fell immense quantities of water flowed down the road, washing along sand and mud, and he did not see how it would be possible to keep the flanges of the line clear at such times. The trams would be obliged to jump the rail, and nothing he could imagine, having regard to the gradient, would stop them.

Mr. THOMAS, C.E., said the system of cross-overs proposed in Dyke-road would only aggravate the difficulties of the position. The proposal would mean practically that the line would be one of continuous sinuosity for its whole length at this point.

After further evidence the committee decided that the preamble of the bill was proved so far as concerned the tramways portion, excepting as regarded the proposed tramway in Dyke-road.

On Tuesday Mr. LITTLER, Q.C. (for the Brighton and Hove General Gas Co.), said the Corporation had conceded what the company thought were fair and reasonable terms with regard to his clients' opposition. Such opposition was withdrawn, except to consider the clauses which would be brought up to give effect to the agreement. He added that if the opposition had been gone into, there would have been some interesting evidence regarding electric fusion.

Mr. PEMBER said the next part of the bill dealt with the powers as to the supply of electricity, which were in effect to buy compulsorily certain lands adjoining the eastern arm of Shoreham Harbour, and erect a generating station there. Thence the wires would be taken across the harbour, along a road on the northern shore, and so by various roads until the borough of Brighton was reached. The present supply was given under an order obtained in 1883, so that the question was merely one of erecting a larger generating station outside the limits of supply. The area of the site was about 10 acres, and it was about 3¼ miles from Brighton, but by the route proposed the wires would cover a distance of 4¾ miles. The present generating station in Brighton was a comparatively small one, but the growth of increase in the consumption of electricity had been enormous. In 1892, when they began to supply, the consumers were 213; now they were 2,400. In the same period the number of 8 c.p. lamps furnished had grown from 11,000 to 130,000, the units sold from 156,000 to 3,208,000, the capital invested from £53,000 to £290,000, and the profits from £2,200 to nearly £17,000. These facts showed the importance of a large generating station, which importance was added to by the fact that, great as had been the growth, there was room for still greater expansion, 18,000 houses being still unsupplied. The charge of the Corporation was very low, averaging 2·94d. per unit. The money which it was sought to raise for the electric undertaking was £400,000.

Mr. ARTHUR WRIGHT, engineer to the Brighton Corporation electric undertaking, said at present there were 2,450 consumers, and about 50 consumers were still waiting to be supplied. Current was supplied at as low a rate as gas, and seemed to be appreciated by the poorer classes, who were largely adopting it. The rate of increase was increasing, and was likely to grow greater. From the first the undertaking had paid, the profit last year being £16,000, or 5¾ per cent. on the total capital; besides which they had accumulated out of profits £48,920 to create sinking, reserve, and depreciation funds, and paid over £9,500 to the rates. So rapidly had the demand increased that there was no doubt Brighton required a site where a very much larger production of electricity than that originally contemplated could take place. The site selected at Shoreham was very suitable. It would be transmitted as high-pressure alternating current, and then at the present station of the Corporation in Brighton reduced to the lower pressure for the consumers. Power was taken by the Corporation to supply the local authorities all along the route if they desired it.

Cross-examined by Mr. RAM (for Hove Town Council): He did not agree that the usual method in London was to lay trunk mains in conduits with manholes. The Brighton Corporation had no objection to supply Hove in bulk on fair terms, but to supply them at cost price, regard being had in that price simply to interest and sinking fund, would be very uncommercial. Something more should be paid.

By the Committee: The insulation problem in connection with cables was solved long ago; the difficult matter was to protect the pipes.

Mr. JAMES SWINBURNE said it was necessary to extend the works of the Corporation, but it was not advisable to make the extension on the present site, especially in a place like Brighton, owing to the nuisance it would create. It was a principle generally recognised by electrical engineers to have the generating station outside the area of supply, and the site selected under this bill seemed admirable in every way. He saw no necessity whatever for the special protection the Hove Council now sought. Under the circumstances it was reasonable to lay the mains in troughs, and there was no necessity for manholes. The great drawback to the trough or solid system was that the mains could not be drawn in and out as with the conduit system.

On Wednesday Mr. ENDACOTT, town clerk of Hove, said the houses in that borough were chiefly large and of very high class; and building was going on very extensively in the portion of Hove not yet developed. The Hove Corporation had an electric lighting order in 1890, which had been leased with the sanction of the Board of Trade to the Hove Electric Lighting Co.; and there was also an order relating to Aldrington, which district was included in Hove. When the lease was granted the Corporation stipulated that the cables, both trunk and distributing mains, should be laid in conduits, because they did not wish to have the roads broken up. The method proposed by the Brighton Corporation would involve the opening of the roads to enable the mains to be dealt with. Hove did not object to the laying of the cables if they had proper protection. The mains in Hove should be laid in culverts, or by such other system as the Hove Corporation might approve.

Mr. WORSLEY TAYLOR said under the Act of last year the promoters had to submit their plans to the Postmaster-General, who could ask for certain things. If the promoters did not agree, the matter was to be referred to the Board of Trade to decide. But suppose the present committee were to order that the cables were to be laid in a conduit, what became of the right of the Postmaster-General to require them to be laid in some other way?

Witness thought the Postmaster-General would submit very much to the wishes of the local authorities.

Mr. WORSLEY TAYLOR quoted sec. 14 of the Act of last year, and went on to ask what was to happen if the Postmaster-General did not approve of the proposal of the Brighton Corporation, and the Board of Trade decided that the Postmaster-General was right, and also if the special provisions sought in the present bill were given?

WITNESS: The three bodies would have to confer, and no doubt they would arrange some system satisfactory to all parties.

Mr. WORSLEY TAYLOR, in reply to the Chairman, said there were no decisions as to clause 14 showing whether the Postmaster-General had the right to object to any system, or whether he could only object to details; but they could not have wider words than those of the clause.

Mr. MOON said this question had not been decided yet in committee this session.

The CHAIRMAN (addressing Mr. Worsley Taylor) said the feeling of the committee was that they would leave the Postmaster-General to take care of himself.

Mr. WORSLEY TAYLOR said he thought the committee would not, unless with very grave reason, introduce into a private Act conditions which were absolutely contrary to the provisions of the public Act passed last year.

Sir WILLIAM PREECE, consulting electrical engineer to the Postmaster-General, said he was consulted by the Hove Corporation as to the best mode of conveying current from Shoreham Harbour to Brighton. The Hove Corporation only objected to the laying of the mains through Hove to prevent unnecessary interference with the surface of the roads, and in order to secure that the mains should be so laid as to leave as large a portion of the road as free as possible from sewers gas, and other pipes. The only difference between Mr. Wright, the expert for the Brighton Corporation, and witness was as to the way in which these mains should be laid. As he had had for 20 years to look after the interests of the Postmaster-General, he could say that the Postmaster-General simply looked at the systems of electrical undertakers with the view of protecting his wires; and the Board of Trade, in his experience, simply had regard to the security of property. In some places mains were laid as proposed by the Hove Corporation, in others as the Brighton Corporation proposed. If the solid system were adopted by Brighton, they would have to lay a sufficient number of mains to provide for the whole possible power they proposed to generate; or if they laid mains for a portion only, sooner or later they would have to open again the whole of the road from Shoreham Harbour to Brighton. In the system he advocated, the drawing in, it would only be necessary, where extensions were carried out, to open the manholes and draw in the new cables. It was not likely that the Postmaster-General or Board of Trade would object to this system, because they had both approved of it in many instances. This was the first case, he thought, which had come before a committee of one corporation seeking power to go through another Corporation's area. He agreed there was no difference in principle between a commercial company going through a Corporation's area and a Corporation going through another Corporation's area, and unless some very special circumstances were shown, he would not like to see varying provisions inserted in the bills. The general law ought to be regarded.

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The solid system was perfectly well known, and had been adopted in 70 towns, in some under his own advice; but there were just as many towns where other systems were used. The solid system was not the best for Hove

By Mr. MOON: If the solid system were adopted there were two causes which would lead to the roads being opened—the cables becoming defective or the desire to lay additional cables. The first was most important. One thing was sure to occur in connection with electrical mains—and that was the unexpected. We never knew what was going to happen with regard to electrical matters. Lightning or something else might lead to a fault; with the manhole system the fault could be located between two manholes, and easily remedied without opening the road.

By Commander BETHELL: The question of difference of price between the two systems did not enter into consideration. One possible objection to manholes was the possibility of the accumulation of gas; and in London 20 or 30 explosions had arisen from this cause. But the accumulation of gas was simply the result of neglecting proper ventilation.

By the CHAIRMAN: He knew of no provisional order in which the special provisions sought had been inserted, but this was the first case, he believed, which had come before the House of one Corporation desiring to carry their mains through the area of another Corporation.

Mr. ARTHUR WRIGHT, recalled, did not agree that there was no difference in the two methods as to cost. In country roads, where the level was constantly altering, the cost of upkeep of manholes must be very serious, and the manhole system therefore the more expensive. The advantage of this system was that they could pull out a short length of main. It would be unwise for Brighton to adopt the culvert system; it was entirely unnecessary and unsafe. There were 150 miles of the solid system of cable in Brighton. Moreover, the cable which would be laid would weigh about 3 tons for 50 yards, so that if it were pulled through the pipe a good deal of the insulation would probably be worn off by friction.

After a short deliberation the committee passed that portion of the preamble of the bill relating to the electricity undertaking, declining to accept the clauses submitted by the Hove Corporation.

[Pressure on our space compels the leaving over to next issue of the proceedings in committee on the Huddersfield and Stockport Corporations' Tramways Bills.—ED. *E.*].

LEGAL INTELLIGENCE.

The Attorney General v. National Telephone Co. (Ltd.).

This case came before Mr. Justice Grantham and Mr. Justice Phillimore on Friday last, on a motion for an interim injunction to prohibit the National Telephone Co. from breaking up streets and laying down underground works without the consent of the Postmaster-General, pending the hearing of an information filed by the Attorney-General for the purpose of raising the question of the company's right to do so.

The ATTORNEY-GENERAL said the case raised very important questions of law as to whether the defendants could break up the streets without the licence of the Postmaster-General and also the licence of the London County Council. Sir E. Clarke appeared on the other side, and had raised the defence that the Telephone Co. had independent rights, and could go on without the licence of the Postmaster-General or the County Council. The Telephone Co. did not wish to be hampered in their business, still, if they were allowed to go on, the result would be that the streets would be broken up indefinitely. What was wanted was a decision as to the company's rights. He (the Attorney-General) proposed that there should be an adjournment till April 5, when the whole of the legal points could be argued.

Mr. Justice GRANTHAM said that all matters with which the Attorney-General was connected had precedence over any other matters in that court, and if the parties were ready the motion could be heard there and then.

The ATTORNEY-GENERAL said that in the regular course he would ask for an undertaking, but his learned friend (Sir E. Clarke) said he could not give that. He quite understood that this undertaking could not be given, and as he understood that no fresh work would be entered upon, he would not press the matter. He should now ask for an interim injunction, and subsequently the Court would be asked to give a permanent decision.

Sir E. CLARKE said that this matter was of immense importance to the Telephone Co., and he hoped that an actual decision would be arrived at as quickly as possible. He was, however, content to let the matter stand over until April 5.

Decision accordingly.

National Telephone Co. v. Tunbridge Wells Corporation.

At the Tunbridge County Court on Wednesday, before Judge Emden, an application was made on behalf of the National Co. for an order permitting the company to lay underground wires in the streets without the consent of the Corporation. Mr. Cripps, Q.C., appeared for the company, and Mr. Macmorran, Q.C., for the Corporation.

Mr. CRIPPS said the telephone company already had permission to lay down underground wires in certain streets, but it was desired to extend the wires under other streets, and to this extension the Council refused its consent.

Judge EMDEN said it seemed a pity to waste his time with an appeal for an order when, if either party was dissatisfied with his decision, they could go to the Railway Commissioners.

Mr. CRIPPS said that was not quite so, as both parties would probably abide by his Honour's ruling.

Mr. MACMORRAN contended that the Acts in regard to telephone wires extension in urban districts were not the same as regarded the National Co. and the Post Office. He contested the interpretation of the Acts by Mr. Cripps, and said the Corporation was within its rights in refusing consent.

Decision reserved.

Hores, Pattisson and Bathurst v. National Telephone Co. (Ltd.)

This was an action asking for a mandatory order to compel the defendant company to remove 610 wires and a derrick from the roof of plaintiffs' premises. When the case was called on, on Wednesday, before Mr. Justice Buckley, Mr. Astbury, Q.C., said defendants had agreed to consent to judgment, and therefore all that was now required was a formal mandatory order and an inquiry as to damages.

His lordship made the order asked for, and gave the plaintiff the costs up to and including the judgment.

Moody Brothers v. A. Henley and Co. (Ltd.).

Mr. Justice Ridley and a common jury yesterday heard this case, which was brought to recover £315 for work done at defendants' studio at Epsom. Defendants counterclaimed for £445 damages incurred, as they alleged, by their premises being burnt down owing to defective electric light installation.

Mr. Witt, Q.C., and Mr. Sturgess represented plaintiffs, and Mr. Shee, Q.C., and Mr. Alfred Sington defendants.

The counterclaim was first taken. It appeared that defendants have a London address at Great Wild-court, Holborn, and works and studios at Epsom, and are photographic printers. In Dec., 1898, they gave plaintiffs a contract for a complete installation of electric light, a condition being that the work should be done in a skilful and workmanlike manner, and that no risk of fire should ensue from the use of the lamps and installation. Two arc lamps were fitted in the studio for use in photography. The testing duly took place on Sept. 23rd last, and an alteration in the stand of one of the lamps being advisable, it was left, according to plaintiffs, with instructions that it should not be used. On Oct. 2 a fire occurred at the studio, which was burnt down, and the outbreak was traced to this lamp. Defendants' case was that the fire was caused either by imperfect insulation of the wires which supplied the current to the lamp, or to the fact that the switch was placed on the wrong side of the resistance coil, whereby, when the lamp was not burning and the dynamo was working which supplied current to the other lamps in the works, the current going through made the resistance coil red hot. This, it was suggested, caused the asbestos against which the resistance coil was placed to glow, and to ignite the match-boarding to which the asbestos was fixed. The defendants consequently alleged that by reason of an unskilful and unworkmanlike installation they suffered the damage claimed; alternatively that the contract that no risk should ensue from the use of the lamps and installation was not fulfilled. £100 was claimed for the destruction of the lamp, £215 for damage to studio and contents not covered by insurance, and £100 hindrance in business. In reply plaintiffs denied any negligence on their part, and it was suggested that the installation had been interfered with.

Prof. C. V. Boys, Mr. Haydn Harrison and Mr. Hinchley were called in support of defendants' case.

Mr. MOODY, a member of the plaintiffs' firm, stated that after the test he suggested that the lamp should have a special movable stand made, and be sent back to London for that purpose, and in his presence his partner detached the wires. Witness explained the construction of the Crompton lamp as perfect in every way, and he did not believe that the lamp itself had had anything to do with the outbreak. He had no theory as to the origin of the fire.

Mr. HERROND, partner with Mr. Moody, gave similar evidence, stating that after the lamp-switch was turned off he took the wires off the connectors and also off the lamps. It should have been sent up to London on the Monday after the test on Saturday.

Mr. Justice RIDLEY, in summing up, said the plaintiffs' claim was admitted. The only question was the counterclaim. Defendants said plaintiffs had put up the electrical installation in such a way, so carelessly that the result was the fire. First of all, was the fire due to the electrical apparatus; and, secondly, was the electrical installation constructed in a negligent manner? If it was, the jury would find a verdict for the defendants, who were the plaintiffs on the counterclaim. It seemed to his lordship that there was no doubt that the fire was due to the electrical apparatus, and that on the evidence the jury could not find any other answer but that. The evidence was all one way, and that was that the fire was due to the electrical apparatus and to nothing else. The lamp and all its connections would admittedly work properly when all was perfect, but the jury would have to consider whether the placing of the resistance coil within 4in. of the wooden matchboarding partition was, under the circumstances, a careful and properly-constructed arrangement. If, as a matter of fact, the switch was turned off, this fire could not have occurred; and as the plaintiffs had said that they themselves turned off the switch, they might very well have set up that somebody must have turned it on subsequently. But though their counsel suggested that, the plaintiffs in the witness box took quite another line, and said it was impossible, in their opinion, that the lamp and its wires could have caused the fire at all. He left three questions for the jury: (1) Was the fire caused by the electric installation? (2) Was the apparatus constructed in an improper and negligent manner? (3) If so, what were the damages?

The jury answered the first question "Yes," the second question "No," and added, "The jury are of opinion that the fire was due to some interference with the apparatus after the departure of Mr. Moody and his partner."

Mr. Justice RIDLEY gave judgment for the plaintiffs on both the claim and counterclaim, and granted a stay of execution for 14 days pending notice of appeal.

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Goldberg and Son v. Liverpool Corporation.

In the Chancery Court of Lancashire on Monday this action (fully reported in our issues of March 2 and March 9) was again mentioned. Mr. Maberly, representing the Corporation, said that notice of appeal had been given, and he asked that the order for the removal of the tramway pole and fuse box should be suspended until the resolution was known.

Mr. ROTCH, for the plaintiff, urged that the appeal might not be heard for some time, and if the Corporation were successful the plaintiff would have to pay the cost of the removal. He therefore asked that the order for removal be executed at once.

The Vice-Chancellor continued the suspension until the disposal of he motion.

TRADE NOTES AND NOTICES.

[Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.]

TENDERS INVITED.

The *Southampton* Harbour Board invite tenders for a motor transformer with accessories. Specification may be seen at the offices of the electrical engineer (Mr. J. G. W. Aldridge), 9, Victoria-street, Westminster, S.W., and copies may be obtained of the clerk (Mr. A. H. Skelton), Harbour Offices, Town Quay, Southampton. Tenders must be in by April 7. An advertisement contains further particulars.

The *Maidstone* Corporation require tenders for the supply and erection of steam and water pipes and valves for their electricity works. Specifications, &c., may be obtained after 20th inst. on application to the engineers (Messrs. Stevens and Barker), St. Peters-street, Maidstone, and tenders should be addressed to the town clerk (Mr. Herbert Monckton) by 10 a.m. of April 3. An advertisement gives further particulars.

The directors of the *Lancashire and Yorkshire Railway* invite tenders for various stores for twelve months ending April 30, 1901, including signal and telegraph fittings, signal, telegraph, and electric light wires, copper tubing, glass, oil, screws, &c. Further particulars and forms of tender may be obtained at the stores department, Osborne-street, Manchester, where samples can be seen. An advertisement contains additional information, and tenders must be lodged with the secretary (Mr. R. C. Irwin), Hunt's Bank, Manchester, not later than 10 a.m. of April 9.

The *Salford* Corporation invite tenders for an ash conveyer and two electrically-driven travelling jib cranes. Specifications may be seen at the offices of the consulting engineers (Messrs. Lacey, Clirehugh and Sillar), 2, Queen Anne's-gate, Westminster, S.W., and 78, King-street, Manchester, but can only be obtained at the latter office. An advertisement contains further particulars, and tenders must be delivered to the town clerk (Mr. L. C. Evans) by 10 a.m. April 9.

The *Edinburgh* Corporation desire tenders for the supply of (1) steam coal; (2) arc lamp carbons; (3) cast-iron pipes, pavement boxes, frames, &c., for the Corporation's electricity supply stations. Further particulars are given in an advertisement, and specifications can be had at the resident engineer's office, 5, Dewar-place, Edinburgh. Tenders have to be lodged with Mr. Thomas Hunter, W.S., town clerk, City Chambers, Edinburgh, by April 7.

The Visiting Committee of the *Northumberland* Lunatic Asylum, near Morpeth, invite tenders for an electric lighting installation. An advertisement contains further particulars, and specifications, &c., can be obtained at the offices of the consulting engineer (Mr. A. A. Campbell Swinton), 66, Victoria-street, London, S.W. Tenders to the clerk (Mr. H. Vassall), Market-place, Morpeth, by April 9.

The *Keighley* Corporation invite tenders for wiring the new municipal offices. Copies of specification can be obtained from the borough electrical engineer (Mr. J. M. Smyth), Bridge-street, Keighley. An advertisement contains further particulars, and tenders (addressed chairman, Municipal Offices committee) must be delivered at Mr. Smyth's office by 10 a.m., 31st. inst.

The *Metropolitan Electric Supply Co.* invite tenders for ten 100 kw. transformers. An advertisement contains additional particulars, and specifications can be obtained from the engineer (Mr. R. R. Todd), 17, South-street, Manchester-square, London, W.

The *Buxton* District Council invite tenders for the supply of electricity meters. Some particulars are given in an advertisement, and tenders must be sent to Mr. J. Taylor, clerk, Town Hall, Buxton, by Wednesday, April 4.

The *Dublin* Electric Lighting committee invite tenders for the supply and erection of electric lighting plant. Tenders to town clerk, City Hall, Dublin, by 4 p.m., April 26.

The *Sunderland* Corporation invite tenders for the supply of india-rubber-covered cables, wrought-iron and cast-iron piping, box frames and covers, and stoneware casings. Tenders to chairman, Lighting committee, by noon, 30th inst.

The *Cardiff* Corporation require tenders for wiring the new fish market. Tenders to town clerk by April 3.

The *Dartford* District Council require tenders for electricity generating plant. Tenders to clerk, Sessions House, Dartford, by noon 27th inst.

Barnes District Council require tenders for erection of electricity station buildings, chimney shaft, &c. Tenders to clerk by April 10

Maidstone District Council require tenders for erection of electricity station buildings and chimney shaft. Tenders to town clerk by April 9.

Tenders are required for electric lighting of Victoria Concert Hall, *Halifax*. Tenders to W. C. Williams, 29, Southgate, Halifax, by April 7.

The *Dundee* Town Council invite tenders for the construction of permanent way for tramways and for steel rails, crossings, &c. Specifications from engineer, and tenders by April 3.

The *Corunna* (Spain) Electric Co-operative Society invite tenders for the supply of electricity generating machinery having a capacity of 400 H.P. or capable of supplying 12,000 10 c.p. lamps. Particulars from Dr. Enrique Sors, 81, Calle Real, Corunna, and tenders to Dr. Manuel Baifa, Calle de Zafateria, No. 5, Corunna, before April 15.

The municipal authorities of *Wilna* (Russia) invite tenders until April 13 for the electric lighting concession in the town. Particulars from and tenders to der Magistrat.

The Receiver-General and Director of Contracts, *Valetta* (Malta) requires tenders for dynamo oil, &c., until April 5.

Tenders are invited until Aug. 1 for the public lighting of the city of *Buenos Ayres*.

TENDERS RECEIVED AND ACCEPTED.

The tender of the British Thomson-Houston Co. has been accepted by the Newcastle-upon-Tyne Corporation for the supply of 130 electric tramcars, at £75,776. 10s. The cars will be of four kinds—double-decked for the Gosforth route, four-wheel cars with tops for Westgate Hill and other steep gradients, and two types of bogie cars.

The following tenders have been accepted by the Ilford District Council for the supply of plant, &c., for their electricity works:—

Babcock & Wilcox (water-tube boilers, economiser, feed pumps, pipework, &c.)	£4,767 0 0
General Electric Co. (two 200 kw. and one 100 kw. steam dynamos and motor boosters)	5,321 0 0
E.P.S. Co. (storage batteries)	1,750 0 0
James White (main switchboard and connections)	1,387 11 6
Southgate Engineering Co. (15-ton crane)	317 10 0
W. T. Henley's Telegraph Works Co. (mains, conduits, and road-work for public and private lighting)	24,636 10 5
Veritys Ltd. (arc lamps and posts)	2,671 0 0
L. G. Tate (station lighting)	83 0 0

The total of the accepted tenders amounts to £41,341. 11s. 11d. and an agreement has been entered into with the E.P.S. Co. for the maintenance of the batteries for three years at £405, with the option to extend to five years at £675.

The Shoreditch (London) Vestry have received the following tenders for the supply of two additional boilers:—

Babcock and Wilcox (*conditionally accepted*)	£1,650
Haythorne Tubular Boiler Syndicate	2,400

The Vestry have also accepted the under-noted tenders in connection with the annual contracts for the Lighting committee: Electrical sundries, the Edison and Swan Co., Johnstone, Benjamin and Co., and Williamson and Joseph; engineer's stores, W. H. Willcox and Co. and Hunns and Co.; ironmongery and tools, J. E. and S. Spencer and F. Bird and Co. The Lighting committee recommend the tender of Messrs. W. Storrs, Sons and Co. for the erection of the chimney shaft at the new station at £5,499, less £600 allowance for old buildings.

The Aberdeen Corporation have received the following tenders for the supply of four electrically-equipped tramcars:—

Macartney, McElroy and Co. (*accepted*)	£3,900 0 0	British Thomson-Houston Co.	£4,185 15 0
Dick, Kerr and Co.	4,380 0 0	British Westinghouse Co.	4,110 0 0
R. W. Blackwell & Co.	4,365 3 2		
Siemens Bros and Co.	4,280 0 0		

The Brighton Corporation have received eight tenders for a combined feeder and dynamo switchboard for their electricity works, viz.:—

Edison and Swan Co. (*accep'ed*)	£502 0 0	Crompton and Co.	£673 0 0
Nalder Bros. & Thompson	840 0 0	Electric Construction Co.	660 0 0
Fowler-Lancaster (Ltd.)	743 0 0	Veritys Ltd.	536 15 7
General Electric Co.	680 0 0	Lowdon Bros.	500 0 0

The Newington (London) Vestry have accepted the tender of Messrs. Babcock and Wilcox for two additional boilers, feed pump, ironwork, and extensions to the steam and water mains, including chain-grate stokers and superheaters, for the electricity works, at £9,461.

The Southport Town Council have accepted the tender of Messrs. Dick, Kerr and Co. for the supply of rails for tramway extensions.

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The Glasgow Corporation have accepted the tender of Messrs. A. and P. Steven for an electric lift for the new fine art galleries at £515. 10s.

The Belfast Electric committee recommend the acceptance of tenders of Messrs. Mather and Platt and Messrs. Johnson and Phillips for the supply of dynamos.

The Liverpool Electric Light and Power committee have accepted the tender of Messrs. Morrison and Sons for the erection of a sub-station in Fairclough-lane, at a cost of between £5,000 and £6,000.

The St. Annes-on-Sea Council have accepted a tender from Messrs. McCulloch and Co. for 100 electric lamp-posts, from the Prism Globe Co. for 100 fittings, and from the Reason Manufacturing Co. for 100 switches with sockets.

APPOINTMENTS VACANT AND FILLED.

The Sheffield Electric Light committee require an engineer to take charge of their electric light and power undertaking. Commencing salary £500 per annum. An advertisement contains further particulars, and applications must be sent in to the town clerk (Mr. Henry Sayer) by April 2.

A mains superintendent is required for the Southampton electricity works. An advertisement contains further particulars, and applications must be sent to the borough electrical engineer (Mr. F. H. Chaplin) before noon of 31st inst.

The Hanley Town Council require an assistant electrical engineer. Applications to the electrical engineer (Mr. C. A. Cowell) by 31st inst. See advertisement.

The Islington (London) Vestry require a qualified mechanical draughtsman and a skilled mechanician for their electricity department. Further particulars are given in advertisements, and applications must be sent to the Vestry clerk (Mr. Wm. F. Dewey) by noon of April 9.

The Buxton District Council require an improver, a switchboard attendant, a cable jointer, and a driver for Belliss engines for their electricity department. Applications to chief engineer (Mr. Edward Calvert). See advertisement.

The Mexborough District Council require a consulting electrical engineer. Applications to clerk (Mr. J. W. Hattersley) by 26th inst.

The Glasgow Corporation require an assistant manager for the Corporation telephone exchange. Particulars from and applications to town clerk, City Chambers, Glasgow, before 26th inst.

Mr. R. M. Carr has been appointed assistant electrical engineer to the Bexhill District Council.

BUSINESS NOTICES.

The Maxim Electrical and Engineering Export Co. (Ltd.) notify their removal from 44, Gillingham-street, London, S.W., to 65, 66 and 67, Gracechurch-street, E.C.

Mr. G. W. Webb has been appointed manager of the show-rooms of Messrs. Fry and Co. (Ltd.), 19, Farringdon-avenue, London, E.C. representatives of Messrs. C. Joyner and Co., of Birmingham.

BANKRUPTCIES, LIQUIDATIONS, &c.

William Paul Theerman, electrical engineer and contractor, trading as W. P. Theerman and Co., 22, Devonshire-street, Chorlton-on-Medlock, Manchester, and 36, Lord-street, Rochdale, has executed a deed of arrangement. Liabilities £3,371. 7s. 4d., assets £5,247. Mr. W. J. Coates, 5, John Dalton-street, Manchester is trustee. The principal creditors are:—

Moores, Farrell and Co.	£306	Adams and Co.	£31
Veritys Ltd.	282	W. T. Beesley and Co.	31
Newton Electrical Works	223	Mather and Platt	28
Electrical Co.	217	J. Hewitt and Son	28
Dorman and Smith	208	S. Howes	25
Alley and MacLellan	175	Schofield and Co.	22
Johnson and Phillips	128	Simplex Steel Conduit Co.	22
W. T. Glover and Co.	125	Sharples, Taffs and Co.	18
J. Turner and Sons	110	Rhodes and Webster	17
Baxendale and Co.	86	C. Holmes and Co.	16
J. G. Allison and Co.	85	Simon, Berry and Co.	13
International Electric Co.	70	T. Bell and Co. (Ltd.)	13
Blackman Ventilating Co.	62	Edwards and Armstrong	11
Moon, Loughlin and Co.	52	F. O. S. Leake	11
E. Mercier	48	St. Helens Cable Co.	10
Croft and Perkins	36	Penistone Electrical Co.	10
Telegraph Manufacturing Co.	35		

Claims against W. H. F. Bowman, electrical engineer, &c., of Gainsborough, must be in by April 4. Mr. R. J. Ward, 31, Silver-street, Lincoln, is trustee.

A first and final dividend of 4s. 8d. will be payable on April 4 at Messrs. Yates and Scampton's, 4 and 6, Wood-street, Bolton, in the failure of B. Wild and J. H. Clarke (trading as Wild, Rothwell and Co.), electrical and general engineers, Virginia-street, Southport.

The trustee in bankruptcy of H. W. Thane, electrical and general engineer, of Northfleet, has been released.

A meeting of the creditors of Frederick Metcalfe, electrical engineer, White Horse-street, Boar-lane, and Cardigan-road, Leeds, took place on Wednesday. Liabilities £125. 16s. 10d., assets £6. 7s. 10d. Debtor attributed failure to loss on contracts.

The adjourned public examination of Benjamin Symmons, electrical engineer, late North-street, Quadrant, Brighton, took place last week. Debtor stated that he had been defrauded by his managers. He could not tell how much he had lost in this way, but feared it was a considerable sum. A large number of book debts had been collected and not marked off, something like £30 and £40 having already been accounted for in this way. Examination concluded.

Works for Sale.—As announced in another column, Messrs. Fuller, Horsey, Sons and Cassell have been instructed to offer for sale by tender the freehold works of Accles (Ltd.), at Perry Bar, Birmingham, comprising extensive ammunition, cycle, and general engineering works, &c. Tenders must be addressed to Master Whitehead, Mr. Justice Cozens-Hardy's-chambers, Room 706, Royal Courts of Justice, Strand, London, by 11 a.m. of Tuesday, April 10, and may be either for the entire property, including the company's plant and machinery, or in three lots—*i.e.* (1), ammunition works and cartridge factory, (2) general engineering and cycle works (occupying about 10½ acres, with substantial, well-lighted, modern buildings, fitted with costly collection of engineers' machine tools), and (3) proof range for heavy ordnance. Further particulars, with conditions of sale, &c., may be obtained from the receiver (Mr. P. E. Beachcroft), 1 and 2, Great Winchester-street, E.C.; Messrs. Wilson, Bristow and Carpmael, solicitors, 1, Copthall-buildings, E.C.; Messrs. Pritchard, Englefield and Co., solicitors, Painters'-hall, Little Trinity-lane, E.C.; and of the auctioneers, 11, Billiter-square, E.C., London

Plant for Sale.—Messrs. Albright and Wilson (Ltd.), Oldbury near Birmingham, have a Willans Crompton steam dynamo for sale. See advertisement.

Mr. T. Johnson, Wigan, has a 120 I.H.P. vertical compound engine (by Easton, Anderson and Goolden) for sale.

Messrs. A. Verey & Co., Dover, advertise some electrical instruments, arc lamps, wire, switches, &c., for sale.

Presentation.—The employés of the Consolidated Telephone Construction and Manufacturing Co., at Coventry, on the 17th inst., presented Mr. W. J. M. Menzies, late general manager of the company, with a handsome framed and illuminated address as a token of the very high esteem and regard in which Mr. Menzies was held during his 15 years' association with the company. The address expresses regret at Mr. Menzies' retirement, and an appreciation of his many efforts on behalf of the staff.

The "Journal."—Part 143 of the *Journal* of the Institution of Electrical Engineers is now ready, and particulars of contents are given in an advertisement.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from March 14 to March 20, with the ports of destination:—

Africa—Alexandria, £36; Cape Town, £29; Delagoa Bay, £2,621; Durban, £518 (including £327 telegraph material); East London, £281 (including £166 telegraph apparatus). *Argentina*—Buenos Ayres, £420 (including £240 telegraph material). *Australasia*—Adelaide, £550; Auckland, £114; Freemantle, £104; Melbourne, £274 (including £201 telegraph material); Rockhampton, £1,400; Sydney, £1,816 (including £40 telegraph material). *British Guiana*—Demerara, £20. *Burma*—Rangoon, £30. *Ceylon*—Colombo, £683. *China*—Shanghai, £39. *Denmark*—Copenhagen, £342. *Germany*—Hamburg, £230 (including £200 telegraph material). *Holland*—Amsterdam, £15; Rotterdam, £727 (including £300 telegraph material). *India*—Calcutta, £133. *Japan*—Yokohama, £20,419 (telegraph cable). *Malta*, £55. *North Atlantic*, £20,000 (telegraph cable). *Russia*—Reval, £527 (including £400 telegraph material). *Spain*—Carthagena, £48. *Straits Settlements*—Penang, £140 (telegraph material). *Sweden*—Gothenburg, £90. Total £52,665, against £9,042 in the corresponding week last year (March 15 to 21).

MUNICIPAL, FOREIGN, AND GENERAL NOTES.

Aberdeen.—The Gas and Electric Light committee have been requested to report upon the existing charge for electric current and the effect the maximum demand system of charging has on the accounts of consumers who use the electric light all the year round.

The street lighting system is to be extended to several additional streets, and the Lighting committee propose to erect 40 additional electric lamps at an estimated cost of £1,272.

Ayr.—The report of the burgh electrical engineer (Mr. A. J. Fuller) for the past three months states that the units generated show an increase over the corresponding period of the previous year of 48,000. The maximum load during the winter was 256 kw., against 200 kw. last year. At present the department can only store 600 tons of coal—equal to five week's supply—and Mr. Fuller suggests that the capacity should be increased to a stock of at least

2,000 tons. The Tramways committee have sent a deputation to towns in England where electric tramways are in operation in connection with the projected system of tramways in Ayr.

Barnard Castle.—The Council have sanctioned the Northern Counties Electricity Supply Co.'s application for a provisional electric lighting order. The Council retain the right of purchase at 31 years.

Bath.—£13,000 further is to be expended in extending the electric lighting system for public and private lighting.

Birmingham.—It is remarkable that this once enterprising and progressive Council should display such apathy in regard to electric traction. Several attempts have been made by the City of Birmingham Tramways Co. to come to an understanding with the Corporation in regard to electric traction, but hitherto without success. The Tramways sub-committee met on Tuesday to consider a communication from the chairman of the company (Mr. Ross) in regard to the conversion of the Bristol-road route (at present worked by accumulator cars) to the overhead system. The lease of this route has about 11 years to run, and the company are willing to effect the conversion at their own expense without an extension of the lease, provided that on the expiration of the term the Corporation purchase the rolling stock at a valuation. The Public Works committee are advised to accept the proposal, subject, however, to some slight modification.

Bradford.—The accounts of the electricity department, which were presented and passed at the meeting of the Corporation last week, stated that the total income for the half-year ended Dec. 31, 1899, was £17,654. 5s. 2d., compared with £13,011. 3s. 8d. for the corresponding period of 1898, an increase of £4,643. 1s. 6d. The total expenditure (including interest and sinking fund) was £14,256. 19s. 5d., against £10,519. 10s. 3½d., and the net profit £3,397. 5s. 9d., against £2,491. 13s. 4½d., an increase of £905. 12s. 4½d. The number of consumers was 1,075, against 850, an increase of 21 per cent. The total number of units consumed was 1,360,319, against 926,732, an increase of 47 per cent., irrespective of current supplied for public lamps. The total profits since the opening of the works in September, 1889, to the date of these accounts, after paying interest and sinking fund, amounted to £26,013. 12s. 5d., and the total amount written off for depreciation had been £14,372. 17s., leaving £11,640. 15s. 5d. to be appropriated as the Council might direct. The trade profit for the last half-year worked out at £4. 19s. 2d. per cent. on a capital outlay of £202,702, and the net profit (after charging interest and sinking fund) at £1. 13s. 5d. For the whole year the trade profit amounted to £17,617. 19s. 1½d., representing £8. 13s. 10d. per cent. on the capital outlay, and the net profit to £5,130. 8s. 4d., representing £2. 10s. 8d. per cent.

Bridgwater.—Mr. W. H. Trentham has been appointed consulting engineer for the purpose of drawing up an electric lighting scheme.

Brighton.—At the Council meeting last week the Lighting committee's recommendation as to new arrangements with the engineer and manager of the electricity works (Mr. Arthur Wright) was withdrawn. The accounts of the department for 1899, an abstract of which appeared in our last issue, were submitted and passed.

Cambridge.—Fresh proposals for the extension of the existing tramway system and for the introduction of electric traction have been submitted to the Council by the Cambridge Street Tramways Co. and are at present under consideration by the Tramways committee. It is proposed to adopt the overhead trolley system, and the extensions, which would be constructed under the Light Railways Act, would embrace the Romsey Town and Chesterton districts.

Carlisle.—In our last issue we stated that the local tramways company wished to modify their original scheme for the extension of the system and for the introduction of electric traction, and that the company had disposed of their undertaking to the British Electric Traction Co. The latter statement is, we find, incorrect, the City of Carlisle Electric Tramways Co. (Ltd.) having no intention of disposing of their undertaking.

Electric Dust Carts.—The London Common Council have authorised the Streets committee to employ an electric motor car in order to make experiments in the collection of dust and refuse.

Electric Traction in Belgium.—A company has been formed for constructing an electric tramway between Brussels and Antwerp, a distance of about 24 miles.

Greenock.—The burgh electrical engineer (Mr. S. E. Fedden) reports that the number of lamps applied for during the month to March 9 by private consumers was equivalent to 4,247 8 c.p., which with arc lamps brings the total to 5,151, an increase of 795 8 c.p. since last report. The number of consumers is now 72, against 60 last month.

The Law and Finance committee have accepted the offer of the Greenock and Port Glasgow Tramways Co. for a lease of the tramways. The lines are to be converted to electric traction, and the company will take current from the Corporation at 1½d. per unit for a minimum of 500,000 units per annum. Above this figure special terms are to be arranged.

Guildford.—The local electricity supply company have intimated their willingness to sell the undertaking for £25,000. Since the company is prepared to negotiate, the Council will appoint a committee to deal with the matter.

Hampstead (London).—In the report of the Lighting committee for the quarter ended Christmas last the receipts amounted to £11,471. 11s. 9d., compared with £8,514. 4s. 7d. for the corresponding period of 1898, an increase of 38 per cent. The Vestry are supporting the Poplar District Board of Works in requesting the London County Council to promote legislation to enable metropolitan local authorities to borrow money for wiring consumers' premises, &c.

Huddersfield.—It has been decided to increase the salary of the borough electrical engineer from £350 to £450 per annum. The increase was moved by Ald. Calvert, at the meeting of the Town Council on Wednesday. He said that between 1896 and 1899 the capital expenditure had more than doubled. The consumers had increased from 385 to 1,082, the equivalent number of 8 c.p. lamps connected from 28,983 to 70,178, the units metered from 304,000 to 951,000, and the expenditure from £3,140 to £6,660. The gross surplus had increased from £3,728 to £9,040, and in interest on loans and their repayment the sum of £1,789. 14s. 3d. had been paid.

Islington (London).—The Electric Lighting committee unanimously recommend that, having regard to the efficient manner in which Mr. Albert Gay discharges his duties as electrical engineer, his salary be increased from £500 to £600 per annum as from January last.

Leamington.—The Council have decided not to oppose the application of the Midland Electric Light and Power Co., provided the company accept certain suggested clauses and amendments filed for incorporation in the order. In this event the Council will abandon the order obtained by them in 1899. Ald. Bland said that the Electric Light committee, before coming to their present decision, had exhausted all possible means of coming to an agreement with the company. He had since written to the chairman (Mr. A. Chamberlain) asking whether he was prepared to accept a sum (nearly £30,000) for the undertaking, which had previously been mentioned, but Mr. Chamberlain demanded something like double that sum. The only alternative left was to go to arbitration, and owing to the conditions which the Board of Trade had attached to the Corporation order, they did not feel justified in doing that. The committee had spent £1,100 in endeavouring to obtain a satisfactory order. A conference between the parties has been arranged for to-day at the Board of Trade.

Leicester.—The Corporation (who are about to take over the local tramways) are considering the advisability of introducing an improved system of traction, and a deputation has been sent to towns where electric traction is in operation. Sheffield, Leeds, Glasgow, and Edinburgh have been visited this week.

Light Railways.—On Friday the inquiry was resumed into the joint application of the Middlesex County Council and the North Metropolitan Tramways Co. for powers to construct a system of light (electric) railways to connect the present system of the London County Council at Highgate with the lines at Tottenham and Edmonton, and also with the outlying districts and with the proposed Hertfordshire scheme. The company's consulting engineer (Mr. V. B. D. Cooper) estimated that the cost for their part of the scheme would be £337,000, and Mr. R. D. M. Littler, Q.C., chairman of the Middlesex County Council, said he believed there would be a profit on the undertaking. The opposition of the Hendon, Tottenham, and Southgate District Councils was withdrawn, and Mr. Wheeler, who opposed on behalf on the Finchley Council, said the scheme was purely speculative, that the district was not ripe, and that the project would cost twice as much as had been represented. Mr. Asquith, who appeared for 750 frontagers and ratepayers, submitted that there was not adequate evidence of public need for the scheme, and the damage and inconvenience which would be caused were entirely out of proportion to the benefits expected.

An inquiry was held on Monday into the application of the Loughborough and District Electric Traction Synd., for an order to construct a system of light (electric) railways in Loughborough and district. The total length of the proposed railways was 8¼ miles, and the overhead electric traction system was proposed, the gauge being 3ft. 6in. The Council and leading ratepayers supported the application. The company's engineer (Mr. C. H. Gadsby) gave technical details. Opposition was offered by the Leicestershire County Council, and the inquiry was adjourned.

The South Staffordshire Light Railway extension order (for constructing light railways in Bilston, Willenhall, and Coseley) has been submitted to the Board of Trade for confirmation, and objections must be lodged by April 14.

The promoters of the Cinque Ports light railway scheme have altered the proposed route from Lydd to Rye. The Council of the latter district also wish an alteration made in the route between Rye and Winchelsea, to prevent the line running through the latter town.

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London County Council.—At Tuesday's meeting a bye-law was approved prohibiting the display of flash lights and search lights in London, subject to the approval of the Home Department. The following are the Council's definitions :—

The expression "flash light" means and includes any light used for the purpose of illuminating, lighting, or exhibiting any word, letter, model, sign, device, or representation in the nature of an advertisement, announcement, or direction which alters suddenly either in intensity, colour, or direction. The expression "search light" means and includes any light exceeding 500 c.p., whether in one lamp or lantern or in a series of lamps or lanterns used together and projected as one concentrated light, and which alters either in intensity, colour, or direction.

The report of the Highways committee on the subject of the tramways under the Council's control recommended that £42,000 of the profits from the tramways be appropriated to the relief of the rates. Mr. Benn said the lines now under horse traction realise £225,000 per annum, and would, in a few years, under electric traction, realise £665,000. It was proposed to reduce the working hours of their employés from 11½ hours to 10 hours per day. The Council had carried 50,000,000 passengers at a ½d. per mile, 50,000,000 at a 1d., and about 17,000,000 at somewhat higher fares.

Long Eaton.—Messrs. Hopkinsons and Talbot have been appointed consulting electrical engineers and to advise on the report recently prepared by the electrical engineer to the Wallasey District Council (Mr. J. H. Crowther).

Lynn.—A very lengthy communication has been forwarded to the Town Council by the consulting engineer (Prof. H. Robinson) on the recent report of the Electrical sub-committee on proposed extensions of the electricity supply undertaking. The committee visited a number of stations in the London district, including two designed by Prof. Robinson, with a view to obtain information to guide them in deciding upon the kind of plant to be adopted for the extensions at Lynn. Prof. Robinson states that excursions of that kind are useful and desirable, provided the committee are accompanied by a competent technical expert who is able to direct attention to the important points in the works, and to sift the information volunteered by persons connected with the works. In regard to the statement in the report, that "the great disadvantage of a gas system was the excessive capital outlay—the capital outlay per unit of plant at Leyton is £192, or twice that of most steam stations," Prof. Robinson retorts :—

The absolute falseness and stupidity of these statements will be apparent from the following facts: (1) The total cost of the stations at Leyton and Lynn have been far below £96 per kilowatt. (2) The cost of stations is the only portion of the capital outlay affected by the type of generating plant adopted. (3) To have saved £96 per kilowatt by the adoption of steam would of course mean getting the central station provided for less than nothing. (4) The figure of £192 per kilowatt was arrived at by dividing the total capital outlay at Leyton, including an exceptionally extensive system of mains to reach the consumers over a large area, and also an extensive system of public lighting, by the number of kilowatts provided in dynamo power. (5) The corresponding figure at Lynn will be under £150 per kilowatt, including a system of mains and public lighting decided upon by the Corporation extending far beyond what I advised them to undertake. (6) The corresponding figure for 15 large continuous-current stations in London is £117. The total capital outlay on these undertakings is £2,438,256, and therefore a fair average for large stations can be arrived at. They contain plant of 20,863 kw. Their maximum load is 16,188 kw. Their stand-by capacity is 4,675 kw. The entire cost of these works "per kilowatt of maximum load" is £150, or practically identical with that of the Lynn works, where the stand-by consists of storage batteries. (7) The cost of continuous-current stations, exclusive of land, is given in a pamphlet (published by me in 1893) as £2,500 + £50 per kilowatt of maximum load delivered to the distributing mains. This basis is a little different to the foregoing calculations, as it allows for the loss in the feeders. The Lynn station has a capacity of 176 kw. on this basis, and should therefore cost about £11,300. The actual cost will probably exceed this by about 10 per cent., including all extras. Having regard to the exceptional work on piling foundations and the rise in the price of machinery since the engineers' strike, it cannot be asserted that the discrepancy is large. (8) The corresponding capacity of the Leyton station as carried out by me was 120 kw. in dynamo capacity. The battery capacity, however, was in excess of that necessary as a stand-by to one dynamo, and therefore 150 kw. should be taken in estimating the cost of my 1893 rule, which then shows £10,000 as the cost of a steam station of the same capacity. The actual cost of the Leyton station up to date was £10,600. It would have been less if the Leyton Council had not, in fear of there being no demand for the larger plant, decided to carry it out in two stages instead of doing the whole at one time. (9) It will be observed that this cost works out at £71 per kw. of maximum load capacity and £53 per kw. capacity provided in dynamos and batteries (200 kw. in all). In face of these facts I am accused of having wasted £96 per kw. by the adoption of gas instead of steam. Is it possible to conceive a statement more idiotic and false? (10) I must warn you against arriving at false comparisons based upon the estimated cost of the extensions proposed by the committee—namely, one boiler, one engine and 200 kw. dynamo, one engine and 120 kw. dynamo, with economisers, condensers, circulating pump, &c. Without a stand-by boiler this plant only serves as an additional unit of 40 kw., as it would not be safe in an electric light station to rely on one particular boiler always being fit for use. Assume, therefore, that another boiler is added, and that all the plant is properly housed and all accessories properly duplicated; then its working capacity may be reckoned at 120 kw., and not 320 or even 200, for it is an established principle that the largest unit of plant (or its equivalent) must be kept in reserve as a stand-by. 120 kw. at the station will correspond to about 105 kw. delivered to the distributing mains, compared with 176 kw. supplied by the existing plant. 105 kw., according to my 1893 rule, should cost £5,250, and a proper extension with gas engines would not cost more than this sum.

The second statement was that "the worst feature" of gas plant is that "the capital outlay increases nearly in proportion to the size of the plant, whilst in a steam station this is not so." If the alleged excess of £96 per kw. were not a myth, this statement would no doubt be a serious one. No evidence is adduced in support of the statement, however, and I have already shown in No. 6 above on the first question that the cost of the Lynn works per kw. is not greater than that of 15 much larger stations in London. I agree that where space occupied is an important factor, and a large output is required, steam power must at present be resorted to, and on these grounds I recognise that the change which is being carried out at Leyton is a wise one, as they unfortunately appropriated part of the original site for other purposes, and have recently had to buy a piece of the adjoining land at a greatly enhanced price. Moreover, the demand at Leyton is increasing at a rate far beyond the expectations of everyone concerned in promoting the original undertaking, and this is undoubtedly due to the extremely low price at which current is supplied. At Lynn there is no probability of the question of space ever becoming a difficulty. You will recollect that when the "Walks" site was contemplated I advised a steam plant there, but when the large area of waste land at your present site was adopted I advised gas plant instead.

The third inaccurate statement is that as the plant increases in size the economy in fuel consumption with gas plant vanishes, and that at Leyton "when 500 H.P. was reached the consumption was less for steam than for gas." In support of this statement the committee adopt the foolish expedient of quoting the cost of fuel per unit at Leyton during the Welsh strike, and in 10 places not affected by that strike, where the actual price of coal is usually from one-fourth to one-half the price which has to be paid in London. The proper way to test the question is to compare different works in the same district. Of the 15 large continuous-current stations in London only two companies attained lower fuel costs than Leyton. During the period referred to, however, the South Wales coal strike disturbed the condition and affected Leyton (using anthracite) more than the other stations, where inferior coal was used, and frequently fines were thereby incurred on account of smoke nuisances.

The fourth point on which great stress has been laid is that "the maintenance, repairs, and attendance of gas plant are greater than that of steam plant." In 103 cases the cost of repairs and maintenance is less than at Leyton in only 15 places; equal to Leyton in only five places; and greater than Leyton in 85 places. . . . . I have not in my comparisons referred to any of the alternating-current stations, because the electrical arrangements are so different. If they had been included, the superior economy of the Leyton system would have been still more conspicuous. . . . .

The sub-committee say they were much concerned about the gas stations at Morecambe, Coatbridge, and Belfast being unsuccessful. As regards Belfast, I believe the fact is that the Corporation Gas committee were afraid that the introduction of electric light would injure their department, and therefore induced the engineer to use their gas for working the electric light station. It is generally recognised that this was a mistaken policy, but it in no way reflects upon the wisdom of using producer gas. The engines adopted at Belfast were of a much more complicated design than those at Lynn. Morecambe and Coatbridge are both situated within the area of cheap coal supply, and it is surprising that gas engines were ever put down there, because cheap coal or slack cannot at present be converted into gas by any process suitable for an electric light station. The North-Western Railway Co., however, have rather a large gas station at Liverpool, and I believe are satisfied with the results. The sub-committee say that "a more satisfactory service can be given by steam plant than by gas plant." I venture to submit that the ordinary consumer is best pleased with a "cheap supply" so long as the pressure is steady. The supply in Lynn is quite as steady as the best steam engine supplies, and the only failures I have heard of have been due to neglect on the part of the attendants. As regards cheapness, you will find out by practical experience that my advice has been justified by the results. I have already warned the Electric Lighting committee that if their scheme of extensions is carried out it will throw the working of the station into utter confusion next winter. The committee's justification for this ill-advised scheme is based upon a series of utterly false propositions, which I feel it my duty to protest against at once.

The following is an extract from a lengthy report on the same subject from the resident electrical engineer (Mr. Pilling) :—

I have gone over Prof. Robinson's comments on the report of the extension sub-committee, and I think the first point which need be noticed is his denial that a gas system of generation is greater in capital cost than a steam system of equivalent power, but more particularly that the capital cost of the works of the Leyton Urban District Council is not excessive. He compares the Leyton and Lynn works with the great London companies, some of which have been working eight to 12 years, and in many cases have spent considerable sums in alteration of works during the time. They have had to expend considerable sums on land, and even purchase buildings and clear sites, while at Leyton and Lynn land has been secured for next to nothing. Large sums have also been expended on items incidental to company finance. Prof. Robinson refers to a pamphlet published by himself in 1893, but I should think he must admit that the deductions set forth will not hold good to-day. As to Leyton, the station has the highest capital cost per kw. of plant amongst works using a low-pressure supply, and is only exceeded by one alternating-current station. These works are all compared on the same basis—*i.e.*, the total capital cost divided by the dynamo capacity in the works. I believe that without exception

all the direct-current works in the provinces use batteries, and in many cases have large systems of public lighting included in the outlay. When the sub-committee visited Leyton, reference was not made in any way to the initial scheme of 140 kw., but to the capital outlay to date, which is certainly excessive when compared with balance-sheets of other similar works. Prof. Robinson says that no evidence is adduced in support of the statement that the capital outlay with gas engines increases nearly in proportion with the plant. The capital outlay at Leyton in 1898, with 140 kw. of plant, was £201 per kw.; in 1899, with 245 kw. of plant, it dropped to only £192 per kw.; but in 1900, when the plant has increased to 578 kw. by the addition of more gas and a large steam dynamo, it has dropped to £103 per kw.

In a gas system you are compelled to put down engines of comparatively small power, and drive the dynamos by belts (unless you are willing to try experiments). These small sets are comparatively more expensive than direct-coupled steam dynamos, the foundations are larger and thus more expensive, and they occupy considerably more space, thus adding to the cost of buildings. The dynamos being of small size, there is more switch gearing for a given power than with larger steam sets. Prof. Robinson states that they have got a large storage battery at Leyton, which has affected their capital expenditure largely. Other stations have batteries. If the cost of the batteries is taken away there still remains a sum of £80 per kw. for the works, without mains, public lamps, services and batteries, which is higher than some works including everything.

Mr. Pilling then sets out the comparative cost of gas over steam plant for the proposed extensions at Lynn, and generally traverses Prof. Robinson's claims for gas-driven over steam-driven plant. Mr. Pilling concludes as follows:—

With the steadiness of running of gas engines I will not deal here, as it is entirely a technical question. The committee has been advised by me strongly, as by Prof. Robinson, that nothing must be done to the existing plant calculated to interfere with the supply during the next autumn, and I also advised that the Local Government Board may require the loss on the gas engine, if sold, to be taken out of revenue. On this advice the committee understood that it should not be done if found impracticable. As it was intended to fix the two steam engines in the room occupied by one gas engine, the committee expected that more would be saved on the extension of buildings than would be lost on the sale of the engine. Nothing is said on the noise and vibration set up, which have been one of the reasons for the committee's recommendation, and which would increase if extensions were carried out by gas.

Mangotsfield (Bristol).—The Parish Council are making inquiries into the question of lighting the district electrically.

Newcastle-upon-Tyne.—The Tramways committee estimate they will have to incur an expenditure on capital account during the coming year of £300,000, and on revenue account of £7,365, the expenditure being due to the introduction of electric traction. The estimates were adopted at the meeting on Wednesday.

Poplar (London).—Arrangements have been made with the National Electric Wiring Co. for wiring premises on the "easy" payment system.

Private Bill Legislation.—The estimate of cost of the proposed extensions of the Baker-street and Waterloo Railway is put at £945,000.

The Whitechapel and Bow Railway Co.'s bill has been passed by the Standing Orders committee of the House of Lords. The bill seeks power to raise £300,000 additional share capital, with a proportionate addition to the company's borrowing powers, and for extension of time for constructing the railway.

The Knott End Railway and the Christchurch, Bournemouth, and Winton Tramway Bills were read a second time on Tuesday.

The House of Lords Committee on Standing Orders have decided that the standing orders may be dispensed with in the case of the Dublin Electric Lighting Bill.

Provisional Order Transfer.—The Birkdale District Council notify intention to transfer their provisional electric lighting order to the British Electric Traction Co., the consideration being £700. The Council reserve the right to purchase at 14 years or at end of any subsequent seven years.

Rathmines and Rathgar (Dublin).—An inquiry was held on Wednesday into the application of the Council to borrow £21,000 for electric lighting extensions. The application was supported by the clerk (Mr. F. P. Fawcett), who said that in 1898 a loan of £50,000 was obtained for erecting electricity works, which were completed. Technical details were given by the consulting engineer (Mr. Robert Hammond), and evidence was also given by Mr. C. P. Cotton, late chief inspector of the Local Government Board, and Mr. Pilditch, the resident electrical engineer.

Ryde (I. of W.).—It has been decided to apply for sanction to borrow £30,000 for establishing electricity works. The consulting engineers (Messrs. Kincaid, Waller and Manville) have been instructed to prepare plans and specifications.

St. Pancras (London).—Crowndale-road and Goldington-crescent are to be lighted by eight arc lamps, at an estimated cost of £685.

At the last meeting of the Vestry the Officers' committee brought up a report upon the application of Mr. J. T. Baron, resident engineer at the Regent's Park electricity station, asking for an increase of salary. The Electricity committee had unanimously recommended an increase from £300 to £350, by annual increments of £25. The Officers' committee were, however, of opinion that the salary and emoluments of the office were commensurate, and were not prepared to recommend any increase. Ultimately it was agreed to refer the report back for further consideration.

Skipton.—The local traders' association urge the Council to consider the question of obtaining electric lighting powers.

Southend-on-Sea.—The Light Railways committee have been empowered to appoint an electrical assistant in the borough engineer's department.

Stirling.—The formal opening of the electricity works took place on Wednesday. There are 30 public arc lamps.

Taunton.—In our issue of Feb. 16, we announced that the Council had unanimously resolved to make some recognition of the services rendered by the chairman of the Electric Lighting committee (Ald. Potter) in connection with the electric lighting undertaking, which is now a financial success. It has been decided to present Ald. Potter with an illuminated address, and to make a presentation to Mrs. Potter. The town clerk (Mr. George H. Kite) has consented to act as treasurer, and will receive subscriptions.

Tunbridge Wells.—Sanction to a loan of £24,682 for electric lighting extensions has been obtained by the Council, the period of repayment being 24 years.

Vienna.—As stated in our last issue, the City Council have placed the contract with the Schuckert Co., of Nuremberg, for the erection of electricity generating stations for the Vienna electric lighting and traction schemes. It is proposed at the outset to instal eight generating sets with an output of 3,000 H.P. each, of which 15,000 H.P. will be used for tramway purposes. The estimated value of the contract is over £1,250,000.

Whitby.—An inquiry was held on Friday into the application of the Council to borrow £26,000 for establishing electricity works. The application was supported by the clerk, and technical details were furnished by Mr. A. H. Preece (Messrs. Preece and Cardew). There was practically no opposition.

Wolverhampton.—An inquiry was held here on Friday into the application of the Council to borrow further £11,000 for providing additional plant at the electricity generating station. There was no opposition.

COMPANIES' MEETINGS AND REPORTS.

Potteries Electric Traction Co. (Ltd.).

The second ordinary general meeting of this company was held on Monday, under the presidency of Mr. EMILE GARCKE.

The SECRETARY (Mr. J. G. B. Elliot) read the notice calling the meeting.

The CHAIRMAN said that this was practically the first occasion upon which the directors and shareholders had met together, and he hoped the shareholders would consider that the progress made during what was practically their first year's working had been satisfactory. The Potteries tramway undertaking consisted really of four separate tramway and light railway enterprises, and the object of the Potteries Electric Traction Co. (Ltd.), was the amalgamation of these various undertakings. There were no less than 18 local authorities affected by this enterprise. Thanks to the far-seeing manner in which the schemes of these tramways were originally initiated by Mr. Stephen Sellon, the engineer to the company and one of their directors, the combined undertaking was emerging from a period of weary negotiations during the past five years, and would doubtless return to the shareholders satisfactory dividends on their investments. The permanent way was and had practically been completed over the whole of the company's area, but until all the sections and the whole of the system was being worked a large proportion of their capital must remain unproductive. There were many inconveniences inseparable from the working of only a part of a large system of tramways. The whole of the engineering staff and the administrative officials had been appointed with a view, not of running a small system of a few miles, but of an extensive system, and so the standing charges of their undertaking were at present out of all proportion to their earning capacity. The whole of the capital of the company when everything had been completed would be under £600,000, and they would own and be working over 30 miles of lines, so that the average capital cost would be less than £20,000 a mile. The directors had during the past year made the greatest efforts to complete the whole of the works as quickly as possible, and as the subscribed capital had not been quite sufficient to meet the expenditure, the directors had considered it necessary to make temporary arrangements for providing the additional moneys required. Until the middle of May last they had been working the North Staffordshire section of their lines (6½ miles) by steam, but these were converted to electric traction. Up to the end of December last a further three miles had been added, and during January a further section (bringing the total up to 12¾ miles) had been opened, while at the present moment the lines actually working represented something like 20 miles. The whole of the conversion of the North Staffordshire line from steam to electric traction had been carried out without any interruption to the service. On May 16 the steam cars were sent out in the morning in the usual way, and by 12 o'clock noon were all replaced by electric cars

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without the smallest hitch or interruption of the traffic. A large price had had to be paid for the North Staffordshire undertaking, out of all proportion to the mileage, but this undertaking constituted the kernel of the company's system. While it was difficult to make any useful comparison between the working of the North Staffordshire lines during the past year with previous periods, it would be interesting to know that during the first few weeks of electric working on these lines the number of passengers and the receipts increased by about 27 per cent., and that increase had not only been maintained but had been improved upon; and as the additional lines were opened still further improvement might fairly be anticipated. Summarising the results of the year's working, they had earned a dividend on half the capital employed, although they had been working less than a third of their system and under most disadvantageous conditions. They had carried 5,250,000 passengers. While the old North Staffordshire line had 20 steam cars at work, and the Potteries had started with 20 electric cars, they soon added a further 28, were now equipping 15 further cars, and have 20 additional large cars on order, so that before the summer they would have nearly 90 cars in regular operation. Turning to the profit and loss account, the receipts on the credit side—£10,981, £6,021, and £3,179—did not represent the traffic receipts on the system which had been in working, but, as regards the first two items, represented the net profits which the North Staffordshire Co. had distributed in respect of their holdings in that company. The same remark would serve to explain the expenses on the other side. £6,914 for power and running expenses were not all the expenses that had been incurred for the purpose of keeping the cars running, because that portion of the running expenses which is due to working the North Staffordshire Co.'s lines had been paid by that company; but the item of £6,914 included the electrical power and some other items necessary for working the North Staffordshire cars at 4d. per car per mile. The British Electric Traction Co. agreed to find the electric power and the motormen, and the North Staffordshire Co. the conductors, as well as to provide for other items. That agreement under which these arrangements were come to was made many years ago, long before it was considered probable that they would be able to carry out the complete amalgamation of the undertakings. The directors had, since the beginning of this year, made an agreement with the North Staffordshire Co., by which all this complication of accounts would be removed. Referring to the balance-sheet, they would see that the actual capital was £200,000 in ordinary and £200,000 in preference shares. The prospectus, at the time this capital was issued, mentioned that they expected to have to expend something like £540,000 in order to complete the works, and so they anticipated from the outset to have to provide at least £140,000 over and above the share capital, and some of that excess had already been expended. The company had borrowed from their bankers and from the British Electric Traction Co. altogether £37,600, and they owed to creditors, balance on construction of works, &c., £400,000, so that it was expedient to raise additional capital, and the directors proposed to issue debenture stock, as originally contemplated. They did not propose to issue at once all the capital that would have to be raised, but only £125,000. He now moved the adoption of the report and accounts, and the recommendations therein contained.

Mr. STEPHEN MEAR seconded the resolution.

Mr. CROFT said he had intended to refer to the manner in which the accounts had been presented, and to ask that they might be given in greater detail, but he gathered that in future they would be presented in such a way that the shareholders would have the opportunity of knowing what the progress of the undertaking was in regard to the number of passengers carried, and with regard to the rolling stock and other matters of that kind. He thought the auditors' certificate was not quite in the form that was usual in companies of this kind. As to their difficulties with the local authorities, these bodies had in many cases sprung a mine on shareholders of tramway companies by suddenly enforcing their rights to take over the shareholders' property after a certain period. He did not see any reference made to the matter in the report, and he thought it would be some satisfaction to know that they were free from the incursions of the local authorities for a considerable period. He did not think that such bodies were so competent to work electrical tramway and light railway undertakings as were companies such as their own.

The CHAIRMAN: As to the auditors' certificate, that is a matter over which, of course, the directors have no control. He was glad to say they are on very good terms with the local authorities in their district. There were a large number of them, and they all appreciated fully the very great difficulties that the directors had had in carrying out this large undertaking. With regard to the tenure under which the company held their lines, that was fairly set out in the prospectus. In regard to the light railway extensions, they would hold the lines at any rate for 35 years, and then the local authority would have the right to purchase, but only on paying the fair market value of the undertaking as a going concern.

Mr. DRUCKETT asked why no lines were proposed between Newcastle and Stoke.

The CHAIRMAN said a line between those places was under consideration and was still in contemplation, but they had to proceed very cautiously, because one local authority wished the line to go into its town from one direction, and another local authority preferred the traffic to be taken into its district; and therefore they had to consult all these local authorities, and be careful they did not give rise to jealousies in making the extensions and in carrying the traffic to points where the local authorities did not wish it.

The resolution was then agreed to unanimously.

The meeting then formally approved an agreement made between the North Staffordshire Co. and this company for working the North Staffordshire Co.'s lines. Mr. Emile Garcke and Major T. E. Pilkington were re-elected directors, and Messrs. Bourner, Bullock and Co. were reappointed auditors, and a vote of thanks to the chairman and directors terminated the proceedings.

Brush Electrical Engineering Co. (Ltd.).

The ordinary general meeting of this company was held at the Cannon-street Hotel, Mr. J. B. BRAITHWAITE, jun., presiding.

The SECRETARY (Mr. B. Broadhurst) read the notice calling the meeting.

The CHAIRMAN said: I think we may congratulate ourselves upon the gradual but steady progress which the company is making. This progress is perhaps most easily seen by referring to the dividends that we have been able to pay in recent years. You may remember that we were able to pay for the year ended June 30, 1898, 3 per cent. on the ordinary shares, for 1899 5 per cent., and for the half-year just terminated we are proposing to pay 6 per cent. That, I think, shows that we are making progress in the right direction. If we examine the balance-sheet you will see that our capital account remains the same so far as our ordinary and preference shares are concerned. Our first debenture stock also remains the same; but during the half-year we have issued the £125,000 second debenture stock which I referred to at our meeting in September. We offered £75,000 to the public, reserving £50,000 to retire our existing second debenture stock. The £75,000 was over-subscribed and all allotted We gave our second debenture stock holders the opportunity of exchanging their holdings for the new debenture stock, and of that option holders to the amount of £33,610 stock availed themselves, leaving a small balance of £16,000 odd, which, in accordance with notice given, will be paid off in cash at 105 per cent. on July 1 next. For the first time in our history we have a half-yearly balance-sheet. I told you at our annual meeting in September that it was our intention to alter the time of closing our financial year to the end of December instead of to the end of June. Therefore all the figures you have here in the profit and loss account require multiplying by two to compare them with the figures of last year. The salient features perhaps of the balance-sheet are the following: Creditors we owe £49,344, against £55,222; we owe, you see, a little less. On the other hand, debtors show an increase—£129,930, against £123,380; so that we are owed £6,000 more and we ourselves owe about £6,000 less. The balance therefore in our favour on these two items is about £12,000 better than at the end of June. That is simply an indication of what I said, that our business is gradually and steadily improving. The item of shares and debentures stands at £70,953, and I am glad to be able to assure you, as I have done on previous occasions, that the market valuation of those that are quoted is considerably in excess of the figures that we have in our balance-sheet. Our depreciation reserve fund now stands at £15,000 instead of £10,000, as the result of your vote in September last agreeing to place £5,000 out of last year's profits to the fund, and we are asking you to-day to increase this reserve by an amount in the same ratio for the last half-year. Of course there are drawbacks to having a depreciation reserve fund invested in gilt-edged securities outside the business, but there are also advantages, and we are trying to steer the happy medium between the two. The advantage of having your depreciation reserve fund so invested is that if at any time you want the money it is available, instead of being mixed up in our business. This is distinctly a depreciation reserve fund, and if at any time we should have a very large and exceptional outlay on renewal of plant or anything of the kind, we should feel we were justified in going to that fund. Hitherto we have not found it necessary to do so, and I dare say we shall not for a considerable time to come; but I must ask you to bear in mind that it is a depreciation reserve fund, and therefore, if anything should arise in a big way for the renewal of plant—£5,000 or £10,000—we should look to the reserve fund to supply the necessary moneys. The disadvantage of having your reserve fund invested outside is that it withdraws a certain amount of capital from the business which would otherwise be useful as working capital. Therefore, I do not think, if our company becomes as prosperous as we all hope it will in the next few years, you must expect to see a corresponding large increase in the sum we shall put to depreciation reserve invested outside the business. We shall rather be disposed to adopt the policy of keeping our contributions to that invested reserve at a pretty regular figure, and forming inner reserves in various ways inside the business, which will give us practically additional working capital. I mention this because some people seem to think that if our profits increase the amount we put to depreciation, invested outside the business, ought to increase *pro rata*. I think there are good, sound reasons why that should not be the case, but that we should have a reasonable amount invested outside the business and also a reasonable amount invested inside. By that means we shall combine the advantages of both methods and the disadvantages of neither.

Turning to the profit and loss account, the gross profit on the trading which, as I have pointed out on previous occasions, includes our profit from all sources, stands at £28,347. 17*s.* 6d. for the half-year. Although this is the lean half-year in our business, that figure is a little in excess of half the total profits we made up to June 30 last year. If the figure had been exactly *pro rata*, it would have been £27,000; so that we are £1,300 better on the *pro rata* proportion for the half-year, although it is the lean half-year in our business. There is no particular item on the credit side in addition to that to which I need refer; but on the debit side you will see that we have again spent large sums on the maintenance of buildings and plant. That is equivalent to putting further money out of revenue to depreciation. We have spent £2,703 during the half-year, or at the rate of £5,400 for the whole year, as against an expenditure for the whole year ended June 30, 1899, of £4,438; so that you see we have availed ourselves of the increasing prosperity of the company to make a larger expenditure on the maintenance of buildings and plant, which I have no doubt you will approve. The interest on debenture stock stands practically the same, and the cost of issuing the £75,000

perpetual debenture stock is exactly met by the premiums we received, shown on the other side. We carry forward a balance of profit to the balance-sheet of £19,410 for the half-year. The figure for the whole year ended June 30, 1899, is £31,880; so that half that to compare with this would be just under £16,000. You may say, therefore, that the half-year shows an improved result of about £3,400 in net profits.

Coming to the question of capital expenditure, I told you when we met in September that, owing to the rapid increase in our business, we were forced to continue capital expenditure on a somewhat considerable scale. During the half-year we have spent £23,571 on further additions to our works at Loughborough, and we have other extensions in progress or under contract amounting to another £53,000. I mentioned in September that we had acquired a further portion of about nine acres of freehold land there; so that we now own altogether something like 23 acres of freehold land. During the half-year we have made an arrangement to acquire some additional land immediately in front of part of our works, and available for extensions, the effect of which will be that we shall have the whole of our works together. It will give us an additional frontage to the Midland Railway, and if it should become necessary to add to our large engineering shops, or even to add to our foundry and warehouse capacity, it gives us the land on which to do so. We have not made any arrangements for that at present, but we may have to do so if our business continues to increase. You will naturally ask me how we propose to provide the capital for the further capital expenditure that is being pressed upon us by the state of the market in our products, the very good prices that we are at present able to get, and the large orders offered to us. We contemplate issuing a portion of the unissued ordinary and preference shares that we have available. We propose to make an issue of a sufficient amount to provide for all the capital expenditure that we see ahead of us for some considerable time, and also to put additional working capital into the business, which we anticipate will be required by the increased overturn of the works. You will notice that there is usually a difference between our debtors and creditors of from £80,000 to £100,000. That represents the working capital necessary in our business, and as our overturn increases—and it is increasing very rapidly at present—that amount of working capital will probably require to be increased. We therefore propose to issue 30,000 preference shares and 30,000 ordinary, and we propose to offer them to our shareholders, whether preference or ordinary, linked together in the proportion, as near as may be, of one new preference share and one new ordinary share for every six shares, whether preference or ordinary, already held—that is to say, the holders of say 60 preference shares, with 20 preference and 40 ordinary shares, will be offered 10 ordinary and 10 preference shares, the condition of the offer being that they take them both. By that means we think the premium which there is on our preference shares will go to the benefit of the shareholders, and we think that is the most equitable way of issuing the capital. We do not want the whole of the money at present. We want to have it in instalments as the new buildings are put up, and we are particularly anxious to spread the instalments in such a way that we shall not have to pay dividends on the additional issue of shares until the new shops are producing the necessary profits. We propose to make the instalments payable in four portions of 10s. each, the shares of each class being £2. These will be as follows: 10s. a share on allotment, probably in the middle of April, 10s. on July 16, 10s. some time in November, and the remaining 10s. in March, 1901. By that time we hope the new shops we have contracted for and the new tools on order will be delivered and earning revenue, so that we anticipate the result of issuing this further amount of preference and ordinary capital will be that we shall be in the position to continue a steady increase of the dividend of our ordinary stock that we have been able to pay for the last few years. With regard to the Workmen's Compensation Act, it is satisfactory to see that we have been free from any serious accident, and that the policy we inaugurated when the Act was passed, of placing £1,000 out of profits to an insurance fund and placing a percentage on the weekly wages we pay to meet current claims, has again proved entirely successful, the amount spent in connection with the Act during the past half-year being quite a trifling sum.

You will wish to know what are the prospects of the business. I told you when we last met, in September, that although we were spending large sums on new shops and plant, the effect of that expenditure on the profit and loss account could not be felt for some considerable time. In the first place, all the engineering and tool works are very busy, so that we cannot get delivery of any big tool under 12 months; so, that if we ordered a new tool now, we should not get it delivered until next year, and it would not begin to earn revenue for us until June next year. Still, we have been feeling during the past half-year the benefit of some of the expenditure incurred before June 30. The new car shop is now in full working order, and now we are obliged to construct another car shop of equal size, covering about two acres and a half; thus the whole of the five-acre piece of land we bought is now entirely covered with shops for the construction of rolling stock and with the timber stores necessary for same. Then we have added considerably to our heavy engineering shop. That extension is making good progress, and I think we shall have it in operation some time before the end of next June, when the outturn of heavy work will be largely increased. The new inductor alternator, of which I mentioned we have great hopes, has fully realised our expectations, and apparently it is becoming one of the most popular generators on the market. We have on order 2,000 kw. of these inductors for the County of London and Brush Provincial Electric Lighting Co., another 2,000 kw. for the Leicester Corporation, and others of various sizes for other Corporations up and down the country, while we look forward to the demand for these inductor alternators steadily increasing. We also have a very large amount of work in our car shop in hand. That is where we have felt the pinch most during the last 12 months. The various Corporations of the country who are adopting municipal electric traction are all wanting cars, not by the dozen, as we have been accustomed to, but by the hundred; and therefore we have been able to fill our new shops before they were ready; and if our new car shop were ready at this moment, we have orders which would fill it immediately. We have large orders for cars in hand for various places, including Manchester, Norwich, Bradford, Sheffield, St. Helens, Swansea, &c., besides turning out some trains for the Central London Railway, which is likely to be shortly opened. When this railway is opened I hope the shareholders who live in London will pay us the compliment of travelling on it, to see what our rolling stock is like; and I think you will agree that our cars are very nice. We have already delivered one train, and we are building several others. Naturally, these have taken up a good deal of room in our shops, and we shall be rather glad to get rid of them, so that we may replace them by the electrical cars, which are easily handled.

In addition to the large orders we have for electric lighting plant, both engines and generators, and electric traction plant and rolling stock of all kinds, from the humble police van up to the Central London Railway rolling stock, we are building locomotives. We have built all the locomotives for the Beira Railway, and we have locomotives in hand for the North Borneo Railway and for other lines; so that we have orders for a variety of manufactures, which I hope will result in our always having a fair amount of business in hand. If one department is a little slack other departments are exceptionally busy, which to some extent compensates. I do not know that there is any other matter with which I need trouble you, except to express the regret which I and my colleagues feel at the death during the past half-year of Mr. Van Tromp, our vice-chairman. Mr. Van Tromp had been connected with the company for a great number of years, and his attention to its interests had been close and constant. We are not proposing at this moment to fill up the vacancy thus created on the board; but we shall as opportunities offer elect men of electrical and technical experience to serve on the board, so that we may have a board thoroughly capable of carrying on the large manufacturing industry which you have entrusted to us. The great point, I think, for the shareholders to get into their minds at the present moment is that which I mentioned in September, and which is perhaps more noticeable now—viz., that the increased overturn at our works, with the increased manufacturing profit we make, is earned without any corresponding increase in our head office charges; that is to say, our head office charges, as you will see from the balance-sheet, may be taken roughly at about £12,000 or £13,000 a year, including directors' fees, auditors' fees, insurance, law charges, workmen's compensation, rent, rates and taxes, &c.—in fact, all the standing charges of the company. Now, if our overturn doubles itself, as it shows every sign of doing, these standing charges will not be doubled—in fact, the increase will be very trifling indeed. Therefore you will see that of the increased profit we make on the increased turnover a very much larger proportion will be retained as net than has been the case hitherto; and that is what makes me think that the prospect before our ordinary shares is now a brighter one. Given a continuance of the present demand, the increased capacity of our works cannot but add considerably to our earnings, and as these will not be subject to a corresponding increase in our standing charges, I think it is clear that there will be a larger surplus left for the ordinary shareholders. We are not anxious, however, to increase our dividend very rapidly. We want to solidify our position as we go along. I will conclude by moving—

"*That the accounts for the half-year ended Dec. 31, 1899, be and they are hereby adopted.*"

Mr. AYMOR H. SANDERSON seconded the resolution, which was carried unanimously.

The CHAIRMAN moved that the recommendation of the directors to pay a dividend at the rate of 6 per cent. per annum on both the preference and ordinary shares for the half-year ending Dec. 31, 1899, be adopted, and the motion was agreed to.

On the motion of the CHAIRMAN, seconded by Mr. TROAKE, the retiring directors (Mr. J. S. Rawworth and Col. F. G. Steuart) were unanimously re-elected, and the auditors (Messrs. Cooper Brothers and Co.) were also reappointed.

Mr. LAMB moved and Mr. SNELL seconded a cordial vote of thanks to the chairman and directors, which was agreed to, and the proceedings terminated.

Bournemouth and Poole Electricity Supply Co. (Ltd.).

The third ordinary general meeting of this company was held on Monday, under the presidency of Mr. A. H. SANDERSON.

The SECRETARY (Mr. H. B. Renwick) having read the notice convening the meeting,

The CHAIRMAN said: Gentlemen, the report and accounts now submitted relate to the second year of this company's existence, and this is the first year in which the accounts of the two companies (the Bournemouth and Poole Co. and the Bournemouth and District Co.) have been amalgamated. I would remind you that the whole of the undertaking of the Bournemouth and District Electric Supply Co. (Ltd.), now in course of voluntary liquidation, has been vested in this company, and that on November 16 last the purchase of the Richmond (Surrey) Electric Light and Power Co. (Ltd.) was authorised, and has since been carried out. In December last the balance authorised share capital of this company was issued to the shareholders, and the balance premium received therefrom has been carried to reserve. Referring to the balance-sheet, the chairman stated that a considerable sum had been expended during the year on capital account by the Bournemouth Co. in respect of machinery, mains, meters, and other items. Referring to the revenue account, he said that the gross receipts derived from the Bournemouth undertaking amounted to £14,466. 12s. 1d., an increase of £2,542. 14s. 5d. compared with 1898. The profit balance, after deducting works expenses, legal and general charges, was £8,883. 10s. 4d., a substantial increase over the previous

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year. Other items increased this total to £8,979. 15s. 3d., from which had to be deducted the London office administration expenses and two years' directors' fees, leaving a balance to net revenue of £7,717. 6s. 3d., compared with £6,013. 4s. 10d. for 1898. After deducting £1,500 for depreciation and £693. 15s. 2d. for interest and special redemption, there was available for dividend £6,799. 13s. 5d., out of which the full year's dividend on the preference shares, first issue, had been paid, and the directors now recommended the payment of a dividend on the ordinary shares, first issue, at the rate of 5 per cent., less tax, for the year to Dec. 31 last. These payments would absorb £5,510, eaving £1,289. 13s. 5d. to be carried forward. The shareholders had, he thought, every reason to be satisfied with the progress of the business at Bournemouth. The lamp connections were the equivalent of 44,096 8 c.p. lamps at Dec. 31, an increase of 10,364 8 c.p. lamps for the year, and applications representing a further 681 lamps were then awaiting connection. The increase for the year was a record, and succeeded a record in 1898. During the year they sold 528,039 units of current, against 414,662 for 1898, an increase of 113,377 units. Terms had been arranged for the supply of current for power for a period of years to the Poole and District Electric Traction Co. for the working of the tramways between Bournemouth and Poole, and the directors anticipated a considerable addition to revenue from this source. It would provide them to a great extent with a day load—an important matter for any electricity supply company. A provisional order for Christchurch and Winton had been granted to the company. During last month the directors made an issue of £70,000 4½ per cent. debentures, which were over-subscribed. With regard to the Richmond Co., they had only lately purchased this undertaking, and could hardly hope to derive much benefit from the reforms which they had introduced, and which would ultimately considerably increase the revenue from this source. The directors considered they had made a satisfactory purchase, and that the shareholders might confidently look forward to the future in this regard. He now moved that the report and accounts of the directors and the payments of dividends be approved.

The resolution was unanimously adopted.

Messrs. F. E. Savory and R. Percy Sellon, retiring directors, were re-elected, and Mr. R. H. Marsh was reappointed auditor; and after £500 per annum had been approved as the remuneration of the directors, a vote of thanks to the chairman terminated the proceedings.

Imperial Tramways Co. (Ltd.).

An ordinary meeting of this company was held at Bristol on Saturday. Mr. George White, who presided, said: With regard to the Reading tramways, the Corporation wanted to purchase the undertaking, and the directors had intimated that at a proper price they would be ready to treat. They were advised that under the special order which originally authorised the tramways the right to purchase was defined as at quite a different date to that which the Corporation now claim, and the company therefore disputed the legality of the proceedings. The company had also petitioned against a bill introduced by the Reading Corporation for adopting electric traction and for carrying out certain extensions. Turning their attention to the accounts of the London United Tramways, in which the Imperial Co. were largely interested, these showed an increasing revenue. The preparations for the opening of the first section of about 10 miles of tramway route on this company's system were in an advanced state, and they had the satisfaction of knowing that they had considerable interest in the first electric tramway to be worked in London. He thought the opening of the tramway would be nearly coincident with the opening of the Central London Electric Railway, which terminated at the commencement of their new electric tramways, so that London's millions of population would have the advantage of through communication with a number of the western suburbs, an advantage which would be still further improved when the remainder of the authorised electric tramways were completed. The most interesting feature of the London United report was, however, that which detailed the steps taken during the past year to obtain powers for further extensions. Negotiations had taken place with the various local authorities concerned, and the company were therefore confident that the Light Railway Commissioners would favourably regard their application. Owing to the opposition of the London and South Western Railway Co., however, the Commissioners had been compelled to refer the company to Parliament, in whose hands they confidently placed their proposals. As to the opposition of the Middlesex County Council, it seems strange that a public body which had over and over again approved the principle of a tramway scheme should now desire to wring impossible terms from the company, which was proposing to give Isleworth, Twickenham, Teddington, Hampton Wick, and Hampton the advantages of being connected with their main electric tramway system. The introduction of these tramways would greatly facilitate the movement of the travelling public in the district, and serve to bring a great access of traffic to the general railway system. The directors' views on this subject had been placed before the board of the London and South Western Railway Co., who had taken a statesmanlike view of the situation, and had determined not to oppose the company's bill in Parliament. Arrangements had also been come to with the Councils of Ealing, Hanwell, and Acton, so that by filling up this gap of about three miles in their authorised system they would have a line of electric tramways about 12 miles in length on the main road from London to Oxford, commencing at the Central London Railway terminus at Shepherd's Bush and terminating at Uxbridge. Their endeavour to supply the western suburbs of London with about 40 miles of electric tramways was therefore being realised.

In the provinces the company had secured the Light Railway Commissioners' approval to their proposal to give Darlington a new and extended system of tramways worked by electricity, and they were in communication with the Darlington Corporation to take electric current from the municipal mains. With respect to the Middlesbrough, Stockton, and Thornaby electric tramways, they had carried about 8,500,000 passengers at very low average fares, and had made a profit of £14,611. The proposed extensions were favourably entertained by the Light Railway Commissioners, but as yet the company had not arrived at an arrangement with the owners of certain "toll gates." Altogether the work being performed at Middlesbrough, Stockton, and Thornaby was satisfactory to the public and profitable to the company. The Imperial Co. had a net profit of £30,251 on its investments in the various undertakings, and after allowing for debenture interest and the interim dividends, they were able to recommend a dividend at the rate of 8½ per cent. on the ordinary shares. The reserve funds had also been increased during the year from £47,824 to £69,203. The directors' report was adopted.

London Electric Supply Corporation (Ltd.).

The directors' report for the year ended Dec. 31, 1899, states that the number of equivalent 8 c.p. lights at that date was 173,906, an increase of 18,587 for the year. The directors think this would have been more than doubled but for the default of contractors in delivering additional plant ordered in 1898, some of which has not even yet been completed. The strain thrown upon the existing plant through this default, the great increase in price and difficulty in obtaining an adequate supply of Welsh coal, have all tended to increase the cost of generation and to temporarily impair the efficiency of the service. A new 900 H.P. plant has been added during the year. 3,889 yards of new trunk mains and 18,362 yards of new distributing mains have been laid, the total length of mains now being over 106 miles. The lease of the offices and distributing station in Cockspur-street have been purchased on advantageous terms. The plant and machinery have been entirely maintained out of revenue.

Additional capital being required for further development and extensions, the shareholders are to be asked to pass a resolution authorising the raising of such capital as may from time to time be required

The profit on the year's working is £21,547. 16s. 6d., in addition to £589. 0s. 6d. interest on deposit, and the amount brought forward (£3,275. 9s. 7d.), making £25,412. 6s. 7d. Interest on debentures to Dec. 31 (£8,000) and an interim dividend at the rate of 6 per cent. per annum on the preference shares to June 30 (£7,476) has been paid, leaving £9,936. 6s. 7d., which the board propose to deal with as follows: Payment of dividend at rate of 6 per cent. per annum on preference shares, for half-year to Dec. 31, £7,476; provision for special rebates, £1,000; forward, £1,460. 6s. 7d.

County of London and Brush Provincial Electric Lighting Co. (Ltd.).

The directors' report for the year to Dec. 31, 1899, states that the capital expenditure during the year, on account of the company's London districts, amounted to £155,608. 12s. 9d., making the total £718,195. 18s. 11d. This expenditure was met by the issue, in January, 1899, of £200,000 4½ per cent. debenture stock, at a premium of £8 per cent. The premium has been applied in the reduction of general preliminary expenses (£10,000), writing off costs in connection with applications for provisional orders (£2,000), and £4,000 has been placed to reserve for depreciation, repairs, and renewals.

The balance from last account, after payment of final dividend on preference shares for half-year ended Dec. 31, 1898 (less tax), was £5,773.18s.6d., and the balance from revenue account, after payment of directors' fees, rent, rates, taxes, general establishment charges, wages and proportion of salaries, amounted to £45,417. 8s. 6d., making a total of £51,193. 7s., from which must be deducted interest on debenture stock (£5,032. 11s.), interim dividend on 20,000 6 per cent. preference shares for half-year ended June 30, less tax (£5,800), and amount placed to reserve for depreciation, repairs, and renewals (£6,500), leaving £33,860. 16s. for distribution. The directors now recommend that payment of interim dividend on the 20,000 6 per cent. preference shares for half-year ended June 30, less tax, be confirmed; that a further dividend on the same shares for half-year ended Dec. 31, less tax, be declared; and that a dividend on the 40,000 ordinary shares for the year ended Dec. 31, 1899, at the rate of 4 per cent. per annum, less tax, be declared. This will absorb £21,266. 13s. 4d., and leave £12,594. 2s. 8d. to be carried forward.

The company's interest in the Richmond (Surrey) Electric Light and Power Co. has been disposed of to the Bournemouth and Poole Electricity Supply Co. at a profit. The directors, having accepted in November last Mr. A. J. Lawson's resignation as engineer and manager, have appointed Mr. Charles B. Sparks as chief engineer.

LONDON STATIONS. *Northern Districts.*—The balance to credit of revenue for the twelve months amounted to £8,707. 7s. 9d. The total applications to Dec. 31, including power, represented the equivalent of 80,923 8 c.p. lamps, of which 61,188 were then connected. The applications for the year represented an increase of 37,324, and the connections an increase of 21,686. At the same date 84 users of motors, aggregating 381 H.P., were supplied from the mains, an increase of 253 H.P. for the year, and further applications have since been received, raising the total to 125 users, representing 686 H.P. The special plant erected for the generation of continuous current for power purposes is capable of supplying 2,000 H.P. A supply of current in the western Holborn and St. Giles district was commenced last summer. The local authorities have not yet given their consent for the commencement of the compulsory works under the provisional orders for Mile End Old Town, St. George's-in-the-East, and Limehouse.

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Southern Districts.—The balance to credit of revenue amounted to £11,136. 10s. The total applications represented the equivalent of 56,876 8 c.p. lamps, of which 54,647 were connected. The applications for the year represented an increase of 24,240, and the connections an increase of 25,733. The work of laying mains throughout the compulsory area, and some additional streets in the Camberwell district, has been completed, and a supply of current was commenced in July last. A supply is also available in the district of St. George-the-Martyr, Southwark, and work is in hand for the St. Olave district.

INVESTMENTS IN PROVINCIAL COMPANIES.

The *Bournemouth and Poole Electricity Supply Co.* has made satisfactory progress during the past year. The directors have recommended the payment of a dividend on the ordinary shares at the rate of 5 per cent. for the year, less tax, compared with 4 per cent. for the previous year.

The *Dover Electricity Supply Co.* has reached a dividend-earning stage. The balance from revenue for the last year, after providing for interest charges and reserve for depreciation, has allowed the payment of a dividend on the share capital at the rate of 3 per cent. per annum.

BARCELONA TRAMWAYS CO.—An ordinary meeting was held on Wednesday. The chairman (Mr. E. M. Underdown, Q.C.) said that during the past year they had really been working two systems at the same time, and at the present time a certain portion of the system was still being worked by animal traction, as was also the whole of the traffic on the Ensanche system. Those sections would gradually disappear, and at no distant date the board would come before the shareholders with a proposal to adopt electric traction on the Ensanche section. The gross traffic was increasing in a very satisfactory manner, the receipts for January and February of the current year showing an increase of £4,522 over last year, or nearly 31 per cent., and the board had no reason to suppose that that increase would not continue. The balance at credit of net revenue, including £79 from previous year, amounted to £5,211, out of which the directors proposed to apply £4,000 in payment of dividend at the rate of 2 per cent. (4s. per share) for 1899, carrying over £1,211. The report was adopted and the dividend approved.

DIRECT SPANISH TELEGRAPH CO. (LTD.)—The report of the directors for the year 1899 states, after providing for interest on and redemption of debentures, there is a balance to credit of revenue of £9,325. 4s. 8d. After adding the usual sum of £5,000 to reserve, £4,325. 4s. 8d. remains, which, with £1,160. 19s. 4d. from contingencies account, enables the directors to recommend the declaration of the dividend of 10 per cent. on the preference and a dividend of 4 per cent. (free of tax) on the ordinary shares for the year (absorbing £5,486. 4s.). Half this sum was distributed on Oct. 1, 1899. The traffic receipts show a decrease of £6,352. 9s. 8d. compared with 1898, when they were exceptionally large owing to the Spanish-American war. The ordinary working expenses were £598. 7s. 1d. in excess of those for the year 1898. On Oct. 11, 1899, the Falmouth-Bilbao cable broke at about 200 knots from the English landing. The cost of repairs (£1,743. 7s. 4d.) has been taken from reserve.

DOVER ELECTRICITY SUPPLY CO. (LTD.)—The annual meeting was held at Dover on Wednesday. The chairman (Sir W. H. Crundall) said the directors recommended the distribution of a dividend of 3 per cent. During the year, when no dividend had even been recommended or declared, the £5 shares had commanded a premium of £1. 10s. per share. Since Dover stock paying 3 per cent. was at that moment at probably a slight discount, it was evident that the price of the shares was based upon future prospects, which were satisfactory. An ample sum had been carried to depreciation, and the plant and property had been kept in a satisfactory condition. For the period from Jan. 1 of this year more than twice as many lights had been applied for as during the same period last year. A change had been made in the price charged for current for lighting by giving the option of a fixed all-round charge, and besides this the low charge of 2½d. per unit had been decided upon for heating and power. It was hoped that by these reductions considerably more business would result, and already, from the records kept, an increased profit of some £170 had been secured compared with 1899. They had already made such reductions in the price of current that by the terms of their transfer they could without any further reduction distribute in dividends 18 per cent. per annum, besides placing a large sum to reserve. Sanction was asked for the increase of the capital of the company by the creation of £25,000 of 5 per cent. preference shares of £5 each, which it was hoped would be placed at a considerable premium. Only a part of this (about £6,000) would be placed at present. The board hoped to be able to formulate some means of assisting in the wiring of premises, which he (the chairman) felt convinced was the chief difficulty in the way of extensions. The report and accounts were adopted, and the dividend at the rate of 3 per cent. approved.

LIVERPOOL DISTRICT LIGHTING CO. (LTD.)—The annual report of the directors states that the company's operations in the Great Crosby and Waterloo district resulted in the connecting at the beginning of 1899 of 2,059 8 c.p. lights, which had increased to 4,243 at Dec. 31, and is now nearly 5,000. The number of consumers has more than doubled. To meet this demand new plant has been put down, including two large Willans and Robinson high-speed engines, with Parker dynamos, each of 1,000 lights capacity, and a third set is on order, making a total capacity of about 4,000 lights. This plant will be sufficient for at least 12 months. The "free" wiring system has proved successful, about 1,000 lights having been connected. During the year the receipts from this source were £37. 19s. 2d., interest £30. 15s. 1d., leaving £7. 4s. 1d. to be applied to the reduction of cost of wiring. The demand for electric lighting in the Allerton and Woolton district has not increased to the extent anticipated, the year's operations resulting in a slight loss. An offer has been received for the purchase of this portion of the business on favourable terms, which is waiting the approval of Parliament. The shareholders will be asked to authorise the transfer of this undertaking. The contracting business of the company has again been fairly successful, resulting in a net profit of £217. 16s. 7d. The total profit for the year amounted to £640. 12s. 8d., out of which £293. 15s. 3d. has been applied to depreciation, and £100 deducted from preliminary expenses, leaving £191. 12s. 8d. to be carried forward.

RICHMOND (SURREY) ELECTRIC LIGHT AND POWER CO. (LTD.)—The ordinary general meeting was held on Monday. The chairman (Mr. F. W. Reynolds, J.P.) said the steady progress shown in the company's business during the past few years had been maintained in 1899. The equivalent of 14,256 8 c.p. lamps were connected at Dec. 31, and the units sold amounted to 191,084. In December they decided to reduce the charges for current, and to further lower the rentals for meters. The directors were confident that this step would be appreciated, and, aided by a scheme of assisted wiring, would lead to increased business. The directors' report was adopted.

YORKSHIRE HOUSE-TO-HOUSE ELECTRICITY CO. (LTD.)—A meeting of the members was held at Leeds on Wednesday to receive a winding-up report from the liquidator (Mr. Grosvenor Talbot). Mr. Talbot said that the company went into liquidation on Feb. 10, 1899. On Nov. 8, 1898, an agreement was entered into with the Leeds Corporation for taking over the undertaking of the company, the purchase price being the amount expended by the company and chargeable to capital account up to Aug. 31, 1898, such price to be discharged by the issue of Corporation 5 per cent. stock. It was ascertained the amount due to the company was £217,420, and the Corporation issued 5 per cent. irredeemable stock for this amount. It was found to be impracticable to divide the stock among the shareholders, and it was resolved to sell it. In May, 1899, it was offered for sale by tender at the minimum of £170 per cent. The issue was over-applied for, and the average price obtained was £170. 8s. 11½d. per nominal £100 of stock. The proceeds of the sale amounted to £370,591. 6s. gross. After allotment the sale price was payable in instalments, due July 3, Aug. 3, and Sept. 3, 1899, and immediately after the various instalments had been paid the liquidator made divisions among the shareholders. The liquidator had paid off liabilities to the extent of £39,783. 10s. 10d. These, and sundry other payments and receipts, left a balance in the bank of £18,002. 3s. 11d., but until the question of a probable claim by Mr. Rucker had been disposed of, he did not think it advisable to divide any part of this amount. This action was still threatened. The amount at disposal, supposing everything went favourably in regard to the action by Mr. Rucker, would be £15,219. 18s. 2d.

CITY NOTES.

MEMORANDA.—**Bank rate 4 per cent. (since Jan. 25, 1900). Price of silver 27⅞d. per oz. (Mar. 22). Consols (2¾ per cent.) 102—102¼ for money, 102 3/16—102 5/16 for account; 2½ per cent. 98½—99 (Mar. 23). Stock Exchange Settling Day: Consols, April 4; Stocks and Shares Continuation Days, Mar. 27 and Apl. 9; Ticket Days, Mar. 28 and Apl. 10; Pay Days, Mar. 29 and Apl. 11; Mining Share Carry-over Days, Mar. 26 and Apl. 6.**

AMAZON TELEGRAPH CO. (LTD.)—A meeting of the debenture-holders of this company was held on Wednesday. One of the trustees (Sir Cuthbert Quilter, Bart., M.P.) presided, and explained the position of the company to the debenture-holders, when resolutions were unanimously passed postponing the payment of interest on the debentures to June 30, 1901. The redemption of the debentures was also postponed to the same date.

ARON ELECTRICITY METER (LTD.).—The transfer books of the preference shares will be closed from the 26th to the 31st inst., inclusive, for the preparation of dividend warrants.

ELECTRICAL UNDERTAKINGS (LTD.)—A private meeting of this company was held on Friday last, at Winchester House, Old Broad-street, London.

EVERED AND CO. (LTD.)—After paying debenture interest, the net profit on the past year's working, including £6,986 brought forward, amounted to £40,329. The directors write £5,000 off plant and buildings, place £7,000 to reserve, and declare dividends and a bonus equal to 12½ per cent. for the year, leaving the balance forward unchanged.

GUILDFORD ELECTRICITY SUPPLY CO. (LTD.)—The directors' report for 1899 states that, after allowing £130. 11s. 5d. for depreciation of plant, &c., and paying interest, the profits have been sufficient to wipe off the 1898 deficit of £222. 19s. 8d. A provisional order has been obtained extending the company's supply area to Artington, Compton, Merrow, Stoke-next-Guilford, West Clandon, Worplesdon, Shalford, St. Martha, and part of Godalming Rural. Considerable extensions of mains has been made, both inside and outside the borough, and a constant increase in the demand for current has rendered necessary additions to the machinery and plant. Further capital is required for erecting a permanent building at the works, increasing accumulators, and extending mains. Mr. Leonard A. Ellis has retired from the board.

MARQUAND ACCUMULATOR CO. (LTD.).—The first annual meeting was held at Cardiff on Wednesday (Lord William Beresford presiding). The accounts were unanimously adopted. Being the first year of the com-

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pany's working, the trading showed no results justifying a dividend, a large part of the capital having been spent on equipment.

NORDDEUTSCHE SEEKABELWERKE AKTIENGESELLSCHAFT (KOLN).—The first annual report of this company, which acquired the Nordenham cable factory of the Land und Seekabelwerke Aktiengesellschaft has been published, and gives the paid-up capital as 1,500,000 marks (£75,000). The nominal capital is to be increased from 2,000,000 marks (£100,000) to 4,000,000 (£200,000), and the administration hope to be in working order by the end of May.

ROBEY AND CO. (LTD.)—The directors' report for 1899 states that, after writing off £6,106 for depreciation, the net profit amounted to £36,860. Deducting debenture interest and adding £351 brought forward, there is a balance of £30,256 available, from which the directors recommend a dividend of 6 per cent. (£16,699), to add £11,000 to reserve (increasing it to £40,000), and to carry forward £2,557.

ROSSENDALE VALLEY TRAMWAYS CO.—The chairman (Mr. Alfred Love) announced at a recent meeting that the directors considered that the time had arrived when steam power should give place to electric traction, and the Corporations of Bacup and Rawtenstall had expressed themselves willing to welcome any such change.

ROYAL ELECTRIC CO. OF MONTREAL.—A quarterly dividend of 2 per cent., payable April 1, has been declared. The numbers are published of 77 £100 4½ per cent. debentures of the company which have been drawn for payment on April 1.

STOCK EXCHANGE NOTICES.—The 28th inst. has been appointed a special settling day in the further issue of 20,000 £10 fully-paid 6 per cent. cumulative preference shares (Nos. 90,001 to 110,000) of the *British Electric Traction Co. (Ltd.)*, and £150,000 4½ per cent. first mortgage debenture stock of the *Castner-Kellner Alkali Co. (Ltd.)*, and the Stock Exchange committee has ordered the securities to be quoted in the Official List. Application has been made to the committee to appoint a special settling day in and to grant a quotation to £120,000 5 per cent. second debenture stock of the *Buenos Ayres and Belgrano Electric Tramways Co. (Ltd.)*, and £500,000 4 per cent. debenture stock and the further issue of 100,000 £5 ordinary shares of the *National Telephone Co. (Ltd.)*. The committee has also been asked to allow £75,000 4½ per cent. first mortgage debenture stock of *Edmundson's Electricity Corporation (Ltd.)* and the £5 fully-paid shares of the *Electric Railway and Tramway Carriage Works (Ltd.)* to be quoted in the Official List.

SWANSEA IMPROVEMENTS AND TRAMWAYS CO.—Mr. Emile Garcke presided at the annual meeting on Wednesday. He said that the directors had been much surprised to learn that the Swansea Corporation contemplated promoting competing lines. The proposal to promote these lines could have no possible good result either for the Corporation, the public of Swansea, or their company.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	1900	£	£		£	£
*Birmingham Tramways.	Mar. 17	4,022	+ 165	11	43,350	+ 1,948
Blackpool Corporation...	„ 15	169	...	50	22,215	+ 4,427
Blackpool and Fleetwood	„ 17	212	- 24	11	1,684	- 228
Bradford Corporation...	„ 18	359	+ 66	83	27,708	...
Brisbane Trams	Jan. 31	1,744	+ 548	18	37,807	+11,440
*Bristol Trams & Carriage	Mar.16	2,719	+ 9	11	28,593	+ 1,085
*Buenos Ayres & Belgrano	Feb. 18	2,404	+ 783	7	16,560	+ 5,098
City & South London Ry.	Mar. 18	1,452	+ 353	11	13,227	+ 985
Dover Corporation	„ 17	135	- 6	50	9,785	+ 1,015
Dublin United	„ 16	2,994	+ 269	11	30,944	+2650
Dublin Southern Dist....	„ 16	670	+ 1	11	6,443	
*Glasgow Corporation ...	„ 17	8,356	- 164	...	...	...
*Liverpool Corporation...	„ 10	6,833	+ 857	10	65,958	+ 8,167
Liverpool Overhead Rly.	„ 18	1,340	- 29	11	15,641	+ 1,290
*Sheffield Tramways	„ 18	1,854	+ 693	11	19,899	+ 6,362
*South Staffs. Trams.....	„ 16	646	+ 31	11	6,602	+ 52

* Partly electrical.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, March 14.	Price Wednesday, March 21.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending March 21. Highest	Lowest
			TELEGRAPHS.			£ s. d.			
£110,900	100	4%	*African Direct Telegraph 4% Mort. Deb. (red.)	99 103	99 103	3 17 8	January and July.....	...	...
25,000	10	...	Amazon Telegraph.....	3 4	3 4	...	June and December ...	...	...
£125,000	100	5%	Do. 5 per Cent. Debentures	85 90	85 90	5 11 1		...	...
£875,520	Stock	28/6	Anglo-American	63 66	63 66	5 11 5	Feb., May, Aug., Nov.	64	...
£3,063,240	Stock	30/0	Do. Preferred	115 116	116 117	5 3 0	„ „	116⅝	116⅝
£3,063,240	Stock	27/0	Do. Deferred	14 14½	14½ 15	9 0 0	...	14⅝	14⅝
$10,000,000	$100	$2½	Commercial Cable Capital Stock	165 175	165 175	4 12 1	Jan., Apr., July, Oct.	...	...
£1,563,078	Stock	4%	* Do. 4 per Cent. Debenture Stock	103 105	103 105	3 16 8	„ „	105	104
16,000	10	8/0	Cuba Submarine Ordinary	9 10	9 10	8 0 0	February and August	...	...
6,000	10	10/0	Do. Preference 10 per Cent.	19 20	19 20	5 0 0	„ „	19⅝	...
12,981	5	2/0	Direct Spanish Ordinary.....	4 5	4 5	4 0 0	April and October.....	...	...
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference	9 10	9 10	5 0 0	„ „	..	...
£20,000	50	4½%	Do. 4½ per Cent. Debentures	101⅞ 105⅞	101⅞ 105⅞	4 5 9	January and July.....	...	...
60,710	20	3/0	Direct United States Cable	11⅛ 12	11⅛ 12	5 16 8	Jan., Apr., July, Oct.	11⅛	11⅛
£120,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red.)	99 102	99 103	4 8 3	June and December ...	...	...
£4,000,000	Stock	5%	Eastern Ordinary	155 160	155 160	4 7 6	Jan., Apr., July, Oct.	157½	155
£1,795,000	Stock	3½%	Do. 3½ per Cent. Preference Stock	98 101	98 101	3 9 3	„ „	99½	99
£1,432,268	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.)	116 121	116 121	3 6 8	May and November ...	116	...
250,000	10	2/6	Eastern Extension	16 16½	16 16½	4 4 10	Jan., Apr., July, Oct.	16⅛	16 3/16
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	115 120	115 120	3 6 8	February and August	117½	...
£8,700	100	5%	* Do. 5% (Austin. Gov. Sub.) Deb., 1900 (reg.) ...	100 103	100 103	4 17 1	January and July.....	...	...
£26,600	100	5%	Do. (Bearer)	100 103	100 103	4 17 1	„ „	...	...
£300,000	100	4%	*Eastern and S. African 4% Mort. Deb., 1909.....	100 103	100 103	3 18 5	February and August	...	...
£200,000	25	4%	Do. 4 per Cent. Mauritius Sub. Debs. (red.) ...	101⅞ 104⅞	101⅞ 104⅞	3 16 10	May and November ..	...	...
180,227	10	1/9	Globe Telegraph and Trust	11⅛ 11	11⅛ 12	4 7 6	Jan., Apr., July, Oct.	11⅞	11 3/8
180,043	10	3/0	Do. 6 per Cent. Preference	15½ 16	15½ 16	3 15 0	„ „	15⅞	15½
150,000	10	5/0	Great Northern of Copenhagen	31 33	32 34	3 13 6	January and July.....	...	...
£95,200	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb. (red.) ...	99 102	99 102	4 8 3	...	...	...
17,000	25	12/6	Indo-European.....	50 54	54 58	4 6 2	May and November ...	58	...
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904 ...	104 107	104 107	5 12 2	March and September	...	...
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.)	101 104	101 104	3 16 11	June and December ..	...	...
11,839	8	4/0	Reuter's.....	7 8	7 8	5 0 0	April and October.....	...	...
3,381	£100 Cert.	6%	Submarine Cables Trust	126 131	126 131	4 13 5	„ „	...	...
15,609	10	...	West African Telegraph	2½ 3½	2½ 3½	4 9 3	December and July ...	...	...
£200,000	100	5%	* Do. 5 per Cent. Debentures (red.)	96 99	98 101	4 19 3	March and September	...	...
20,008	2½	...	West Coast of America.....	½ 1	½ 1	...	...	...	...
£150,000	100	4%	* Do. 4 per Cent. Debentures	100 103	100 104	3 17 8	January and July.....	100⅛	...
88,321	10	6d.	West India and Panama	¾ 1⅛	¾ 1⅛	...	May and November ...	...	...
34,563	10	6/0	Do. 6 per Cent. 1st Preference	9½ 9⅝	9½ 9⅝	6 3 1	„ „	...	...
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	7 8	7 8	7 10 0	„ „	...	...
£80,000	100	5%	* Do. 5 per Cent. Debentures	104 107	104 107	4 13 6	January and July.....	...	...
£389,731	Stock	4%	Western & Brazilian 4 per Cent. Debenture Stock ...	100 104	100 104	3 16 11	June and December ...	...	...
207,950	10	3/0	Western Telegraph (late Brazilian Submarine)	14⅛ 15½	14⅛ 15½	4 11 10	Mar., June, Oct., Dec.	17⅛	14⅞
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1900)	106 109	106 109	4 11 9	June and December ...	...	...
£158,100	100	6%	*Western Union 6 per Cent. Sterling Bonds (red.) ..	...	...	5 17 8	March and September	...	...
			TELEPHONES.						
44,000	£5	3/0	Chili Telephone (fully paid)	2 3	2 3	6 13 4	August	...	...
224,850	10s.	0/1½	Consolidated Telephone Const. & Manufacturing ...	¼ ½	¼ ½	4 15 3	July	...	...
72,690	1	2½%	Monte Video Telephone Ordinary	¼ ½	¼ ½	5 0 0	November	...	...
86,492	1	1 0	Do. 5 per Cent. Preference	¾ 1	¾ 1	5 0 0	„	...	...
490,000	5	3/0	National	5 5½	5 5½	5 14 3	February and August	5⅛	5
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Preference ..	14 15	14 15	4 0 0	„ „	...	...
15,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference ..	14 15	14 15	4 0 0	„ „	...	...
250,000	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref. ..	5½ 5⅝	5½ 5⅝	4 10 11	„ „	5⅜	5⅛
2,000,000	Stock	3½%	* Do. Debenture Stock 3½ per Cent. (red.)	97 100	97 100	3 10 0	June and December ...	97½	97⅛
171,504	1	0/4	Oriental	¾ 1	¾ 1	5 0 0	April and October.....	...	...
58,000	5	2/6	United River Plate	4⅜ 5⅛	4⅜ 5⅛	7 2 10	July	4⅜	...
16,639	5	1/3	Do. 5% Cumulative Preference	4⅜ 5⅛	4⅜ 5⅛	4 15 3	June and December ...	...	...
£179,947	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	103 106	103 106	4 14 4	„ „	...	...

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	NAME.	Previous Week's Price, March 14.	Price Wednesday, March 21.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending March 21	
						£ s. d.		Highest	Lowest
			ELECTRICITY SUPPLY COMPANIES.						
100,000	1	...	Bl'ckh'th & Gr'nw'ch D'st'ct Elec.Lt.Ord.(fully pd.)	⅞ ⅞	⅞ ⅞	...	...	...	...
6,000	10	7/9⅔	Bournemouth and Poole Elec. Supply Ord.	12 13	12 13	3 0 0	...	...	...
6,000	10	4/6	Do. 4½ per Cent. Cumulative Pref.	10 11	10 11	4 1 10	...	...	...
19,661	5	2/6	Brompton & Kensington Electricity Supply Ord.	7 8	7 8	3 15 0	...	...	...
12,000	5	3/6	Do. 7 per Cent. Preference	8½ 9½	8½ 9½	3 13 8	March and September	8¾	8½
20,000	5	...	Calcutta Elec. Supply Ordinary (fully paid)	6¾ 7¼	6¾ 7¼	...	...	7	6⅞
30,000	5	5/0	Charing Cross & Strand Electricity Supply Corp.xd	10	9 10	4 10 0	February and August	10	...
20,000	5	4/8	Do. (Nos. 30,000 to 50,000) xd	9 10	9 10	...	...	...	...
20,000	5	2/3	Do. 4½ per Cent. Preference	5½ 6	5½ 6	3 15 0	,, ,,	...	...
34,000	5	2/6	Chelsea Electricity Supply Ordinary xd	7 8	7 8	3 15 0	March	7 1/16	...
£150,000	Stock	4½%	* Do. 4½ per Cent. Debenture Stock (red.)	110 112	110 112	4 0 11	June and December	...	...
$1,200,000	$1,000	5%	Chicago Edison 1st Mort. 5% 30 yr. Gold Bonds (red.) xd	100 110	100 110	4 10 11	April and October	...	...
60,000	10	7/0	City of London Electric Lighting Ordinary	9½ 10½	9½ 10½	3 6 8	February and August	10⅜	10
40,000	10	6%	Do. 6 per Cent. Cumulative Preference	13 14	13 14	4 5 9	January and July	...	...
£100,000	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	122 127	122 127	3 18 9	June and December	...	...
40,000	10	...	County of London and Brush Prov. Ordinary	9½ 10½	9½ 10⅜	...	...	10 5/16	9⅞
20,000	10	6/0	Do. 6 per Cent. Cumulative Preference	12⅜ 13⅜	12⅜ 13⅜	4 8 11	March and September	13⅜	...
£200,000	Stock	4½%	Do. 4½% Deb. Stock Certs. (all pd.) (red.)	109 112	109 112	4 0 11	...	110½	...
15,000	5	10%	Kensington and Knightsbridge Ordinary	12½ 13½	12½ 13½	4 1 6	...	...	...
10,000	5	6%	Do. 6 per Cent. 1st Preference	7 7¼	7 7¼	4 0 0	January and July	...	...
110,000	3	...	London Electric Supply Ordinary	1¾ 2¼	1¾ 2¼	...	...	2	1⅞
48,050	5	3/0	Do. 6 per Cent. Preference	4½ 5	4½ 5⅛	5 14 3	...	5⅛	...
£250,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures	100 102	100 102	3 19 3	Mar., June, Sept., Dec.	...	...
85,000	10	5/0	Metropolitan Elec. Supply Ord. xd	13½ 14½	13½ 14½	3 9 0	April and October	14⅜	14⅛
£220,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage	114 117	114 117	3 16 11	June and December	...	...
£125,000	Stock	24/8	Do. 3½ per Cent. Mort. Deb. Stock (red.)	95 97	96 98	3 11 10	...	...	...
6,452	10	8/0	Notting Hill Electric Ordinary xd	15½ 16⅜	15½ 16½	4 4 10	March	...	...
10,000	5	5/0	Oxford Electric Ordinary xd	6¾ 7	6¾ 7	3 11 5	,,	...	...
300,000	1	8%	Rand Electric	⅜ ⅜	⅜ ⅜	10 13 4	...	...	...
£130,070	Stock	5%	River Plate El.Lt. & Tr'ct'n, Ltd., 5% 1st Mor.Deb.	75 85	75 85	5 18 0	...	...	...
150,000	$100	$2	Royal Electric Company of Montreal Shares	150 170	150 170	4 14 2	...	...	...
£123,200	100	4½%	* Do. 4½ per Cent. 1st Mortgage Debentures	104 106	104 106	4 5 6	April and October	...	...
40,000	5	9/6	St. James's and Pall Mall Electric Ordinary	14½ 15½	14 15	4 16 8	February and August	14⅛	...
20,000	5	3/6	Do. 7 per Cent. Preference	8½ 9½	8½ 9½	3 13 8	,, ,,	9½	...
65,000	5	...	South London Electric Supply Ordinary (fully paid)	3¾ 4¼	3¾ 4¼	...	...	...	...
79,900	5	8/0	Westminster Electric Supply Ordinary	13⅜ 14⅜	13½ 14⅜	4 9 8	March and September	14¼	14
			ELECTRIC MANUFACTURING, &c., COMPANIES.						
125,000	1	7½d.	Aron Electricity Meter 6 per Cent. Cum. Pref.	1 1/16 1 1/16	1 1/16 1 1/16	7 7 8	...	¾	...
45,000	1	...	British Electric Works Co. Ordinary	1 1	1 1	...	...	...	...
50,000	1	...	Do. 5 per Cent. Cumulative Preference	⅞ 1	⅞ 1	...	...	...	...
£50,000	100	4½%	Do. First Mortgage Debentures	99 101	99 101	...	...	...	...
40,000	5	15/0	British Insulated Wire Ordinary	11 12	11 12	4 3 4	...	...	...
27,500	5	3/0	Do. 6 per Cent. Preference	5¾ 6¼	6 6¼	4 12 4	...	...	...
100,000	5	...	British Westinghouse, 6% Preference	4¾ 5¼	4¾ 5¼	...	...	4⅛	...
90,060	2	2/0	Brush Electrical Engineering	1⅞ 2⅛	1⅞ 2⅛	4 14 1	September	2 1/16	...
90,000	2	1/2⅔	Do. 6 per Cent. Pref. Non-Cumulative	2¼ 2⅜	2¼ 2⅜	4 16 0	,,	2⅜	2 5/16
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Deb. Stock	108 113	108 113	3 19 8	February and August	...	...
£50,000	Stock	4½%	* Do. 2nd Debenture Stock (red.)	... ...	... ...	4 5 9	June and December	...	...
20,000	5	5/0	Callender's Cable Construction Ordinary	14 15	14½ 15½	4 16 9	,, ,,	15⅜	15½
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5⅜ 6	5½ 6	4 3 4	...	5⅝	...
£90,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb. (red.)	111 115	111 115	3 18 3	November and May	...	...
300,000	1	0/9⅜	Castner-Kellner Alkali Co. (fully paid)	1⅛ 1⅜	1⅛ 1⅜	5 16 5	...	...	...
60,000	1	0/7½	Chadburn's Ship Telegraph Ordinary	⅝ 1⅛	⅝ 1⅛	5 6 8	...	...	...
60,000	1	0/7½	Do. 6 per Cent. Cumulative Preference	⅝ 1⅛	⅝ 1⅛	5 6 8	...	1 1/16	...
32,098	3	1/9⅜	Crompton and Co. (Nos. 1 to 32,098)	3½ 4	3½ 4	4 10 9	January and July	...	...
£100,000	100	5%	* Do. 5 per Cent. First Mortgage Deb. (red.)	98 101	98 101	4 19 0	,, ,,	...	...
60,000	1	0/3	Davis and Timmins 6 per Cent. Cum. Pref.	¾ 1	¾ 1	...	...	...	...
99,261	5	1/9⅜	Edison and Swan United ("A" Shares) (£3 paid)	2 2½	2 2½	7 3 9	February and August	...	...
17,139	5	2/9⅜	Do. (£5 paid)	3½ 4½	3½ 4½	6 13 4	,, ,,	...	...
£344,023	Stock	4%	Do. 4 per Cent. Mortgage Deb. Stock (red.)	93 95	93 95	4 4 3	June and December	94	...
26,100	5	5/11½	Edmundson's Electric Corporation Ord. (fully pd.)	4¾ 5½	4¾ 5½	5 14 3	Half-yearly	...	...
112,100	2	1/2½	Electric Construction Co. (Limited)	2⅛ 2⅜	2⅛ 2⅜	4 16 0	January and July	2 5/16	...
25,000	2	2/9⅜	Do. 7 per Cent. Cumulative Preference	2¾ 3¼	2¾ 3¼	4 6 2	July	...	...
182,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	104 107	104 107	3 15 2	January and July	...	...
30,000	5	11 0	Henley's Telegraph Works Ordinary xd	13½ 14½	13½ 14½	3 15 10	February and August	14	...
30,000	5	1/3	Do. 4½ per Cent. Preference xd	5¼ 5¾	5¼ 5¾	3 18 3	,, ,,	5½	...
£50,000	Stock	4½%	Do. 4½ per Cent. Mortgage Deb. Stock (red.)	110 114	110 114	3 18 11	,, ,,	...	...
50,000	10	10/0	India Rubber, Gutta Percha, &c., Works	21 22	21 22	4 11 10	,, ,,	21½	21¼
£300,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	101 105	101 105	3 17 8	March and September	...	...
37,350	12	24/0	Telegraph Construction and Maintenance xd	36 40	36 40	4 9 11	March and July	57	36
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909	102 105	102 105	3 16 2	...	...	...
20,000	5	3/0	Do. Manufacturing Ordinary	9 10	9 10	3 10 0	...	9½	9¼
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5½ 6	5½ 6	4 3 4	...	...	...
30,000	5	5/0	Willans and Robinson Ordinary	11 12	11 12	3 15 0	April and October	...	...
30,000	5	3/0	Do. 6 per Cent. Cumulative Preference	7¼ 7¾	7¼ 7¾	3 17 5	,, ,,	...	...
£100,000	Stock	4¼%	Do. 4¼ per Cent. 1st Mortgage Debentures	104 106	104 106	4 0 2	May and November	...	...
			ELECTRIC RAILWAYS, TRAMWAYS, &c.						
12,000	10	10/0	Blackpool and Fleetwood Tramways	17 18	17 18	4 8 11	...	...	...
£167,900	100	5%	Brisbane Tramway 5 per Cent. Debentures	104 106	104 106	4 14 4	...	...	...
50,000	10	8%	Bristol Tramways and Carriage Ordinary xd	22½ 23½	22½ 23½	...	February and August	...	...
25,000	10	4%	Do. Cumulative Preference (£6 paid)	6¼ 6½	6¼ 6½	...	...	...	...
£100,000	Stock	4%	Do. 4 per Cent. Debentures	117 118	117 118	3 7 3	...	...	...
12,000	10	...	British Columbia Electric Railway 5% Pref.	10⅝ 10⅞	10¼ 10¾	...	...	10 1/16	10⅛
30,000	10	9/0	British Electric Traction Ordinary (Nos. 1 to 30,000)	17 18	17 18	3 6 8	...	17⅛	17⅜
£15,000	10	...	Do. (Nos. 60,001 to 75,000)	16½ 17½	16½ 17½	...	...	16⅝	...
30,000	10	6/0	Do. 6% Cum. Pref. (Nos. 30,001 to 60,000)	13 13⅜	13 13⅜	4 8 11	...	13¼	13
£200,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures	126 127	126 129	3 19 1	...	...	...
40,000	5	1/9	Buenos Ayres & Belgrano 6% "A" Cum. Pref.	4⅛ 5⅛	4⅛ 5⅛	5 17 1	...	...	...
27,500	5	...	Do. "B"	4 4⅛	4 4⅛	...	...	...	...
320,000	Stock	5%	Do. 5 per Cent. Debentures	105 108	105 108	4 12 7	...	...	...
213,553	10	3/0	Central London Ordinary	9¾ 10¼	9¾ 10¼	2 18 6	June and December	10⅛	10 1/16
£855,000	Stock	1½%	City and South London Railway Con. Ordinary	64 68	66 68	2 15 2	January and July	69	6 8
37,500	10	...	Do. (Nos. 22,501 to 60,000) (£5. 10s. paid)	4½ 5⅛	4½ 5⅛	...	...	...	...
£150,000	Stock	5%	Do. 5 per Cent. Perpetual Preference (1891)	140 145	140 145	3 9 0	January and July	...	...
£200,000	Stock	5%	Do. (1896)	132 137	132 137	3 13 0	...	...	...
£187,701	Stock	4%	Do. 4 per Cent. Perpetual Debenture	125 130	125 130	3 1 11	May and November	...	...
20,000	10	7½%	Imperial Tramways Ordinary	23 24	23 24	...	March and September	...	...
10,000	10	6%	† Do. 6 per Cent. Preference	15 15⅜	15 15⅜	3 16 2	,, ,,	...	...
£300,000	Stock	4½%	† Do. 4½ per Cent. Debenture	113 115	113 115	3 17 11	January and July	...	...
30,000	10	1/3	Kidderminster & District E. L. & Tr'ct'n 5% Pref.	10 10½	10 10⅜	4 15 3	May and November	...	...
37,500	10	2½%	Liverpool Overhead Railway Ordinary	8¾ 8⅞	8¾ 8⅞	4 4 6	February and August	...	...
10,000	10	5%	Do. 5 per Cent. Preference	12⅝ 13⅜	13 13½	3 15 4	,, ,,	...	...
125,000	Stock	4%	Do. 4 per Cent. Debenture	105 107	105 107	3 14 11	January and July	...	...
24,000	5	...	New General Traction Ordinary	3¾ 4¼	3¾ 4¼	...	...	...	...
30,000	5	6/0	Do. 6 per Cent. Cumulative Preference	4¼ 5¼	5 5¼	5 9 1	May	...	...
4,000	10	...	Oldham, Ashton and Hyde Elec. Tramway Ord.	18 19	18 19	...	February and August	...	...
4,000	10	5/0	Do. 5 per Cent. Preference	10⅝ 10⅞	10½ 10⅝	4 14 1	,, ,,	...	...
13,334	10	...	Potteries Electric Traction Ordinary	11⅛ 12⅛	11⅛ 12⅛	...	...	...	...
20,000	10	5/0	Do. 5 per Cent. Cumulative Preference	10 11	10 11	4 10 11	...	...	...
£540,000	Stock	3%	Waterloo and City Ordinary	101 104	101 104	2 17 8	June and December	103½	...

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.
† The London Stock Exchange Committee refuses to quote these.

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THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,141. [No. 23. Vol. XLIV.] FRIDAY, MARCH 30, 1900. PRICE SIXPENCE (by post, 6½d.). Abroad, 8d., or 15 cents, or 30fr., or 7½g.

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NOTES.

As usual about this time of the year, the accounts relating to the telegraph service of the country have been issued as Parliamentary papers, one showing the gross receipts and expenditure for the last completed year, the other in more detail and covering the whole period of Post Office administration from 1870 down to March 31, 1899. It is hard to see what useful purpose is served by the publication of these humiliating documents year after year, in which the financial failure of the telegraph service is so painfully exposed. No notice is ever taken of them in Parliament, and the general public appears to accept them with complacent indifference, or as proof that the telegraphs are run not for profit, like the Post Office, but for the sole benefit of customers. The singular thing about it in this connection is that while the administration takes care that its own department, the Post Office, shall yield a very large revenue to the State, it contrives to saddle the telegraph service with a never-failing deficit, and one that shows a general tendency to increase. Last year the deficit amounted to £221,869, which, though less than the preceding year, was vastly larger than it had been in any previous year. And this after nearly 30 years of unexampled prosperity! During the whole of that period only on two occasions have the surplus balances paid anything towards writing off the purchase money; and only on three during the past 16 years has the balance escaped adding materially to the gross deficit, besides failing to pay interest. The upshot is, that against an accumulated interest, amounting to £8,796,822, only £67,602 capital has been cancelled, whilst the aggregate deficits have attained the astounding total of £7,756,654. That is to say, instead of redeeming the stock created for its original purchase in 1870, the telegraph service has not even paid interest on its capital, and has added nearly eight millions to its indebtedness.

THESE figures are the more surprising when we observe that the receipts for many years past have been rapidly increasing. They now reach the handsome total of £3,204,895 yet the profit on the business represented by this large sum in the year 1898-9 is stated to be less than nothing—the balance of expenditure over receipts being £221,869; and of course nothing was paid for interest, which at the present rate amounted to £298,888. The total deficiency therefore was £520,757, a loss of over half a million upon business exceeding three and a quarter millions. We are justly proud of the telegraph service for its excellency as a working department, but from a business and financial point of view it must be condemned as a failure, and a failure for which there seems to be no excuse. A business which in private hands paid handsome dividends —8 to 14 per cent., if we are not mistaken—is now conducted at enormous loss under the management of a State department; and the only explanations ever vouchsafed to account for this state of affairs are a reduced tariff and a higher rate of wages. But as every manufacturer and every railway company, to say nothing of the cable companies, have had precisely similar experience during the same period, the excuse is by no means convincing. For the present, however, Parliament and public alike seem content to accept it as valid, so long as the efficiency of the service continues unimpaired.

MR. P. E. SHAW is to be congratulated on having devised and constructed so delicate an instrument as that which he described at the last meeting of the Physical Society. The instrument was used by him to measure the displacement of the centre of a telephone diaphragm. It consists of a system of levers, carefully and firmly supported, one end of which is attached to an ordinary spherometer screw, and the other to a point, situated close to the diaphragm under investigation, which closes an electrical circuit whenever the amplitude of the diaphragm's movement brings it into contact. When this is the case, a click is heard in a telephone placed in the same circuit. So sensitive is this arrangement that a displacement

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of the order of one micromillimetre ($1\mu\mu$) is readily and accurately measured. The results obtained by Mr. SHAW are as follows: If the movement of the centre is less than $0{\cdot}87\mu\mu$, no sound is audible; motions of $50\mu\mu$ to $1{,}000\mu\mu$ give moderately loud sounds, while a motion of $5{,}000\mu\mu$ corresponds to an intolerably loud noise.

These are the final results obtained for the motion of the centre of a telephone plate corresponding to sounds of varying degrees of loudness. It would be a mistake to suppose, however, that these movements, because they relate to the centre of the disturbed plate, correspond to the *maximum* displacements, with which alone the intensity of the sound emitted is connected. On the contrary, the presence of a magnet pole in close proximity to the centre of the plate, the absence of absolute uniformity in the thickness, and the irregularity in the clamping, would each separately tend to modify its mode of vibration and to move the point of maximum disturbance away from the centre. If, for example, a bar electro-magnet be used in the receiver and the pole of this be fixed opposite the centre of the plate, then, assuming that this will have the same effect as loading it at the centre, Lord RAYLEIGH has shown ("Theory of Sound," Vol. I.) the motion there is of necessity diminished and must tend to zero. Much instructive information is to be expected from a curve showing the variation of the displacement along a diameter, and we hope measurements giving this will be made. In particular, the amplitude of the motion corresponding to a given intensity might be usefully obtained.

IT is interesting to recall, in this connection, some curious results obtained by Lord RAYLEIGH in his investigations on the vibrations of plates and membranes. He found that when the vibrations set up are "forced"—*i.e.*, are produced by some external source such as an organ pipe, plucked violin string, or voice—definite nodes (nodal diameters, nodal circles, or both) are produced only when the pitch of the source has certain definite values. This fact should have some bearing on Mr. SHAW's future experiments and must be borne in mind. We would suggest as supplying a fairly approximate source, that a violin string be tuned up so as to force a certain definite vibration on the plate, a condition very readily determined by strewing it with lycopodium or fine sand. Then he can proceed to his measurements, using always the same source, and trace the variations of the motions along any diameter or circle, as might be suggested by the character of the Savart or Chladin figures obtained in the preliminary sand adjustment.

WE reprint below a note from our American contemporary, the *Electrical World and Engineer*, to the effect that in the United States District Court the Commercial Cable Co. have been awarded $5,000 damages for injury done to one of their cables by the schooner "William H. Bailey":—

Judge William K. Townsend, of the United States District Court, sitting in New Haven, Conn., has awarded the Commercial Cable Co. $5,000 damages for injuries done to a cable by the schooner "William H. Bailey." Early in January it was discovered that a cable of the company had been cut in Gowanus Bay, and the officials of the cable company learned that the schooner "William H. Bailey" had anchored near the point where the cable was picked up and found cut. The captain and his crew claimed that when the anchor was hauled up it was found to be so badly entangled with the cable that they had to cut it with a meat saw. Judge TOWNSEND said that although the vessel anchored in specified anchorage grounds, and might not have been able to prevent the anchor from getting entangled in the cable, nevertheless the vessel should have gotten free without cutting the cable. The Cable Co. claimed that their cables in and around New York harbour have been recklessly cut and destroyed by masters of ships, and they decided to make the present case a test one.

The judge, it will be seen, held that although the vessel might not have been able to prevent the anchor from getting entangled in the cable, nevertheless she should have got free without cutting the cable. The case is interesting as being, we believe, the first in which damages have been awarded by a court for cutting a submarine telegraph line. Some time ago the Direct Spanish Telegraph Co. brought a similar action (which was reported in our columns) in this country, but failed on the technical ground that, although it was admitted a cable had been cut, it had not been proved in the action that it was the plaintiff company's cable which had been severed by the defendant's ship. There have been, however, several cases where damages for such injuries have been paid without a verdict of the courts.

Appointment.—Mr. H. R. Kempe has been appointed principal technical officer at the engineer-in-chief's office in the General Post Office, as successor to Mr. F. Cooper, whose death took place suddenly on the 8th inst.

The Postmaster-General.—It is stated in the newspapers as we go to press that the Duke of Norfolk has resigned the office of Postmaster-General, on account of his intended departure for South Africa on military service.

The "James Forrest" Lecture.—The eighth "James Forrest" lecture, on "The Application of Electricity to Engineering," will be delivered at the Institution of Civil Engineers on April 23rd, by Sir William Preece, K.C.B. The time of the lecture is 8 p.m.

Institution of Electrical Engineers: Glasgow Section.—The second general meeting of this section was held in the Glasgow and West of Scotland Technical College, on Friday, 23rd inst., when a Paper was read by Mr. Wm. Lackie, chief assistant at the Glasgow Corporation electricity works, upon the "Methods of Charging for Public Supply of Electricity."

The "Sullivan" Galvanometer Mirror-Speaking Arrangements.—*Apropos* of our article in *The Electrician*, Oct. 20, 1899 (Vol. XLIII., p. 919), describing these arrangements, we learn that Mr. H. W. Sullivan has received orders from the German Admiralty for his "Universal" galvanometer fitted with his special arrangements for enabling a naval officer to establish telegraphic communication in war time through a submarine cable of any length.

Cable Interruptions and Repairs:—

	Date of Interruption.	Date of Repair.
Latakia—Cyprus	June 21, 1899 ...	—
Cayenne—Pinhieros	Oct. 11, 1899 ...	—
Tangier—Tarifa	Jan. 3, 1900 ...	—
Paramaribo—Cayenne	Feb. 16, 1900 ...	—
Ceara—Maranham	Feb. 20, 1900 ...	—
Para—Maranham	Mar. 2, 1900 ...	—
Môle-St. Nicolas—Cap Haitien	Mar. 7, 1900 ...	—
Djedda—Suakim.....	Mar. 13, 1900 ...	Mar. 23, 1900

Telegraphic Development in Alaska.—The Governments of the United States and Canada are now proposing to spend close on $1,000,000 for purposes of telegraphic communication with Alaska. The Dominion has already appropriated $350,000 to connect the Klondike with Quesnelle, while the Army Appropriation Bill of the United States asks for $450,000 for similar work. The United States portion of the work, which is said to be absolutely essential for military purposes, will be begun in April.

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Institution of Electrical Engineers.—At the meeting of the Institution on March 22 contributions amounting to £158. 16s. 6d. were announced as having been received since the ordinary general meeting on Feb. 9 towards the benevolent fund. Donations were also acknowledged for the building fund, but the amount was not stated. As this was the first time such contributions had been acknowledged at meetings of the Institution, Prof. Perry, who was in the chair, in asking for the thanks of the meeting to the donors, hoped that this course might induce other members to send in subscriptions.

Trolley-Fed Automobiles in France.—M. Lombard-Gerin is at present making experiments on a short length of line near Paris, of a trolley-fed automobile system. The principal difficulties encountered in this method of traction are that two trolleys and two wires are necessary, and provision must be made for the vehicle to move a considerable distance from the route underneath the trolley wires in order to let other vehicles pass. The inventor has made the trolley carriage itself an automobile, moving with speeds slightly greater at each instant than the vehicle. The double trolley is driven by a little asynchronous induction motor of the squirrel-cage type, fed by three-phase currents produced by the motor of the vehicle. The armature of the latter carries on the side opposite to the commutator three rings connected to the armature winding at suitable points, thus taking from the motor three-phase currents. The double trolley with its motor are arranged to follow all the variations in speed of the vehicle. Prof. Hospitalier, who gives a complete description of this system with drawings and illustrations, in a recent number of *L'Industrie Electrique*, thinks the system capable of very many important applications. The most obvious consists in its utilisation as an economic extension of the service of existing lines of tramways to serve localities where any extension of the main line is itself inadvisable. These aerial lines distributed over the country districts would be the means of giving the farmer a new source of power for agricultural work.

Royal Meteorological Society Jubilee Celebration.—This Society will attain its jubilee on April 3rd, having been founded on April 3, 1850. The following arrangements have been made for observing this 50th anniversary: On Tuesday, April 3rd, a commemoration meeting will be held at the Institution of Civil Engineers, Great George-street, Westminster, at 3 p.m. The president, Dr. C. Theodore Williams, will deliver an address, and delegates from other societies will be received. This will be followed by a conversazione at the Royal Institute of Painters in Water Colours, Piccadilly, at 8·30 p.m., where, in addition to the pictures in the galleries, there will also be an exhibition of meteorological instruments, models, and photographs; and lantern demonstrations will be given by Col. H. M. Saunders, Mr. T. C. Porter (of Eton), and Mr. W. Marriott. Short concerts will be given by the "Schartau" Part Singers, and instrumental music will be performed by the Royal Artillery String Band. On Wednesday, April 4th, an excursion has been arranged to the Royal Observatory, Greenwich, by permission of the Astronomer Royal, for which tickets of admission should be applied for beforehand. Those who intend taking part in this visit are requested to meet at the Royal Observatory, Greenwich, at 11·30 a.m. A dinner will be given at the Westminster Palace Hotel, Victoria-street, S.W., at 7 p.m. As a memento of the jubilee of the Society, a bronze commemoration medal, bearing on the obverse a portrait of Luke Howard, F.R.S., has been struck.

Stirling Electric Supply Works.—We announced last week the formal opening on the 21st inst. of the Stirling electric light works, and we are now able to give the following particulars of this undertaking. The work was carried out at the instance of the Stirling Police Commissioners, who obtained their provisional order in 1895, but only proceeded to carry it into effect last year. Prof. A. B. W. Kennedy was then appointed consulting engineer, and building operations commenced in April last, a suitable site having been obtained in close proximity to the Caledonian railway. During the course of the building much trouble was experienced from the treacherous nature of the subsoil, in consequence of which precautions had to be taken that the surface should be interfered with as little as possible. Substantial beds of concrete were put down wherever any excessive weight was anticipated. The foundation of the chimney consists, for instance, of about 150 tons of concrete, and is 38ft. in diameter. Steel rails are further embedded in the concrete, intended for stiffening the whole and adding to the stability of the chimney. The system of supply is the three-wire continuous-current, the supply pressure being 460 volts between the outers. The boiler house contains two Lancashire boilers, 28ft. by 8ft., for supplying steam at 160lb. working pressure. At present firing is done by hand, but mechanical stokers will be added if the demand for current increases. Water is fed into the boilers from two Worthington compound feed pumps, each having a capacity of 1,400 gallons of water per hour. The pumps are also connected with a Green's economiser, which can raise the temperature of 1,300 gallons per hour from 60°F. to 200°F. Scrapers and gearing are provided to remove soot or other accumulation on the exterior of the pipes, and a small steam engine has been built on the economiser to work the moving parts. The engine room at present contains four Belliss fast-running and self-oiling engines, two of 120 H.P. each and two of 40 H.P. each, direct-coupled and bolted on to the same bedplate to four continuous-current generators. The dynamos were constructed by Messrs. Mather and Platt, and have capacities of 75 kw. and 12 kw. respectively. In the construction of the switchboard, as indeed in every other department, provision has been made for considerable extensions of the station, especially for the purpose of the local tramway system, which it is anticipated will shortly be converted. The engine room contains also an overhead electric travelling crane, capable of lifting a dead weight of 8 tons, which is to be used for lifting of apparatus during alterations and repairs. There are two storage batteries, containing 125 cells in each, having a capacity of 250 ampere-hours, and capable of discharging at 50 amperes for five hours or at 75 amperes for three hours. These were supplied by Messrs. Pritchetts and Gold. The distributors consist of Callender triple-concentric lead-covered and steel-armoured cables, and are laid direct in the ground. The total station capacity is given as being equivalent to 6,200 8 c.p. lamps, which includes the requirement for 30 arc lamps taking 10 amperes each. The names of the contractors, besides those already mentioned, are as follows: Boilers, Messrs. Anderton and Co., Accrington; engines, dynamos, &c., Messrs. Mather and Platt, Manchester; switchboard, James White, Glasgow; arc lamps, Brockie-Pell; lamp-posts and brackets, W. McFarlane and Co., Glasgow; and meters, Messrs. Ferranti, London. The total expenditure on the station and equipment, including cost of order, extensions, fees, &c., is not expected to exceed £25,000, which sum has been borrowed from the Public Works Loan Commissioners for a period of 30 years at the low rate of 2¾ per cent. Mr. A. C. Hanson has been appointed resident engineer.

MEETINGS OF SCIENTIFIC AND ENGINEERING SOCIETIES, &c.

SATURDAY, March 31st.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture IV. on "Polarised Light," by the Right Hon. Lord Rayleigh, F.R.S.

THURSDAY, April 5th.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary General Meeting, when the discussion on Mr. E. J. Wade's Paper, "Storage Battery Problems," will be concluded A Paper on "The Electrical Equipment of Ships of War" will then be read by Mr. C. E. Grove.

RÖNTGEN SOCIETY.

8 p.m. Ordinary General Meeting at 20, Hanover-square. Paper to be read: "The Influence of the X-Rays upon the Growth and Development of Micro-Organisms," by Dr. Norris Wolfenden and Dr. Forbes Ross.

FRIDAY, April 6th.

ROYAL INSTITUTION.

9 p.m. Evening Discourse on "Solid Hydrogen," by Prof. Dewar, F.R.S.

SATURDAY, April 7th.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture V. on "Polarised Light," by the Right Hon. Lord Rayleigh, F.R.S.

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BOLTON CORPORATION COMBINED LIGHTING AND TRACTION WORKS.

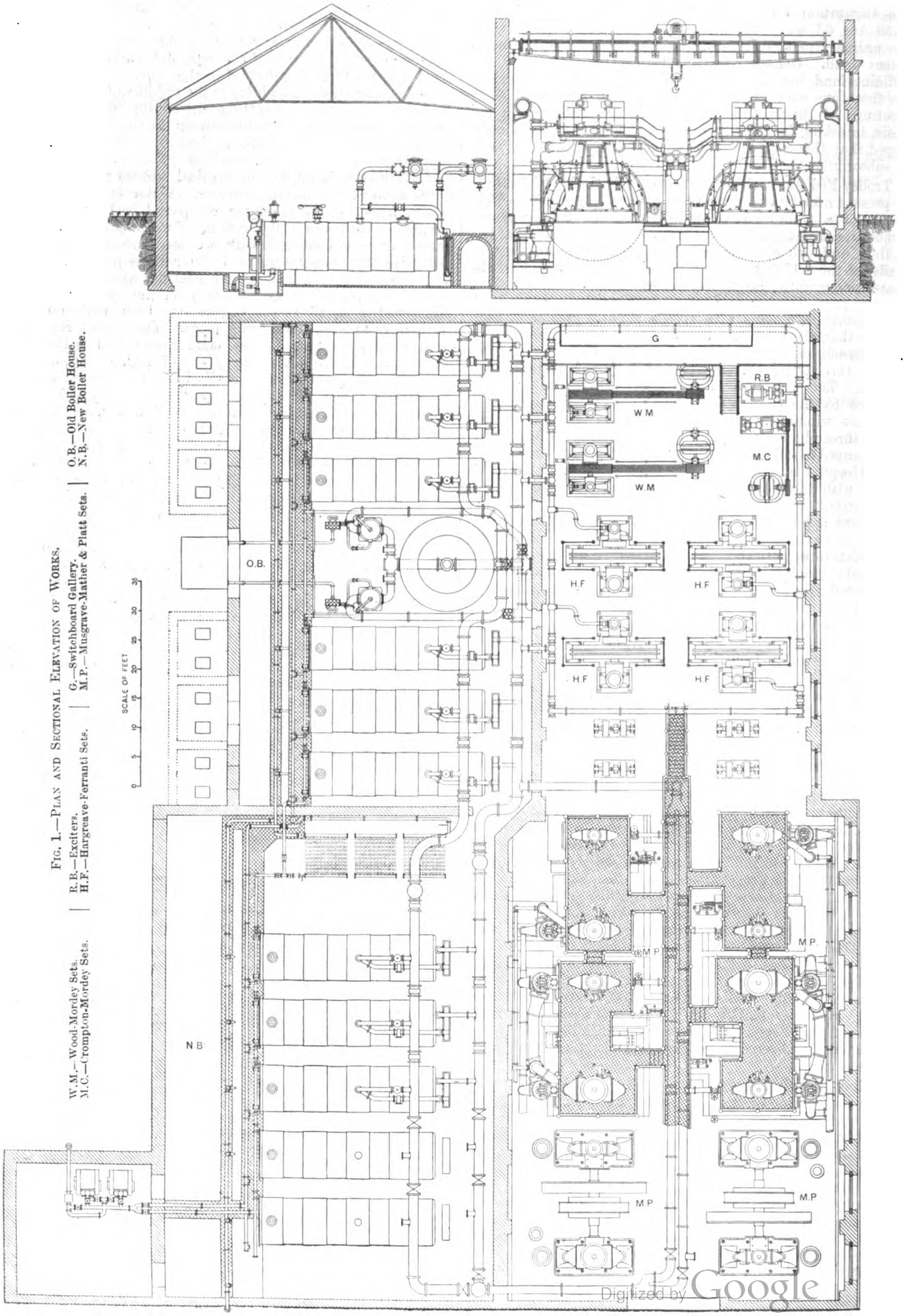

FIG. 1.—PLAN AND SECTIONAL ELEVATION OF WORKS.

W.M.—Wood-Mordey Sets. | R.E.—Exciters. | G.—Switchboard Gallery. | O.B.—Old Boiler House.
M.C.—Crompton-Mordey Sets. | H.F.—Hargreave-Ferranti Sets. | M.P.—Musgrave-Mather & Platt Sets. | N.B.—New Boiler House.

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BOLTON CORPORATION COMBINED LIGHTING AND TRACTION WORKS.

The supply works at Bolton, designed by Mr. J. H. Rider, and put into operation in 1894, were erected on the alternating-current transformer system. The system has undergone the usual process of concentrating into sub-stations those transformers in the central parts of the supply area; and Mr. Arthur Ellis (who is now the resident and consulting engineer), as soon as an electric tramway was decided upon, made use of the opportunity to commence reconstruction on the 2 × 230 volts continuous-current three-wire system, so far as the central district was concerned. When this is completed the same machines will serve both for lighting and traction, the outlying districts, however, being still supplied with single-phase alternating current.

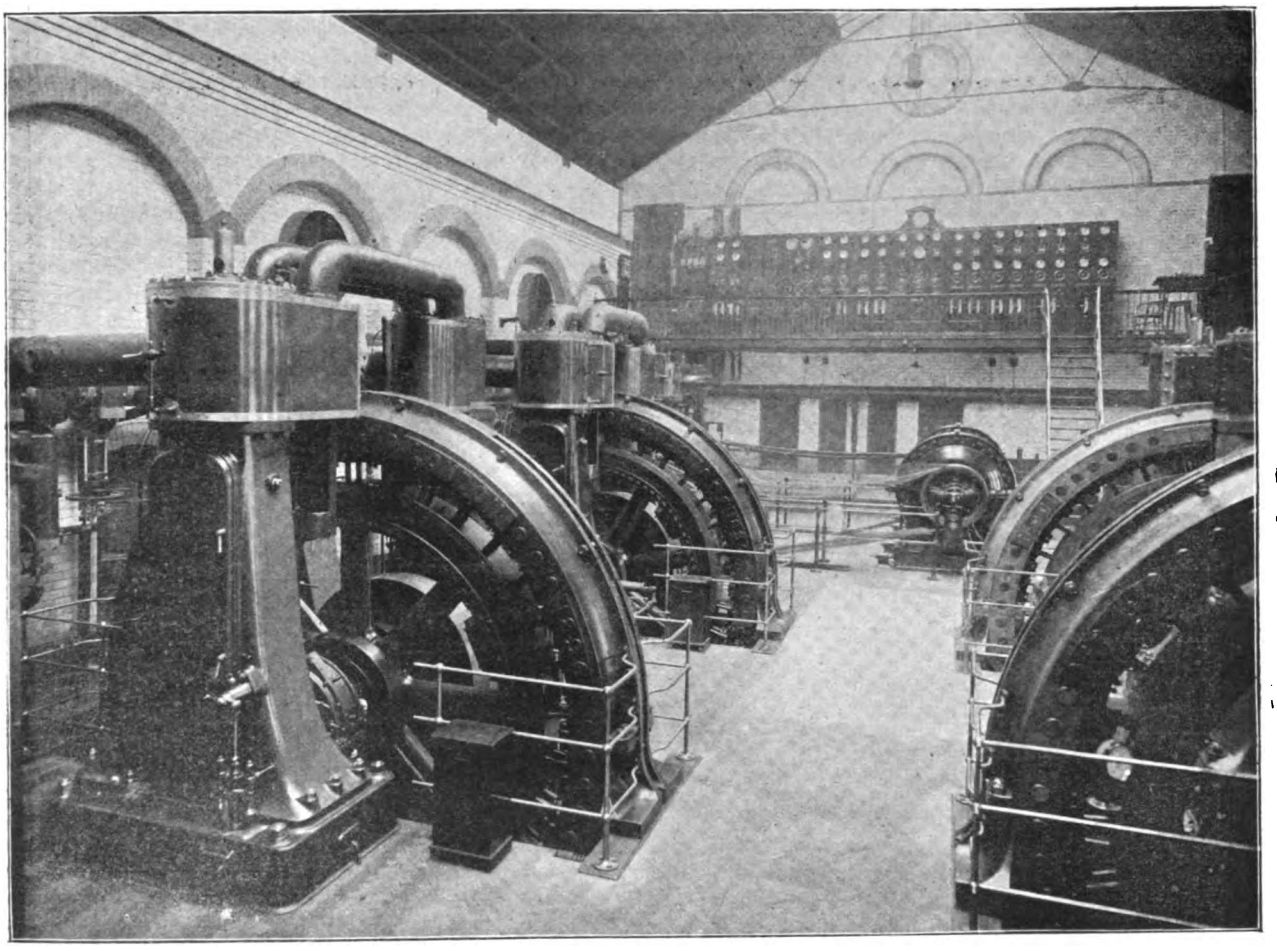

FIG. 2.—GENERAL VIEW OF ALTERNATING CURRENT MACHINERY.

To convey an idea of the configuration of the district and the distribution of the load, it should be explained that within about a mile of the station there is a large density of demand for lighting, and that there are already applications for 750 H.P. of motors in addition to some 1,500 H.P. which will be required for the tramways when all the lines are in operation. The total lamp connections at present amount to an equivalent of 56,000 8 c.p. lamps, and the tramways which radiate from the centre of the town include 31 miles of single track, covering 25 miles of street. When it is stated that during last year 27 per cent. of the total units generated were wasted in magnetising current, it is not surprising that Mr. Ellis saw fit to make this change. A combined station in such circumstances as at Bolton will, moreover, materially decrease the stand-by losses and the necessary capital required for reserve plant, without increasing the size of the station to unpractical dimensions. The only disadvantage to set against the change is the extra cost of the copper in the feeders from the station to the distributing centre, for at the present rate of increase of lighting in the outlying districts it should not take long for all the existing alternating-current plant to be fully loaded.

The original station contained two 100 kw. Mordey alternators, rope driven from the flywheels of Wood engines, marked W M in Fig. 1, and seen in the background in Fig. 2, and a 50 kw. Mordey alternator coupled by ropes to a Crompton two-pole undertype Crompton motor (M C in Fig. 1), which was originally employed, driven from cells, to take the day load. Now the alternator runs as a motor and the Crompton machine serves as exciter. As the original exciting plant two 8½ kw. Brush machines (R B in Fig. 1) were employed, each coupled to a small Robey single-cylinder engine. At present the machines are still all separately excited from exciter 'bus bars to which the battery is connected, the motor-alternator usually being employed for the charging and make-

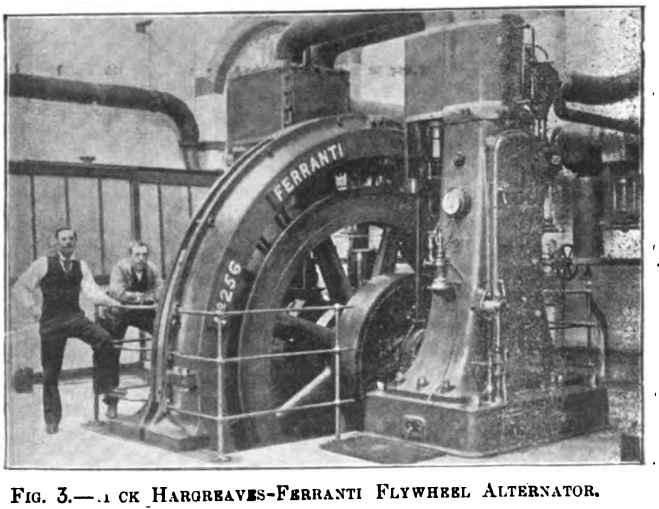

FIG. 3.—... CK HARGREAVES-FERRANTI FLYWHEEL ALTERNATOR.

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up current, and the two steam-driven exciters held as reserve. The Mordey alternators are of the pattern constructed by the Brush Co. in 1894. The Wood engines are inverted vertical compound non-condensing engines with 13in. and 21in. cylinders and 15in. stroke, running at 180 revs per min. of these sets are, as seen, vertical compound two-crank, with the alternator placed on the crank shaft between the high-pressure and low-pressure cylinders. The main dimensions are 16in. and 27in. cylinders and 18in. stroke, and the speed 157 revs. per min. A piston valve,

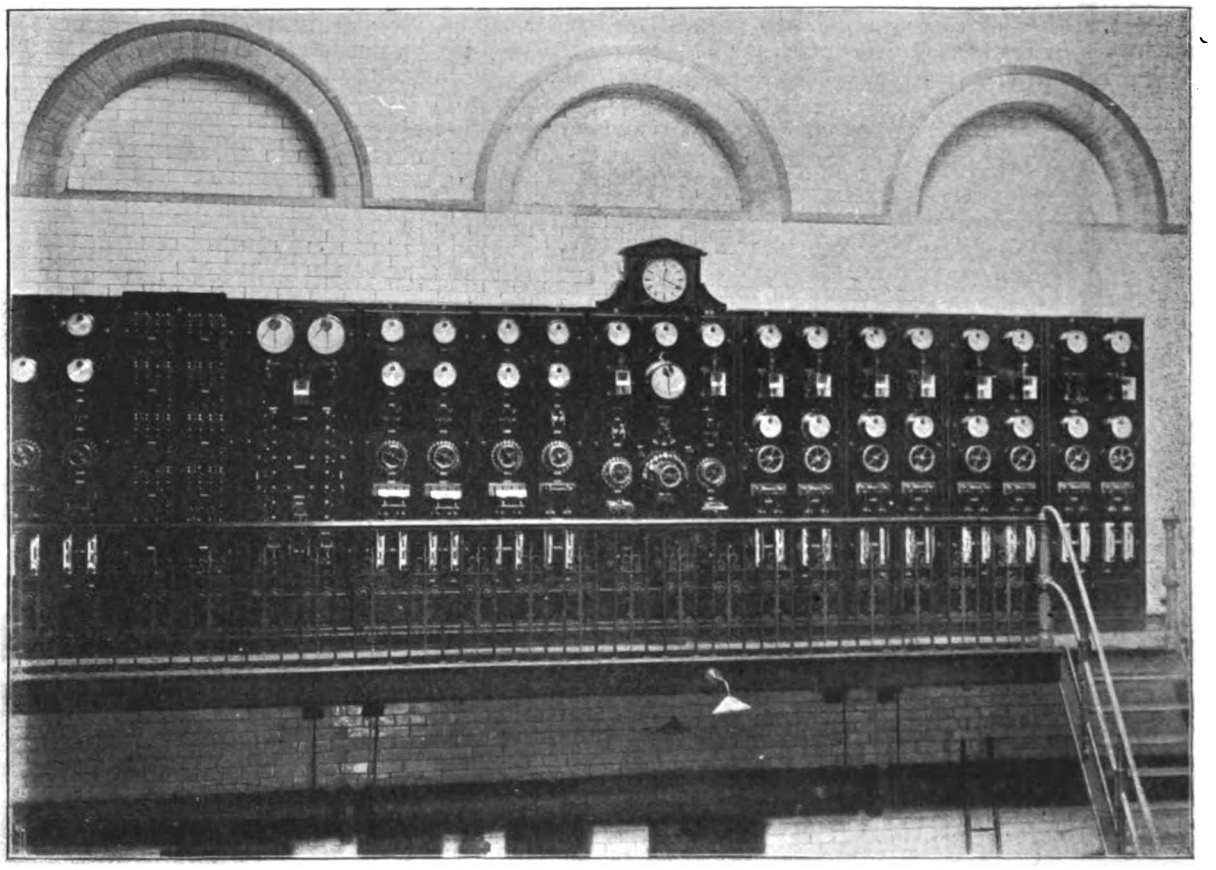

Fig. 4.—Alternating Current Switchboard.

and for 120lbs. boiler pressure. They have automatic slide valve gear to the high-pressure cylinder, and slide and cut-off valves to the low-pressure cylinder.

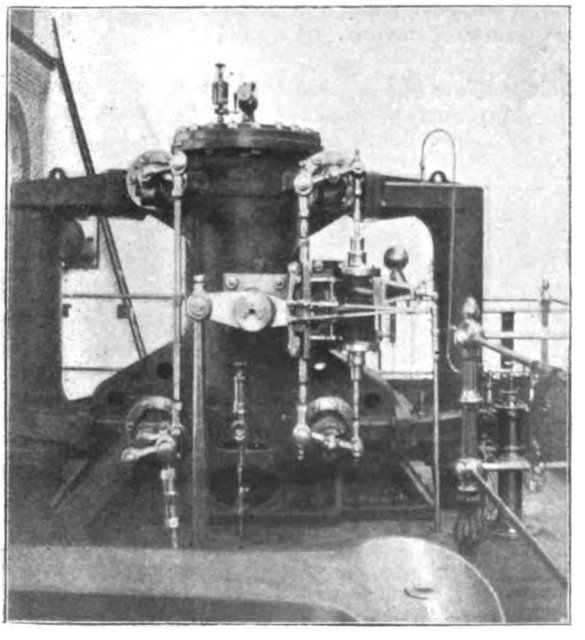

Fig. 6.—High-Pressure Valve Gear of Musgrave Engine.

During the next four years the generating plant was added to by four 200 kw. Ferranti flywheel alternators, driven by Hick Hargreaves engines (H F in Fig. 1, shown in the foreground in Fig. 2, and again in Fig. 3). The engines

controlled by the shaft governor, is employed for the high-pressure cylinder, and an ordinary slide valve on the low-pressure side. As seen in the illustrations, the working parts are enclosed within the standard and are accessible through a door at the side of the latter. The crank shaft has only two bearings, fitting into spherical recesses in the base plates and

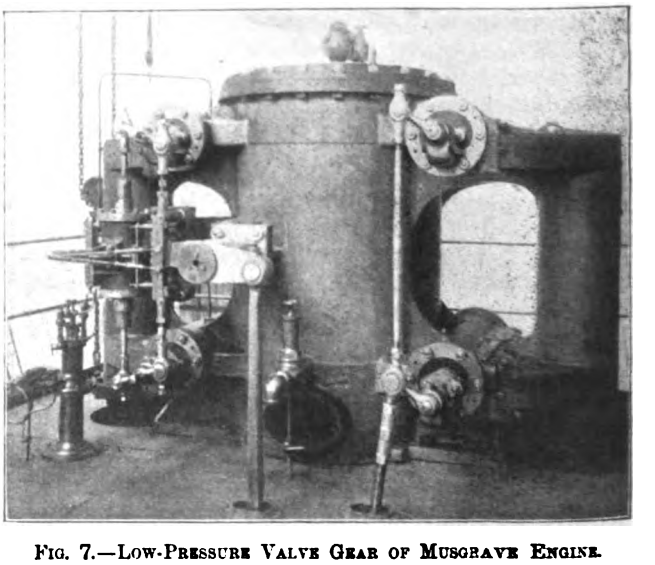

Fig. 7.—Low-Pressure Valve Gear of Musgrave Engine.

lined with white metal. The cranks are overhung and are furnished with balance weights. An oil pump for the forced lubrication is driven off each cross head through a rocking shaft. The rotating armature of the dynamo has a diameter

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ELECTRIC RAILWAYS AND TRAMWAYS OF THE UNITED KINGDOM.

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Data relating to these Lines will be found in the Table of Electric Railways and Tramways, published with our issue of the 26th January, 1900, and also with later revision in "The Electrician." Electrical Trades Directory and Handbook, 1900.

Extra Copies of this Map can be supplied, price 6d. each.

"Electrician" Series, 1, 2 & 3 Salisbury Court, Fleet Street, London.

Red = Overhead Trolley Systems.

□ = Municipality.

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of 10ft. 3in. and weighs 8½ tons, and the machine follows Messrs. Ferranti's usual construction.

This completes the list of the original generating plant, which, as seen in Fig. 1, occupies a distinct portion of the building. In the switchboard for this, built by the Manchester Edison Swan Co., with a subsequent extension by Messrs. Ferranti, it was necessary to make provision for running the machines either on separate circuits or in parallel. There is consequently one main 'bus bar, which can be split up into sections. The outers of the feeders are earthed at the station, and are connected through fuses, as are also the generators. No non-return cut-outs are employed. The chief feature of the old part of the board is the close proximity of the positive and negative poles of the generator switches to one another and to the exciter field rheostat. The switchboard is mounted on a gallery, G, and a general view of it is shown in Fig. 4. Figs. 3 and 4 are from photographs taken by Mr. Ellis himself, who is to be congratulated on his skill as an amateur photographer. The additional Ferranti generator-panels are situated to the extreme right, and are not visible in the illustration. They are of this firm's excellent single-pole pattern with oil bath fuses, whose arrangement is now so well known that a detailed description here is unnecessary.

We now come to the new continuous-current generating plant, M P, which is placed in the extended part of the building, as seen in Fig. 1. Fig. 5 is a view showing one of the large Musgrave — Mather & Platt sets and one of the boosters in the foreground, the photograph having been taken from more or less the same position as Fig. 2, but with the back turned to the alternating-current plant. Owing to the position of the machinery and steam pipes, this part of the engine room is exceedingly difficult to photograph. There are four of these sets—two of these rated at 600 kw. (1,000 I.H.P.), and the other two at 300 kw. (500 I.H.P.). One of the latter is not yet finished. The engines are vertical, cross-compound, condensing, with the flywheel and generator placed between the two cylinders. The cylinder dimensions of the larger units are 24in. and 45in. × 42in. stroke, and of the smaller ones 17½in. and 33in. × 36in. stroke. They are running non-condensing at present, but jet condensers and a Klein cooling tower are to be erected shortly. Trip valve gear is employed on both cylinders, and access to the gear is obtained by a gallery running the length of the engine room extension, with a flight of steps leading up to it. A feature in the gear is an automatic knock-off on the high-pressure cylinder, which acts if the governor rope breaks, the governor being above and driven by rope from the crank shaft. There is also a locking arrangement by means of which, when the engine is at a standstill, the high-pressure valves are set in a position to allow steam to enter both sides of the cylinder, so that before the engine can be started this has to be released. This precaution has been deemed necessary, as a man was recently killed by the unexpected starting of the engine while he was at work on it. Fig. 6 is a view of the high-pressure valve gear, and Fig. 7 of the low-pressure valve gear. These two illustrations are from photographs kindly lent by Messrs. Pownall and Gordon-Smith respectively, who are assistants at the Bolton works. The engines run at 100 revs. per min., and, according to the specification, are to be capable of generating 30 per cent. excess load if required, the steam pressure being 120lb. per sq. in. The following are some of the other dimensions of the larger engines: High-pressure piston rod (steel), 5in. diameter; low-pressure piston rod (steel), 5¼in. diameter. Connecting rod (forged iron, in one piece), 8ft. 9in. from centre to centre and 7½in. diameter at the crank end, tapering to 5¼in. diameter at the cross-head end. Crank necks, 14½in. diameter and 29in. long, the body 15½in. diameter and the wheel boss 19in. diameter. The crank shaft is hollow and of Siemens steel. Diameter of the cast-iron flywheel is 18ft. In the smaller engines the high-pressure and low-pressure piston rods measure 3¾in. diameter, and the connecting rods are 7ft. 6in. from centre to centre, 5¼in. diameter at the crank ends and 3¾in. at the cross-head end. The dimensions of the hollow Martin-steel crank shafts are: Necks 10½in. diameter and 21in. long, bodies 12in. diameter, and wheel bosses 15in. diameter. The small "barring engines" are seen in the illustrations. They start the flywheel by means of a pinion gearing into teeth cut in the side of the rim of the flywheel, and as soon as the engine is in operation and the pressure between the pinion and flywheel is reversed, the former is pulled out of gear by the fall of a counterweight.

The dynamos are compound wound, and so designed that the series windings can be cut out when the machines are

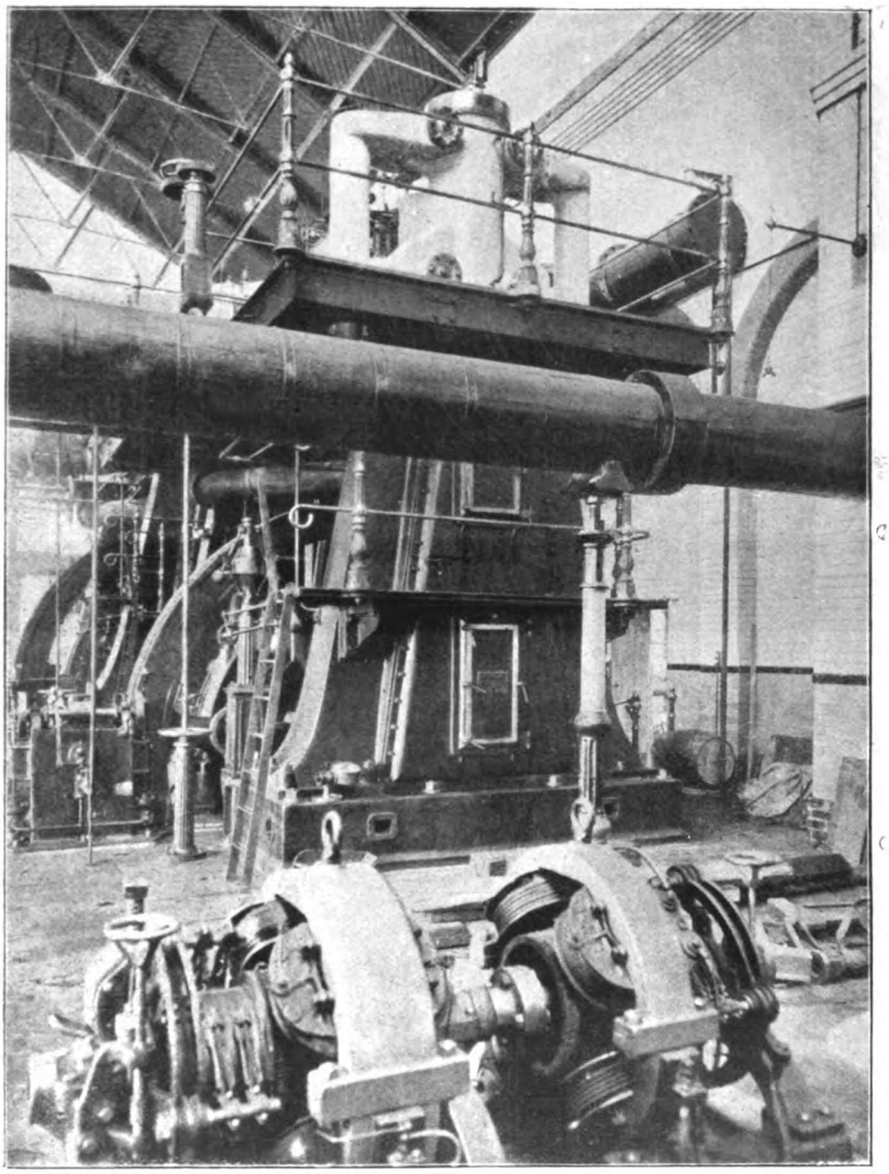

FIG. 5.—MUSGRAVE-MATHER AND PLATT CONTINUOUS CURRENT GENERATOR.

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employed for lighting, at a pressure of from 460 to 500 volts, and cut in for the traction service, for which the dynamo pressure varies from 500 to 530 volts. A side and end elevation of one of the generators is given in Fig. 8. The outputs under the various conditions are given below :—

Large Sets.

460-500 volts ...	1,300 amperes.	As shunt...	} Normal.	
530 do. ...	1,130	do.	compound	
530 do. ...	1,400	do.	do.	for two hours.
530 do. ...	1,700	do.	do.	for short periods.

Small Sets.

460 volts ...	652 amperes.	As shunt...	} Normal.	
500-530 do. ...	0-566	do.	compound	
530 do. ...	708	do.	do.	for two hours.
530 do. ...	850	do.	do.	momentarily.

5ft. 11ins. diameter. The commutator of the large set is fitted with 12 spindles and 6 brushes per spindle, and on the small set there are 12 spindles and three brushes per spindle. All the brushes are of the carbon type, and the lead is absolutely fixed for all loads.

The positive and negative boosters are both motor-driven, and are of the same size. They are of Messrs. Mather and Platt's four-polar design, either being equal to raising the pressure by 105 volts when 112 amperes is passing and the motor is running at 500 to 600 revs. per min. off the 500 volt mains. Probably the idea of having the negative booster of the same size as the positive one is to render them interchangeable. A balancer (Fig. 9), a two-commutator four-pole machine of similar design with one field-magnet for the two armatures, is capable of supplying a make-up current of 190 amperes.

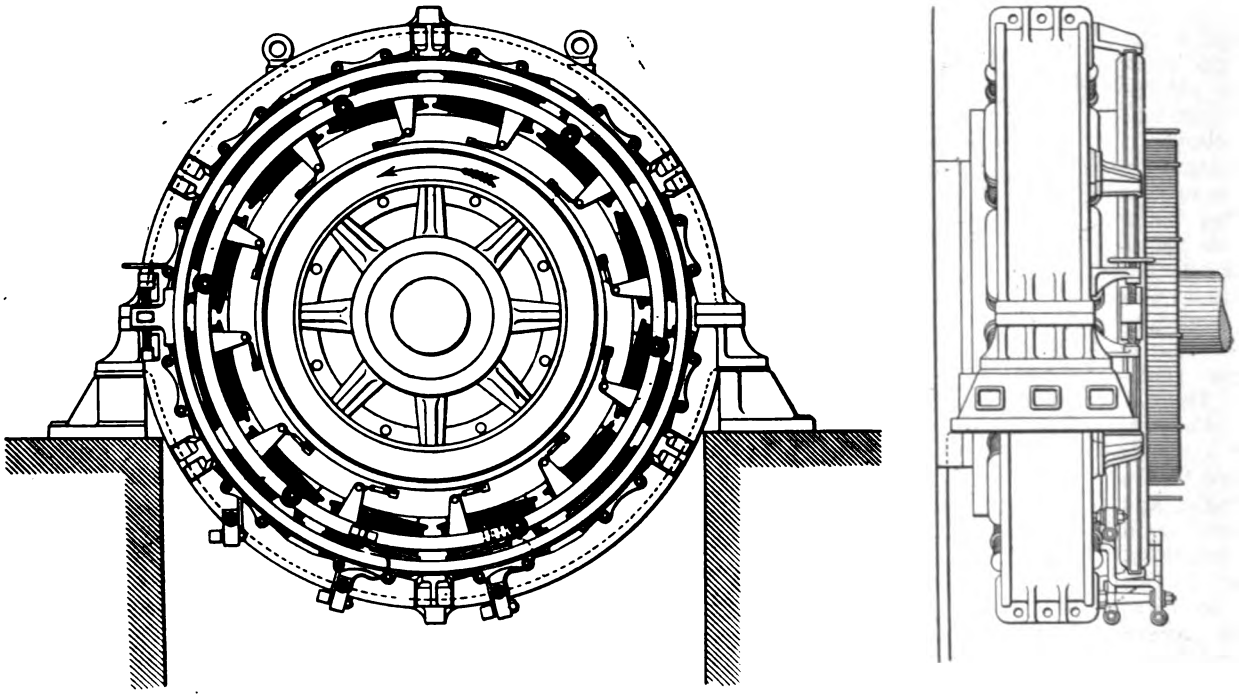

Fig. 8.—Side and End Elevations of 600 kw. Continuous-Current Generator.

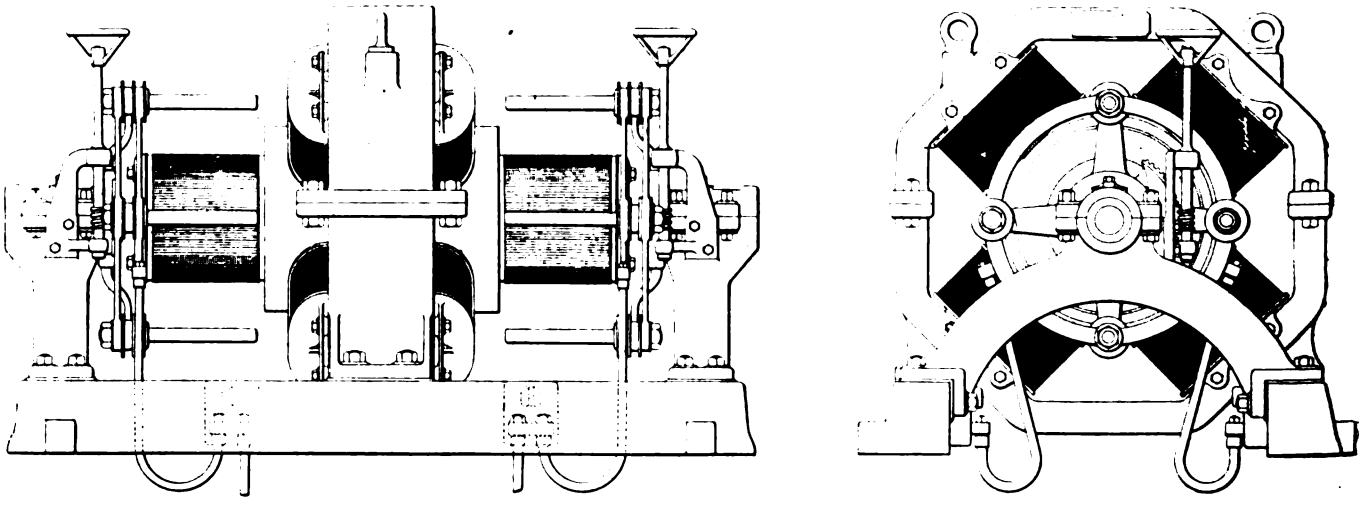

Fig. 9.—Motor-Driven Balancer.

The magnets of the machines consist of massive steel castings mounted between the engine cylinders on foot-steps carried on a concrete foundation. Solid brass sleeves serve as spools, and are mounted over the pole-pieces in such a manner that the series and compound windings are respectively at the top and bottom of the spool, each occupying its own separate compartment on the spool. The armature is of the slot-wound type, the conductors being entirely embedded in the core. The diameter of the armature is 15ft. 3ins. in the large sets and 6ft. 10ins. in the small sets. The commutator of the large machine is 7ft. 3½ins. diameter, and of the small machine

(To be concluded.)

The Royal Society.—Among the Papers down for reading yesterday, were: "On the Retinal Currents on the Frog's Eye, excited by Light and excited Electrically," by Dr. Waller, F.R.S., and "Observations on the Electromotive Phenomena of Non-Medullated Nurve," by Miss Sowton.

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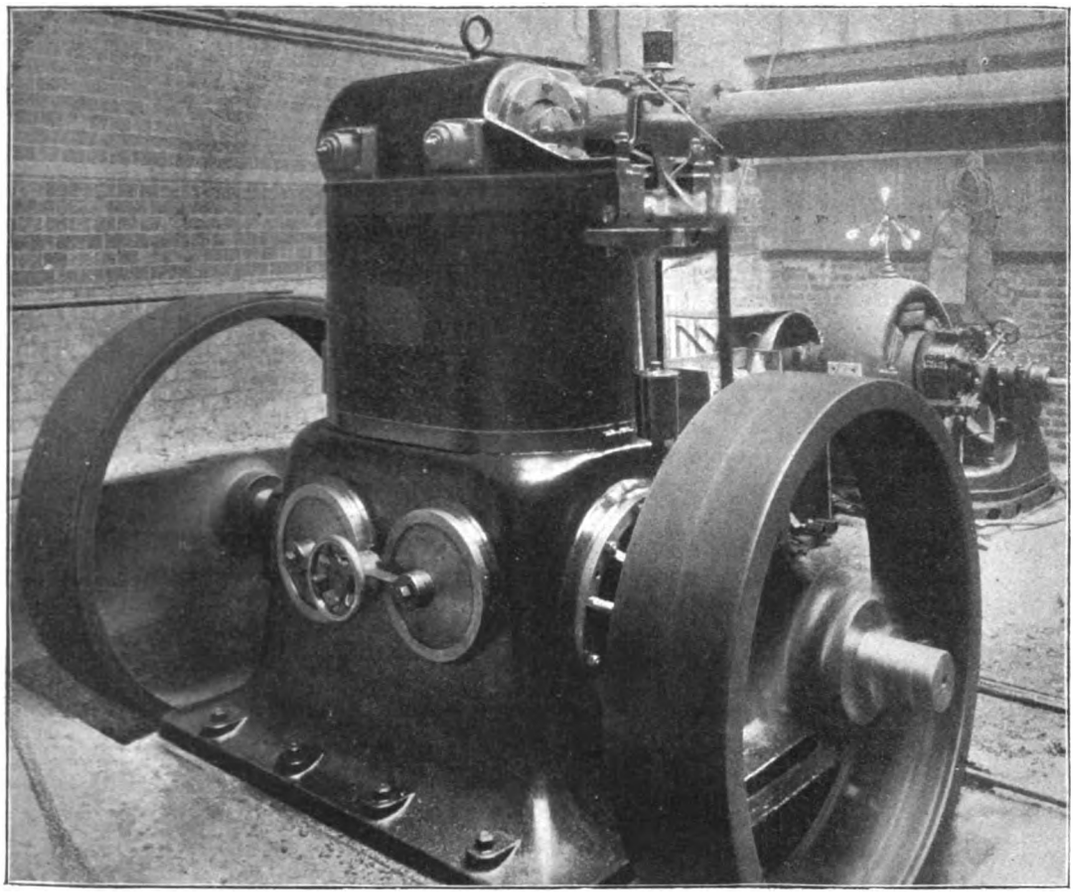
SOUTHAMPTON CORPORATION ELECTRIC TRAMWAYS.

The arrangements for working electrically the Corporation tramways at Southampton present several features of special interest and novelty; and, although only one of the sections is at present running electrically, there is much that is worthy of notice even at the present stage, the more especially as the cars are now being run by temporary generating plant. The section at present running is that extending from the High-street to Shirley, a distance of about a mile. All the other sections are still being worked by horses, except where traffic is temporarily interrupted in order to erect the overhead trolley equipment. The conversion of all the remaining sections, however, is being rapidly pushed forward; and it is hoped that by the time the extensions at the power station are completed the entire system of tramways, covering some eight miles of route and requiring about 20 cars in service, will be ready.



Temporary Tramway Generating Plant at Southampton Power Station

Little need be said at present with regard to the overhead equipment, except that it has been carried out by the contractors, Messrs. Macartney, McElroy and Co., in exceptionally good style. One of our illustrations shows a length of centre-pole double-bracket construction near the High-street end of the section now working. The most exacting critic could find nothing to object to in the treatment of the design and execution of this work from an æsthetic point of view; nor have the electrical requirements been sacrificed in any way to provide these artistic features. The Shirley section, indeed, may be counted among the best examples of electric tramway overhead equipment in the United Kingdom. Besides the centre-pole construction shown in the illustration, a certain amount of side-pole single-bracket construction has been rendered necessary where the road is narrow; and in places single track and interlacing line have been adopted over short lengths. We may refer, *en passant*, to the curious difficulty which arose at the famous Bar-gate in the High-street. Here a mixed Gothic and Roman arch spans the road, the clearance above the top of a tramcar passing underneath being so small that considerable danger of coming in contact with the trolley line and experiencing a 500 volt shock would have confronted the outside passengers. Some were in favour of the removal of the offending archway; others advocated a short length of conduit line under the structure and for a few yards on either side of it; others, again, suggested employing horses to tow the cars past the obstruction; but none of these heroic remedies commended itself to the Corporation. At length it occurred to someone that if the level of the roadway beneath the gateway were lowered a foot or two, the difficulty would be successfully overcome; and this lucid suggestion has been put into effect.

But it is not our present intention to describe in detail these interesting tramways, a task which we reserve until the completion of the tramways themselves. We intend merely to describe the principal features of the system adopted. There has been a system of electrical supply in Southampton since 1891, and although from the outset, when the undertaking was in the hands of a company, the generating plant has been cramped for room, the business of electric lighting has rapidly increased. In recent years, under the control of the local authority and with new and more spacious room for the plant, the growth has been very marked; but the bulk of the business consisted in electric lighting, and, notwithstanding the electric cranes on the harbour quays, the load diagrams had a hungry look in daylight hours. Wisely, therefore, the Corporation, acting on the advice of their consulting engineers, Messrs. Kincaid, Waller and Manville, decided that when the purchase of the tramways from the local company had been settled and the lines had been equipped electrically, the tramway load should be super-added to the supply load, with a view to give the generating plant something to do in the daytime. There may be nothing new in the idea of combining tramway and supply

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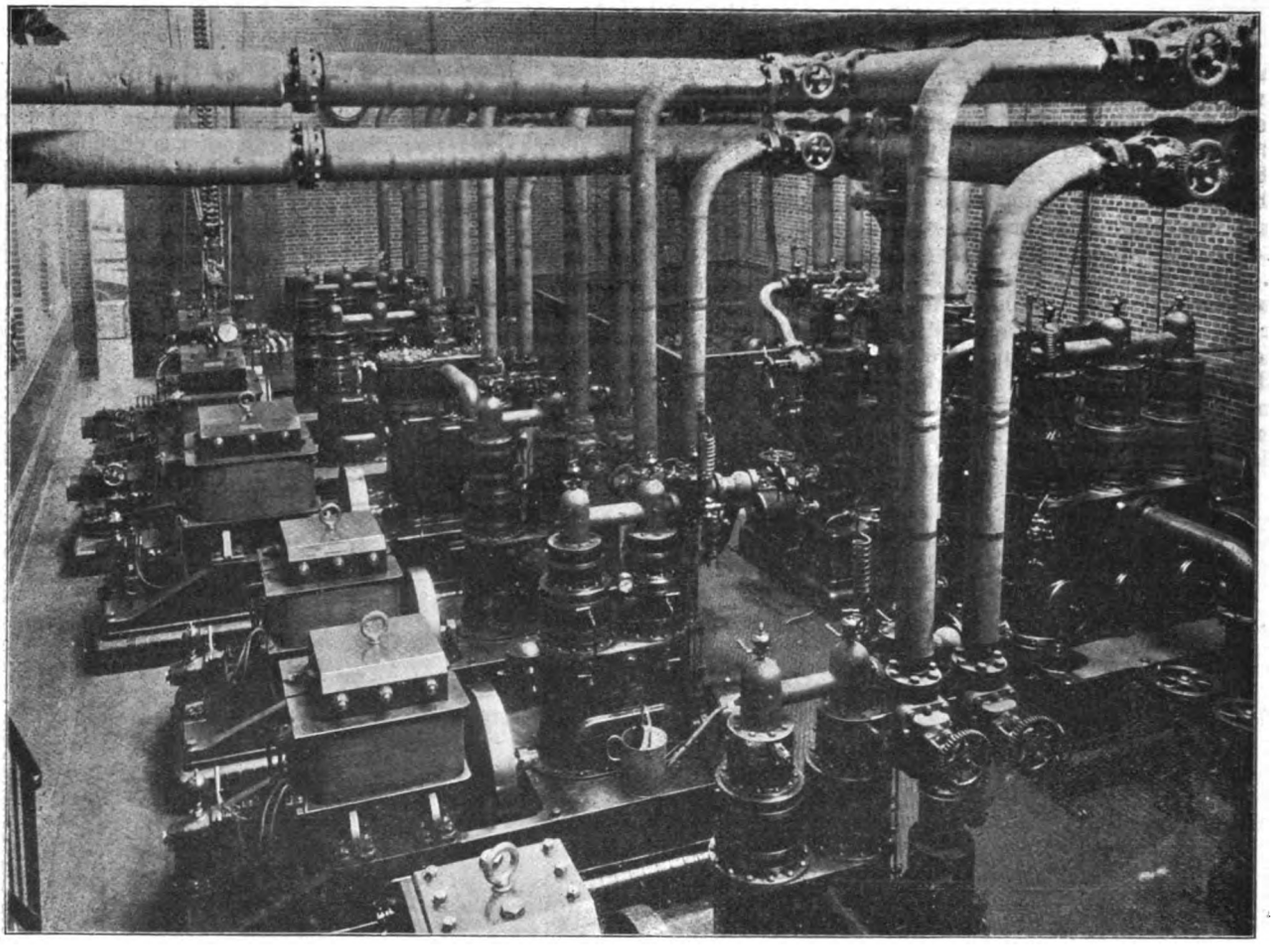
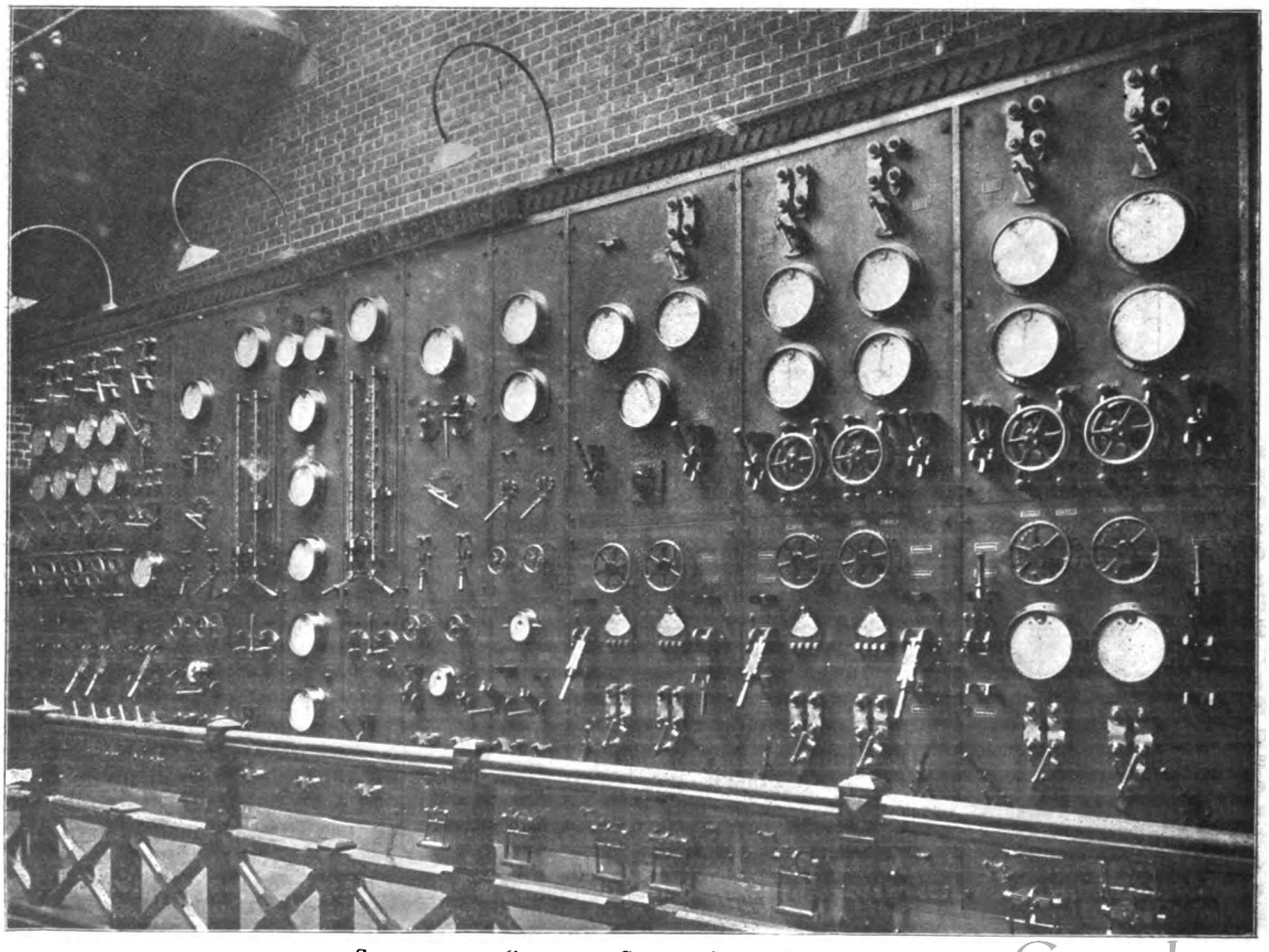


SOUTHAMPTON: GENERAL VIEW OF MACHINERY ROOM.



SOUTHAMPTON: CONTINUOUS-CURRENT SUPPLY SWITCHBOARD.

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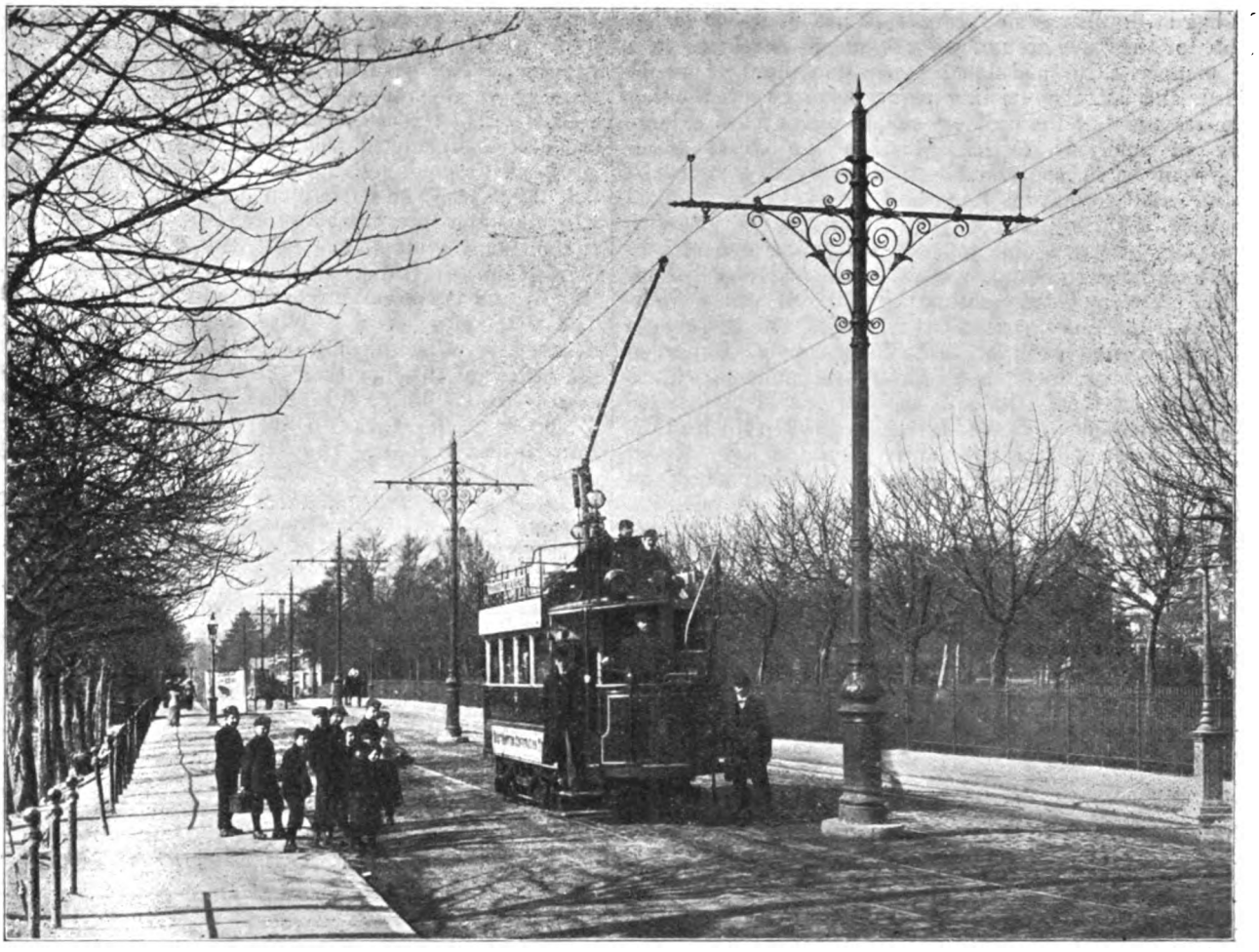
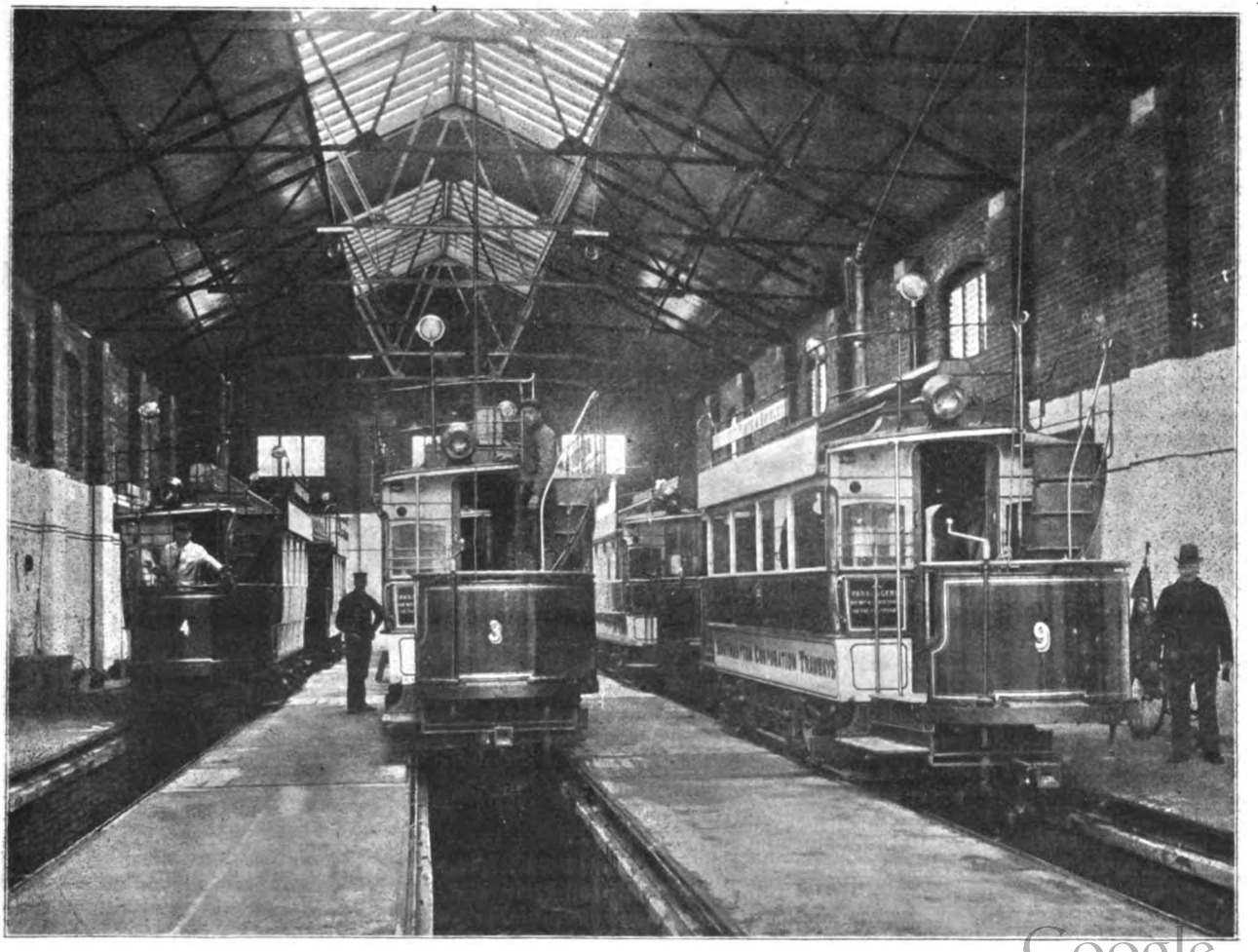


SOUTHAMPTON: CENTRE-POLE CONSTRUCTION ON THE SHIRLEY SECTION.



SOUTHAMPTON: CAR SHED AT SHIRLEY.

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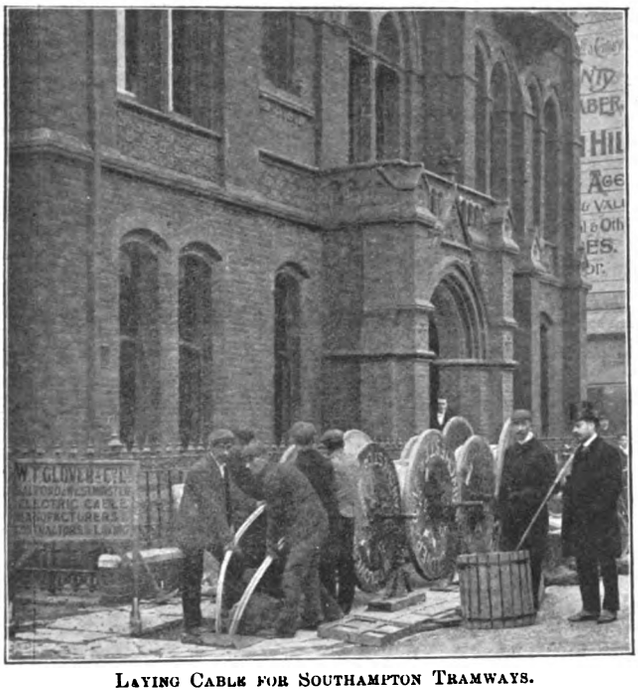
loads, but at Southampton the scheme has been—or rather is to be, for the loads are not yet combined—developed in a novel manner. No additional generating plant is to be provided, and all the existing plant is to be used either for the tramway or the ordinary supply mains; but a large battery of sufficient capacity to run the entire tramway system for a considerable time every day is to be provided, and forms an important part of the method of working. During the daylight hours it is intended to run pairs of the ordinary 230 volt lighting dynamos in series, in conjunction with a booster, on the tramway feeders, with the tramway battery across the 500 volt tramway circuit. Other machines, running at 230 volts, will take charge of the three-wire network for the ordinary supply. But when darkness comes on the demand for lighting current will be so large that all the dynamos in the station will be required for supply service alone, so that during the peak of the load the tramway system will be run entirely on the large Tudor battery, the erection of which is being rapidly pushed forward in the special three-storey battery house adjoining the power station. It will be a novel and striking experiment to run the entire tramways of a town so large as Southampton upon secondary cells alone, and the result will be awaited



Laying Cable for Southampton Tramways.

with something akin to impatience by all who are interested in the development of the secondary battery in connection with traction. Nor will the experiment of running 230 volt shunt machines in series, and boosting up to 500 volts for the tramway service, be without its special interest, for we know of no tramway on which this has been adopted as the permanent arrangement.

But, as we have already stated, this novel system is not yet in vogue, for the sufficient reason that the large battery upon which it hinges has not yet been erected. Accordingly, as the Tramways committee were in a desperate hurry to commence running their electric cars, temporary tramway generating plant had to be hastily erected in a corner of the machinery room. One of our illustrations shows this plant, which was supplied by the British Westinghouse Electric and Manufacturing Co. The plant consists of a 100 kw. Westinghouse continuous-current tramway generator, compound wound for 500 volts at 650 revs. per min., belted to a Westinghouse vertical steam engine. This set is taking the entire tramway load, and is running on a special temporary switchboard quite independent of the lighting plant switchboard and circuits.

Messrs. W. T. Glover and Co. have kindly supplied us with the following particulars of the cable work on these tramways: About 12,300 yards of feeder and 7,300 yards of telephone and pilot wire have been laid and connected to the feeder pillars. At present, as only the Shirley section is running, two of the feeders are used as returns pending the bonding of the rails between this section and the power station. The feeder cables and the pilot and telephone wires are diatrine-insulated and plain lead-covered, drawn into earthenware pipes and ducts. The feeders are single cables 0·3, 0·225, 0·1, and 0·079 in diameter, and the pilot and telephone four-core, three-core, and twin 7/22. From the works to the tramway junction, ¾ mile, two 0·3, one 0·225, and one 4/7/22 cables are laid in one duct; and from here there diverge to Shirley and Portswood a 0·3, 0·1, and 3/7/22 cable each way. The 0·1 stops at the first section pillar, and at the next section pillar the 0·3 cable changes to 0·1 for the remaining section of the line, thus stepping down from a sectional area of 0·4 sq. in. to 0·1. The 0·1 size is also used with 3/7/22 from the works to docks station, and 0·079 to the Bargate switch pillar. The contractors for the tramway plant are as follows:—

Overhead equipment	Macartney, McElroy and Co.
Cars	Geo. F. Milnes and Co.
Car equipment.....	Westinghouse Electric Co.
Cables	W. T. Glover and Co.
Temporary plant	Westinghouse Electric Co.
Storage battery	Tudor Accumulator Co.

We have mentioned that Messrs. Kincaid, Waller and Manville are the consulting engineers for this undertaking. The Corporation electrical engineer in charge of the power station and the electrical operation of the tramways is Mr. F. H. Chaplin, to whom we return our best thanks for his kind assistance in the preparation of this article.

LORD KELVIN'S ELECTRIC TRAMWAY RAIL TESTER.

In the overhead trolley system the track rails play an important electrical part, serving not only to convey the cars

but also to carry the return current. It is therefore of importance not only to give these rails and their joints a high conductivity at the outset, but also to test them from time to time in order to ascertain whether any defect has arisen.

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The accompanying illustration shows the mode of using an ingenious form of rail tester invented by Lord Kelvin. The illustration almost speaks for itself, and indicates how the instrument is to be employed. This rail tester has been specially designed for making conductivity tests of tram rails, detecting faulty bonds, &c. For making contact on the rails a graduated bar has attached to it two steel contacts. These contacts are provided with terminals, and are connected by means of a flexible wire to the terminals of a low-range voltmeter. To render the apparatus most convenient for this work, a light teak case with carrying straps is provided for the voltmeter. The lid of this when opened forms a desk, and on it is provided two paper clips to hold the test sheet. A convenient handle is also provided on the contact bar. The indications of the instrument show directly the resistance of the rail bond or section of rail. Various degrees of sensibility can be obtained by altering the position of the contacts on the contact bar. The apparatus is manufactured by Messrs. James White, of Cambridge-street, Glasgow.

BOOKS RECEIVED.

Copies of any of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price.)

"Mesures Electriques: Essais de Laboratoire." By E. Vigneron and P. Lethenle. (Paris: Gauthier-Villars.) 2fr. 50c.

"Science Abstracts." Vol. III., Part 2. Edited by W. L. Cooper. (London: E. and F. N. Spon.) 2s.

"Record of Transactions of the Institution of Junior Engineers." Vol. IX. 1898 99. Edited by W. T. Dunn. (London: published by the Institution.) 10s. 6d.

"The Consumer's Handbook of the Law Relating to Gas, Water and Electric Lighting." By Lawrence Duckworth. (London: Effingham Wilson.) 1s. 6d.

"Field Testing for Gold and Silver." By. W. Hamilton Merritt. (London: Crosby, Lockwood and Son.) 5s. net.

"Ferric and Heliographic Processes." By G. E. Brown. (London: Dawbarn and Ward.) 2s.

"The Official Gazette of the United States Patent Office." Nos. 8, 9, 10 and 11. Vol. XC. Published by authority of Congress. (Washington: Government Printing Office.)

ELECTRICITY WORKS ACCOUNTS.

The following is a list of electric railway and tramway works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

Blackpool & Fleetwood (Co.)	Feb. 17, 1899	Glasgow Corporation (Mun.)	Aug. 11, 1899
Brighton & Rottingdean Sea-shore (Co.)	April 7, ,,	Isle of Man (Co.)	May 27, 1898
Bristol Tram & Carriage (Co.)	Feb. 17, ,,	Leeds City (Mun.)	June 2, 1899
Br'mpt'n & Picc'dilly Cir. (Co.)	July 8, 1898	Liverpool Overhead (Co.)	Sept 8, ,,
City & South London (Co.)	Mar. 24, 1899	New General Traction (Co.)	May 27, 1898
Douglas Southern (Co.)	May 27, 1898	Waterloo & City (Co)	Feb. 17, 1899

Liverpool Overhead Railway.

The subject of our first table this week is the accounts of the Liverpool Overhead Railway Co. for the half-year ended Dec. 31 last. In order to facilitate comparison, the accounts of the last corresponding half-year are, as usual, represented in a parallel column.

It is quite clear from our figures that in almost every important respect excellent progress has been made. The traffic, at 402,752 train miles, exceeded that of the corresponding period in 1898 by nearly 8 per cent., while there is an increase of slightly over 6½ per cent. in the number of passengers carried. The growth of the traffic since this line was opened is shown in the following table.

Owing to the greater increase in the train mileage as compared with the passenger traffic, and also through a slight drop in the revenue derived per passenger carried, the total revenue per train mile has diminished, but not to the same relative extent as the expenditure. The working profit has thereby been more than maintained, and while a larger sum has been placed aside to the depreciation fund, it has been found possible to distribute an ordinary dividend at the rate of 5 per cent. per annum, besides meeting the calls on the 5 per cent. preference shares and leaving a balance of £4,592 carried forward.

All the chief items of cost have been reduced, excepting two under locomotive power—viz., "coal and coke" and "repairs and renewals," but in spite of the increased expenditure in these items, the aggregate costs per train mile have dropped about 1·2d.

Half-year ended	Passengers.	Train-mileage.	Per cent. dividend. Pref.	Ord.
Mar. 6 to June 30, 1893	1,370,742	...	...	...
Dec. 31, 1893	2,475,639	243,539	5	1
June 30, 1894	2,861,437	...	5	1
Dec. 31, 1894	3,641,379	314,472	5	2
June 30, 1895	3,460,060	311,346	5	2½
Dec. 31, 1895	3,780,375	321,417	5	2½
June 30, 1896	3,739,575	313,010	5	2¾
Dec. 31, 1896	3,919,134	320,993	5	3
June 30, 1897	4,269,260	363,399	5	3
Dec. 31, 1897	4,467,490	371,773	5	3½
June 30, 1898	4,472,941	362,690	5	3
Dec. 31, 1898	4,694,921	373,560	5	4
June 30, 1899	4,475,279	375,500	5	2½
Dec. 31, 1899	5,214,957	402,752	5	5

City and South London Railway.

It is somewhat unfortunate to find from the accounts of the City and South London Railway Co. that there has been a slight retrogression in the results of the working during the latter half of last year, as compared with the corresponding period in 1898. The proximate cause is, as our table shows, a material drop in the number of passengers carried, although the train mileage has increased. The following table will help to indicate more precisely the comparative position of the concern in the matter of traffic during the period:—

Half-year ended	No. of passengers. *	Train mileage.	Receipts †	Ratio of expenditure to total rev. Per cent.	Per cent. dividend. Pref.	Ord.
Dec. 31, '90 (11 days)	165,000	...	£1,568	...	5	...
June 30, 1891	2,412,343	...	19,403	79·0	5	...
Dec. 31, 1891	2,749,055	...	19,799	76·0	6	...
June 30, 1892	2,813,162	...	20,931	70·0	5	⅛
Dec. 31, 1892	3,117,602	...	22,003	67·9	5	⅛
June 30, 1893	3,146,656	...	22,458	64·6	5	¼
Dec. 31, 1893	3,093,351	...	22,068	64·6	5	⅛
June 30, 1894	3,383,154	...	23,565	61·7	5	1
Dec. 31, 1894	3,275,649	...	23,541	60·9	5	1¼
June 30, 1895	3,113,199	...	23,711	61·6	5	1⅛
Dec. 31, 1895	3,172,438	227,350	23,780	59·6	5	1¼
June 30, 1896	3,192,672	225,554	24,022	60·0	5	1⅛
Dec. 31, 1896	3,368,480	231,489	25,456	56·8	5	1¼
June 30, 1897	3,437,810	232,703	26,403	57·6	5	1⅜
Dec. 31, 1897	3,337,861	230,396	25,473	56·7	5	1¼
June 30, 1898	3,478,977	235,342	26,357	56·7	5	2
Dec. 31, 1898	3,462,814	234,166	26,320	56·2	5	1¾
June 30, 1899	3,540,098	235,300	26,749	56·4	5	2¼
Dec. 31, 1899	3,442,942	241,973	26,198	£8·1	5	2

* Exclusive of season ticket holders.

† From passenger traffic, inclusive of that from season tickets.

No doubt the falling off in the passenger traffic is mainly attributable to the severe competition brought about by the reduced fares in force on the paralleling tramways since they have been in the hands of the County Council.

The result of the diminution in the traffic has been that, although the total revenue per passenger has remained fairly constant at 1·9d., the revenue per train mile has dropped from 28·3d. to 26·3d.

The aggregate expenditure out of revenue has very slightly dropped, but the elements composing the total have fluctuated sensibly. The increased charges in respect of rents, rates and taxes, of fuel, of oil and stores, and of some repairs and renewals have been more than balanced by a diminution in the items of maintenance of way, wages, and repairs and renewals of cars.

The working profit shows a decline from £12,090, representing 0·9 per cent. of the mean capital, to £11,538, being 0·64 per cent. of the capital. After meeting interest charges to the extent of £1,215 there was thus, with the balance from 1898, a sum of £11,480 available for distribution, and a full dividend of 5 per cent. per annum was paid on the preference shares and one of 1½ per cent on the ordinary shares.

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	LIVERPOOL OVERHEAD RAILWAY.		CITY AND SOUTH LONDON RAILWAY.	
Worked by	The Liverpool Overhead Railway Co.		The City and South London Railway Co.	
Date of Commencement of Working	March 6, 1893.		December 20, 1890.	
System	Third-rail surface conductor at 600 volts.		Third-rail surface conductor at 500 volts.	
Chief Engineer	S. B. Cottrell.		P. V. McMahon.	
Half-year ended	December 31, 1898.	December 31, 1899.	December 31, 1898.	December 31, 1899.
QUANTITIES.				
Train mileage	*373,560*	*402,752*	*234,166*	*241,973*
Passengers Carried	4,894,921	5,214,967	3,462,814[a]	3,442,942
Length of railway authorised	7 ml. 5 ch.	7 ml. 5 ch.	6 ml. 64·5 ch.	6 ml. 64·5 ch.
Length of railway constructed	6 ml. 57 ch.	6 ml. 57 ch.	3 ml. 12 ch.	3 ml. 12 ch.
Length of Railway Worked	6 ml. 57 ch.	6 ml. 57 ch.	3 ml. 12 ch.	3 ml. 12 ch.
Length of railway under construction	nil	nil	3 ml. 52·5 ch.	3 ml. 52·5 ch.
Rolling stock, number of cars	7[a]	7[a]	54	84
„ number of locos.	44[a]	44[a]	20	28
CAPITAL.				
Authorised (Total)	£760,000	£826,500	£2,198,000	£2,198,000
Authorised (share)	570,000	620,000	1,680,000	1,680,000
Authorised (loan)	190,000	206,500	518,000	518,000
Received (Total)	740,000[b]	740,000[b]	1,347,283[b]	1,748,549
Received (share)	570,000	570,000	1,146,348	1,500,772
Received (loan)	170,000	170,000	187,701	244,315
	Total. / Per mile of working railway.	Total. / Per mile of working railway.	Total. / Per mile of working railway.	Total. / Per mile of working railway.
Expended (Total)	£748,152 / £111,400	£761,174 / £113,300	£1,428,208 / £453,200	£1,884,067[f] / £598,300
On line open for traffic	629,726 / 93,800	629,900 / 93,850	841,800 / 267,000	841,877 / 267,000
On line in course of construction	— / —	8,767 / 1,306	532,450 / 169,000	960,653 / 304,900
On working stock, including power station	118,426 / 17,640	122,507 / 18,150	53,958 / 17,120	74,992 / 23,790
Balance of Capital Account	- 3,681[c] / - 548·5	- 16,703[c] / - 2,589	- 80,925[c] / - 25,680	- 135,518[c] / - 43,030
Renewal Fund	12,400 / 1,848	14,700 / 2,190	— / —	— / —
Contingent Fund	700 / 104·2	900 / 134·0	— / —	— / —
REVENUE.	Total. / Per train mile.	Total. / Per train mile.	Total. / Per train mile.	Total. / Per train mile.
Total	£40,656 / 26·13d.	£42,662 / 25·86d.	£27,588 / 28·28d.	£27,506 / 26·30d.
Passenger traffic	40,072 / 25·73d.	42,011 / 25·04d.	26,320 / 26·96d.	26,198 / 26·00d.
Parcels, rents, transfer fees, &c.	584 / 0·375d.	651 / 0·388d.	1,268 / 1·300d.	1,308 / 1·299d.
EXPENDITURE.				
Total	£23,218 / 14·920d.	£23,007 / 13·710d.	£15,498 / 15·88d.	£15,968 / 15·84d.
Maintenance of way, works, & stations (less depreciation)	*3,327 / 2·137d.*	*2,168 / 1·293d.*	*810 / 0·830d.*	*676 / 0·671d.*
Maintenance of way	1,320 / 0·848d.	839 / 0·500d.	624 / 0·640d.	453 / 0·449d.
Repairs of structure, stations, &c.	2,007 / 1·290d.	1,329 / 0·793d.	186 / 0·191d.	223 / 0·221d.
Locomotive power	*6,085 / 3·910d.*	*6,996 / 4·168d.*	*5,518 / 5·650d.*	*5,899 / 5·850d.*
Coal and coke	1,093 / 0·702d.	1,419 / 0·846d.	1,530 / 1·568d.	1,675 / 1·661d.
Wages at power station	3,108 / 1·997d.	3,089 / 1·841d.	2,440[d] / 2·500d.	2,464 / 2·444d.
Oil and stores	744 / 0·478d.	712 / 0·424d.	336 / 0·334d.	432 / 0·429d.
Repairs and renewals	1,140 / 0·732d.	1,775 / 1·058d.	1,206 / 1·236d.	1,328 / 1·317d.
Repairs and renewals of cars	*822 / 0·528d.*	*446 / 0·266d.*	*554 / 0·568d.*	*488 / 0·484d.*
Traffic expenses	*8,672 / 5·570d.*	*9,071 / 5·408d.*	*6,018 / 6·165d.*	*6,138 / 6·088d.*
Salaries and wages	5,925 / 3·805d.	6,072 / 3·618d.	3,921 / 4·020d.	3,961 / 3·930d.
Other charges	2,747 / 1·765d.	2,999 / 1·788d.	2,097 / 2·149d.	2,177 / 2·160d.
General charges	*2,185 / 1·404d.*	*2,155 / 1·285d.*	*1,821 / 1·866d.*	*1,877 / 1·862d.*
Directors	350 / 0·225d.	350 / 0·209d.	650 / 0·666d.	650 / 0·645d.
Salaries of Secretary, General Manager, and Clerks	1,063 / 0·683d.	1,069 / 0·638d.	489 / 0·501d.	498 / 0·494d.
Other charges	772[e] / 0·496d.	736 / 0·439d.	682 / 0·699d.	729 / 0·723d.
Rents, rates, taxes, &c.	*1,767 / 1·135d.*	*2,010 / 1·198d.*	*724 / 0·742d.*	*835 / 0·828d.*
Miscellaneous items	*358 / 0·230d.*	*161 / 0·096d.*	*59[e] / 0·060d.*	*57[g] / 0·057d.*
FINANCIAL RESULTS.	Total. / Per cent. to mean capital expended.	Total. / Per cent. to mean capital expended.	Total. / Per cent. to mean capital expended.	Total. / Per cent. to mean capital expended.
Working Profit for Half-year	£17,438 / 2·336%	£19,655 / 2·585%	£12,090 / 0·893%	£11,538 / 0·643%
Sum carried to depreciation fund	1,500 / 0·201%	2,000 / 0·264%	— / —	— / —
Net interest on loans	3,216 / 0·431%	3,134 / 0·414%	2,905 / 0·215%	1,215 / 0·068%
Balance from last half-year's account	3,864 / 0·518%	4,320 / 0·571%	1,005 / 0·075%	1,108 / 0·062%
Balance Available for Dividend	16,586 / 2·222%	18,842 / 2·488%	10,191 / 0·755%	11,430 / 0·637%
Ordinary Dividend paid at per cent. per annum	4% / —	5% / —	2% / —	1½% / —
Percentage of total expenditure to revenue	57·1% / —	54% / —	56·2% / —	58·1% / —
Revenue per Mile of Working Railway	£6,060 / —	£6,359 / —	£8,760 / —	£8,730 / —
Expenditure per mile of working railway	£3,460 / —	£3,426 / —	£4,920 / —	£5,070 / —
Revenue per Passenger	1·994d. / —	1·933d. / —	1·914d. / —	1·918d. / —

LIVERPOOL OVERHEAD RAILWAY.—REMARKS—[a] Trailers. *a* Motor carriages. *b* Exclusive of £4,471 received as premium on issue of mortgage debentures. *c* Over-expended. *d* Including general interest £184 in last half-year of 1893. *e* Including auditing £53, contingent fund £100, insurance £252, and office and travelling expenses £263.

CITY AND SOUTH LONDON RAILWAY.—REMARKS—*a* Exclusive of season ticket holders. *b* Includes £13,234 from "premium account." *c* Over-expended. *d* Includes wages connected with working of locomotives. *e* Of which passenger duty is £53 and law £6. *f* Inclusive of £5,000 dividend to June 30, 1899, on £200,000 preference stock, and £1,545 interest on $7,500 ordinary shares at 3 per cent. per annum. *g* Includes passenger duty £53 and law £4.

Two Trolley Tramway Accounts.

The accounts of the two tramway undertakings which are summarised on the next page afford an interesting comparison, owing to the widely differing characteristics of the communities served.

It is important in making a comparison between the two concerns, to bear in mind that the Blackpool line was started nearly a year prior to the opening of the Oldham line. Further, the periods dealt with in the brief analyses we give are those which unduly favour the former tramway.

The Blackpool and Fleetwood accounts are for the half-year ended December 31st last, and therefore practically contain the seaside "season." The Oldham, Ashton, and Hyde accounts are for the period of about 6½ months from June 12, 1899—the date of the opening of the line—to December 31st last.

It is to be noticed that although on the Blackpool-Fleetwood line the number of passengers carried per car mile is only 3·72, as compared with 6·87 on the Oldham system, yet the total revenue per car mile on the former is considerably higher than that on the latter, the figures being respectively 15·7d. and 10·8d.

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The average revenue received per passenger at Blackpool—viz., 4·21d.—indicates the much higher tariff in force there during the period than at Oldham, where, it may be observed, the receipt per passenger is an average of 1·5d.

It is satisfactory to find that the Blackpool-Fleetwood line has succeeded in reducing its costs since 1898 by as much as 0·5d. per car mile. At its present figure it is, however, more than 1·5d. above the aggregate costs of the Oldham and Hyde road. The difference appears to some extent (but not chiefly) due to the larger repairs and maintenance item at the former line. Unfortunately, the particulars available relating to the Oldham tramway are too meagre to permit of separating the power from the running expenses.

As the result of its half-year's operations the Blackpool line paid an ordinary dividend of 10 per cent., absorbing £7,248. A total of £1,021 was also afforded for the writing off of Parliamentary and preliminary expenses, and there was left a balance carried forward of £1,759.

The Oldham and Hyde line paid a dividend of 5 per cent. per annum on the cumulative preference shares, and also met the amount paid by and due to the guarantors of these shares—viz., £2,552. In addition, £500 was placed to the depreciation fund and a balance of £618 was carried forward.

OLDHAM, ASHTON & HYDE ELECTRIC TRAMWAY.

Worked by	The Oldham, Ashton & Hyde Electric Tramway Co., Ld.
Date of Commencement of Working	June 12, 1899.
System	Overhead trolley at 550 vlt.
Tramway Manager	E. H. Mottram.
Engineer	J. A. Fraser.
Period	From June 12 to Dec. 31, '99.

Quantities.	
Car mileage	*293,884*
Passengers Carried	2,021,871
Length of route worked	8·14 miles
Length of single line worked	5·84 miles
Ditto double line worked	2·30 miles
Total equivalent length of single track worked	10·44 miles
Length of line projected	4·50 miles
Rolling stock—No. of motor cars	18[a]
Ditto trailers	12[a]

Capital.	Total.	Per unit of single track.
Authorised (Total)	£120,000	£11 500
Authorised (share)	80,000	7,660
Authorised (loan)	40,000[b]	3,830
Received (Total)	109,910	10,530
Received (share)	80,000	7,660
Received (loan)	29,900	2,860
Expended (Total)	£121,462	£11,630
Depôt and buildings	6,978	668
Elec. equipment and rolling stock	46,279	4,430
Permanent way	54,024	5,170
Balance of Capital Account	-1,462	-140
Reserve Fund	322[c]	30·8

Revenue.	Total.	Per car mile.
Total	£12,603	10·29d.
Traffic receipts	12,398	10·12d.
Advertisements	110	0·09d.
Miscellaneous sources	98	0·08d.
Expenditure.		
Total	£7,353	6·009d.
Repairs and maintenance	*464*	*0·379d.*
Power and running expenses	5,836	4·765d.
Administration and general expenses	1,058	0·864d.

Financial Results.	Total.	% to capital expended.[e]
Working Profit for Period	£5,248	4·32%
Sum carried to depreciation fund	500	0·41%
Net interest on loans	829[d]	0·68%
Balance available for distribution	3,919	3·23%
Ordinary dividend paid	nil	—
Percentage of total expenditure to rev.	58·3%	—
Revenue per mile of single track	£1,207	—
Ditto ditto route	1,548	—
Expenditure per mile of single track	704	—
Expenditure per mile of route	903	—
Revenue per passenger	1·5d.	—

OLDHAM, ASHTON & HYDE ELECTRIC TRAMWAY.—Remarks.—*a* Exclusive of 8 motor cars and 12 trailer cars lately added to the equipment. *b* Four per cent. first mortgage debentures. *c* Being premiums received. *d* Inclusive of interest on contract instalments. *e* To capital expenditure up to end of period.

THE BLACKPOOL AND FLEETWOOD TRAMROAD.

Worked by	The Blackpool and Fleetwood Tramroad Co.
Date of Commencement of Working	July, 1898.
System	Overhead trolley at 500 volts.
Tramway Manager	John Cameron.
Engineer	Joseph McMahon.

Half-year ended	December 31, 1898[a].	December 31, 1899.
Quantities.		
Car mileage	*173,997*	*311,913*
Passengers Carried	734,297	1,161,786
Length of single track worked	15·25 miles	15·25 miles
Length of route worked	7·75 miles	7·75 miles
Rolling stock, No. of motor cars	21	24
Ditto No. of trailers	3	3

Capital.	Total	Per mile of single track.	Total.	Per mile of single track.
Authorised (Total)	£240,000	£15,730	£240,000	£15,730
Authorised (share)	180,000	11,800	180,000	11,800
Authorised (loan)	60,000	3,930	60,000	3,930
Received (Total)	166,440	10,910	189,980	12,450
Received (share)	120,000	7,870	149,980	9,840
Received (loan)	46,440[b]	3,045	40,000	2,620
Capital Expended (Total)				
On permanent way, land, buildings, working stock, &c.	168,659	11,060	192,892	12,650
Balance of Capital Account	-2,219	-145	-2,912	-191

Revenue.	Total.	Per car mile.	Total.	Per car mile.
Total	£14,532	20·04d.	£20,400	15·70d.
Traffic receipts	14,476	19·96d.	20,297	15·62d.
Transfer fees and sundry receipts	56	0·077d	103	0·079d.
Expenditure.				
Total	£5,812	8·125d.	£9,840	7·579d.
Maintenance of way and works	*243*	*0·335d.*	*505*	*0·389d.*
Salaries, wages, &c.	—	—	413	0·318d.
Materials	—	—	91	0·070d.
Engine power	*1,505*	*2·076d.*	*1,977*	*1·521d.*
Coal	—	—	1,017	0·783d.
Salaries and wages	—	—	642[c]	0·494d.
Oil, tallow, waste, and water	—	—	200	0·154d.
Repairs and renewals	—	—	118	0·091d.
Repairs to cars and electrical repairs	*310*	*0·428d.*	*565*	*0·435d.*
Wages	—	—	90	0·069d.
Fittings and materials	—	—	475	0·365d.
Traffic expenses	*1,777*	*2·451d*	*3,078*	*2·369d.*
Salaries and wages	—	—	2,576	1·982d.
Printing and stationery	—	—	119	0·092d.
Other charges	—	—	383	0·295d.
General charges	*1,058*	*1·459d*	*1,739*	*1·339d.*
Directors' fees	—	—	800	0·616d.
Salaries of sec., manager, clerks, &c.	—	—	573	0·441d.
Other charges	—	—	366	0·282d.
Rent, rates, taxes, and insurance	*903*	*1·245d.*	*1,506*	*1·159d.*
Compensation	*96*	*0·132d.*	*471*	*0·362d.*

Financial Results.	Total.	% to capital exp'n'd.[d]	Total.	% to mean capital exp'nd'd.
Working Profit	£3,640	5·12%	£10,560	5·59%
Sum carried to depreciation fund	nil	—	nil	—
Net interest on loans	633	0·375%	924	0·490%
Balance from last half-year's account	—	—	332	0·208%
Balance available for dividend	8,006	4·74%	10,028	5·31%
Ord. div. paid at per cent per annum	8%	—	10%	—
Percentage of total expenditure to rev.	40·5	—	48·2%	—
Revenue per mile of single track	£953	—	£1,338	—
Expenditure per mile of single track	£386	—	£645	—
Revenue per mile of route	£1 875	—	£2,634	—
Expenditure per mile of route	£760	—	£1,270	—
Revenue per passenger	4·75d.	—	4·21d.	—

THE BLACKPOOL AND FLEETWOOD TRAMROAD.—Remarks.—*a* For 5½ months ended Dec. 31, 1898. *b* Inclusive of sundry loans, £6,440. *c* Includes wages under "running expenses," £520, and "salaries, office expenses, and general superintendence," £121. *d* At end of period.

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Editorial Publishing and Printing Offices,

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Telephone: 949 Holborn. *Telegrams:* "ELECTRICIAN NEWSPAPER LONDON."

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PROGRESS IN BRITISH ELECTRIC TRACTION.

We present to our readers this week, as a Supplement, a map of the United Kingdom exhibiting the position and character of all the electric railways and tramways in operation and under construction. This publication is intended to serve as an adjunct or pictorial key to the supplement sheet Table of Electric Railways and Tramways of the United Kingdom published with our issue of January 26th last, and, by the way, revised and brought up to a later date in *The Electrician* Electrical Trades' Directory and Handbook for 1900. For many years past it has been our custom annually to publish a similar map of the electric supply works of the United Kingdom, showing the position of statutory undertakings, and whether they are worked by local authorities or by private enterprise: also whether the supply is by continuous or alternating current. The high appreciation which has been expressed in all quarters with regard to this publication has shown us that it is not only welcomed by our readers as a useful key to our large sheet Table of Electricity Supply Works, but that it is also valued as affording, from year to year, a ready means of comparing at a glance the progress and changes which have taken place in the interval. A glance through an album containing this series of maps is sufficient to show how rapid has been the spread of electric supply throughout the kingdom, and to indicate in which localities the development has been most marked.

The time has now arrived, we believe, when the growth of statutory electric traction undertakings renders a similar presentment of these lines of equal value with the maps hitherto issued in connection with electric supply. The map we publish to-day shows to what a large extent even now electrical systems have been adopted for railway and street tramway traction. But we venture to think that this present map, fairly profusely dotted with electric lines as it shows itself to be, will afford in years to come an instructive comparison with later publications of a similar description. So clear, indeed, are the present indications of a widespread adoption of electric traction for tramways, light railways, and underground or elevated urban lines in the immediate future, that we feel safe in asserting that the contrast between our first supplement tramway map and a similar map published in five years' time would be as striking as a comparison between our first electric supply map—published in 1895—and the crowded map, overflowing into crowded inset maplets, which appeared with our issue of January 12th last.

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One is reminded by the map of the famous exclamation of the individual in *Punch*, when gazing at a map showing the British possessions: "It will all be red soon!"—for the preponderance of the red-indicated trolley system is one of the most striking features. But it is scarcely probable that the lines now worked on the third-rail system, indicated by blue dots, will to any considerable extent be converted to the trolley system, although we have to record that the Portrush-Giants' Causeway railway, in Ireland, has quite recently been thus converted. As this railway is the oldest existing electric line in the kingdom, its secession from the third-rail ranks is a notable event. Another point worthy of notice is the curious distribution of undertakings according to whether they are worked by companies or local authorities. Galaxies of each class are easily to be detected, though, as is often the case also with stellar galaxies, there is occasionally a physical connection that explains the peculiarity in the arrangement. There is a remarkable cluster of company undertakings in the region lying between Stourport, Wolverhampton, and Coventry. And while, on the one hand, municipalisation vigorously presents a square front in the Black Country, the Emerald Isle is free of its much-debated benefits.

A word as to the inset map of metropolitan underground electric railways, and we must pass on to consider another aspect of electric traction progress. The items in the main map indicate the position of each line, but do not show the route; it has, however, seemed to us advantageous to insert a small route map in the case of the important and growing group of underground electric railways in London. Two classes of lines are indicated—those in operation being shown red, the lines still under construction being shown blue. This, like the main map, is a feature likely to show great and rapid changes in the near future. We may add that the short length of "experimental line" on the "Underground" between Earl's Court and High-street, Kensington, is printed red because, although not actually in public service, it is completed and has been put in operation privately already. Its opening to the public may be expected to take place within a few days.

Turning from the map, we will now consider another development in British electric traction, as exemplified in the analyses we publish this week of the official accounts of four electrically-worked lines—viz., two trolley tramways and the third-rail lines at Liverpool and between London and Stockwell. Each of these four lines is representative of a distinct class, and it is necessary to bear this fact in mind when comparing the analyses. The Blackpool-Fleetwood line is a type of the popular seaside pleasure tramway; the Oldham-Hyde line represents a numerous class of street tramways with a miscellaneous traffic. And while the City and South London Railway business is mainly between a city and one of its suburban districts, the Liverpool Overhead Railway combines this class of business with a much larger all-day traffic between the numerous Mersey docks. With regard to the last two-named lines, analyses of the accounts of which we have published half-yearly for some time, progress is clearly marked in the smaller tables included in our comments, as well as by comparison with previous analyses. It must be borne in mind, in this connection, that the London line has recently involved heavy capital expenditure for extensions that have only just begun, in part, to bring in revenue. Competition has been experienced in both these undertakings to an increasing degree: at Liverpool on account of the rapid service afforded by the Corporation's electric tramways; on the South London line because of the lowering of fares on the County Council's tramways, the tramways in both places paralleling the railways. Nevertheless, when these conflicting conditions are taken into account, the analyses indicate unmistakably that each of these railways is representative of a type of line that can be made to pay well when worked electrically. As a natural consequence, we may look for a speedy increase in the number of lines in each class.

Similar inferences are justified by the analyses of the two trolley lines; and it can scarcely require that many more such accounts should be published and analysed before tramway men throughout the kingdom will be convinced of the superiority of the trolley system from the profit-making point of view. To an expert tramway financial man the analyses of the accounts, in the two examples given, speak for themselves, and can support only one conclusion—viz., that the trolley system is *par excellence* the system for tramways. It is the best remedy for the almost hopeless state of numerous existing British horse tramways, the dejected shareholders of which are most aptly symbolised by their jaded horses; and it is the only system of mechanical traction for tramways that combines in a satisfactory degree the requirements of the public, the passengers, and the capitalist, be he ratepayer or shareholder.

ELECTRIC TRACTION ON ITALIAN RAILWAYS.

The problem of electric traction on railway lines continues to be actively discussed in Italy, both in Parliament and in official circles, as well as by the chief railway companies. Since the completion of the electrical equipment on the Milan-Monza line, described in *The Electrician*, Vol. XLII., p. 869, which has always been successful in operation, many schemes have been projected, and some approved for the extension of the electric system on more important trunks. We report the most important results below:—

In Naples an agreement has been signed by the representatives of the provinces of Naples, Caserta, Avellino, and Benevento, and of 28 municipalities, having for its object the construction of an electric railway between Naples and Benevento, the length of which would be about 30 miles. The project is not yet completed. The municipality of Siena has decided upon the construction of an electric railway 15 miles long, between Monte-Amiata and Santa-Fiora, in connection with the trunk Rome-Viterbo line. This line will be operated by the railway company of Follonica, and its cost is estimated at three million lires. The Società delle Strade Ferrate del Mediterraneo has presented a scheme for the electric operation of the trunk Naples-Castellammare line (one of the first two steam railways operated in Italy): the line is double track and 22 miles in length. Power will at first be supplied by a steam power station, to be erected at Torre-Annunziata, near one end of the trunk line, and afterwards it is proposed to derive it wholly from the waterfalls of the river Tusciano, the steam station remaining as a reserve. The system proposed is that of the third rail at high pressure. The electric trains will be composed of one or two cars each, with the departure of an express train every two hours and an ordinary train every 40 minutes. The whole distance will be covered in 35 minutes by the former and in 60 minutes by the latter. The equipment costs are reckoned as follows: About 600,880 lires for the rolling stock (viz., eight complete motor cars); about 2,214,000 lires for the line and stations (not including 586,000 for the third rail). In accordance with this scheme, an application was placed by the railway company before the central committee asking for the concession of the water power of the river Tusciano in the province of Salerno. The committee has finally decided that a part of the available power of Tusciano may be reserved to the railways, provided the railway company engage to start within two years the works for their utilisation; that the remaining power of the

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same river, and of other rivers of the same valley, may be granted to private industry. The minister has fixed on 10,500 H.P. as the part to be reserved for the operation of the principal electric lines in the provinces of Naples and Salerno, under fulfilment of the said condition.

Before the Deputazione Provinciale of Lecce there has been presented a scheme for a light electric railway of 110 miles, from Lecce to Taranto, through Manduria, with branches from San Giorgio to Monopoli and from Monteroni to Nardò. As yet no decision has been announced.

At the same time that the Mediterranean Co. presented its scheme for the Naples-Castellammare line, the Adriatic Railway Co. (Società delle Ferrovie Meridionali, esercente la Rete Adriatica) asked the approval of the Government for a much larger scheme, involving the electric operation of the trunk lines in the Valtellina. These are the Lecco-Colico-Sondrio and Colico-Chiavenna lines, both being of international communication; and they aggregate a length of about 80 miles, and are now operated by steam. The scheme has been approved, and an agreement signed between the company and the minister. Works for the execution are already in progress, and it is believed that the inauguration will take place within next year. The company has obtained a concession for deriving 25 cubic metres per second at a waterfall of 30 metres fall from the river Adda, near the bridge of Desco. This stream will be brought by a tunnel of three miles length to Morbegno, ten miles from Colico, where 10,000 H.P. will be thus available. The power house will contain three reaction turbines of 2,000 H.P. each, directly coupled to three-phase alternators generating 2,000 kw. at 15,000 volts with a frequency of 15 periods per second. The turbines are regulated by motors, and the alternators have exciters mounted on the same shafts. The primary line at 15,000 volts follows the whole length of the railway, mounted on triple petticoat insulators. The conductors are mounted on the same poles as the working conductors, being separated only in those points where the railway enters a tunnel, on account of the difficulties of insulation. The secondary stations are six miles apart. The voltage on the working conductors is kept at 8,000 volts. The diameter of the conductor is 8mm. This is in excess of that required for the current carried, but is required for mechanical considerations. There are two types of motor cars: those for passenger service have four motors of 75 H.P. to 150 H.P. each, those for goods trains have four motors of 125 H.P. to 250 H.P. each. The arrangement of the motors is the same for all: only two motors are always inserted, and their primary coils work at 8,000 volts; the other two are inserted when it is necessary to run at half-speed and to obtain a much higher torque. With this equipment it is possible to reach a speed of 40 miles with the motor car alone on a grade of 25 per 1,000, and with a train of 65 tons on a grade of 10 per 1,000. It is proposed to keep in simultaneous service at first five passenger trains and two goods trains: this will require 2,500 average H.P. on trains, or 8,500 H.P. at the central station, supposing the efficiency to be 65 per cent. The remaining power will be sold for lighting and power distributions. It has been agreed that the plans of this important scheme will be exhibited at the Paris Exhibition, together with some of the electric cars.

The representatives of the Ministero dei Lavori Publici, of the Ministero del Tesoro, and of the Società delle Ferrovie Varesine have signed the act of concession for the Varese-Luino railway, which has a length of 18 miles, and the cost of which has been estimated at 685,000 lires. The Government will give a yearly subsidy, and the company has deposited a caution sum in order to guarantee that the works will be completed by June, 1901. The convention has been promulgated by Royal decree.

The Giovi tunnel between Genoa and Turin, on the Società delle Ferrovie Mediterranee line, has several times been the cause of misfortunes on account of its length, steep gradients, and difficult conditions of working, which make the removal of smoke difficult. This has led to a scheme for the adoption of electric traction between Mignanego and Ronco. It is reported that the following system has been preferred: In Sampierdarena the power station will be installed and driven by hydraulic power. The three-phase current will be led at high pressure up to the stations of Mignanego and Ronco, and there transformed into continuous current at 700 volts. The electric locomotives for passenger trains will have a power of 810 H.P. and those for goods trains about 544 H.P. each.

Schemes have recently been approved by the Italian Government for the construction and operation of an electric railway line between Castelraimondo and Camerino, and another between Rome and Ostia up to the seashore. The latter will afford a direct and rapid communication between Rome and the sea.

THE GILGIT TELEGRAPH LINE.

In our issue of June 25, 1897 (Vol. XXXIX., p. 288) we described a sad disaster in Kashmir, which happened to a party engaged on interruption duty on the telegraph line to Gilgit in January of that year; when five men were swept away and killed by an avalanche on the dreaded Burzil Pass, their bodies being afterwards found in the river bed half a mile below. This winter the duty of keeping open telegraphic communication in that dangerous locality has been attended by another sad accident involving the loss of eight lives—one European and seven natives.

The wire between Minimarg and Astor is carried over the Burzil Pass, 13,500ft., on which during the winter months snow lies to a great depth, and the crossing is a matter of difficulty and danger. This section of the telegraph between Grinagor and Gilgit was interrupted on December 31st last, and on January 1st a party started from Minimarg office to endeavour to effect the needful repairs. The party consisted of a European telegraphist named Scott, his native servant, a telegraph lineman, eight *khalassis* or porters, a native postman, and two postal coolies—all properly equipped and more or less accustomed to the prevailing conditions. Shortly after mid-day Scott attached his telegraph instrument and communicated with Minimarg. He was then two miles distant, progress being slow owing to great depth of snow. This was the last that was heard from him, and at five o'clock in the afternoon the lineman returned and reported the accident.

As the only European present was killed, it is not very easy to arrive at exactly what occurred; but it appears they were walking on some snow, which crumbled away from under them, and then more snow fell on them from above the track, burying them as they stood. There was no avalanche sweeping them away, as on the former occasion—merely a local snow-slip from just above them. The two postal coolies seemed to have lagged behind, and were a hundred yards or so away when the accident happened. They, with two postal runners who chanced to come up at the time, succeeded in extricating two *khalassis* and the native postman; but Mr. Scott, his native servant, and six *khalassis*—a total of eight—perished.

A search party started the following morning from Gurais, the next telegraph station to Minimarg, in the valley of that name, and succeeded in recovering the bodies, which were all near the surface just where they stood when overwhelmed.

The day after the disaster another lineman with the surviving *khalassis*, undeterred by what had happened, went out from Minimarg and succeeded in crossing the Burzil and restoring communication, which speaks well for the pluck and determination of the staff whose duty it is to maintain telegraphic communication in this out-of-the-way corner of the Empire.

The Dutiability of Electricity.—We learn that the Assistant Secretary to the Treasury Department of Washington, before whom was brought the petition of a number of persons in Buffalo as to the expediency of levying a tariff duty on electricity generated in Canada and transmitted to the United States, has decided not to recommend such a proposal. The decision of the former Assistant Secretary Tichener has thus been upheld, and as a consequence it is agreed that on electricity no tariff would or could be collected.

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A WORKSHOP FORM OF WHEATSTONE BRIDGE.

The ordinary form of Wheatstone bridge as made by most instrument makers has some disadvantages when used as a workshop instrument or for outdoor purposes. Instrument makers are much inclined to the use of lacquered brass and polished ebonite, and the ordinary form of Post Office bridge, consisting as it does of a slab of polished ebonite having a number of blocks of lacquered brass fixed upon its surface and a large number of nicely-fitted plugs, is hardly suitable for use by rough hands or in dirty places. Exposure to the light and dirt soon deteriorates the surface insulation of the ebonite, dust accumulates underneath the angles of the blocks and in the plug holes, and the numerous loose plugs get dirty and are

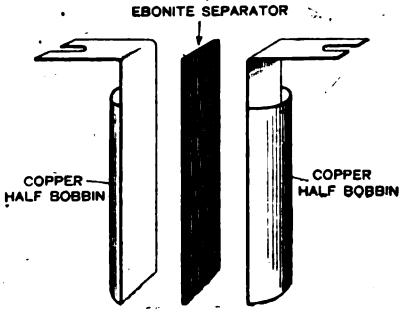

FIG. 1.—Construction of the Resistance Bobbins.

sometimes lost. In the series plug pattern there is always a risk of the plugs becoming jammed in their places, and the heads therefore twisted off in the process of extricating them.

A form of Wheatstone bridge has been devised by Dr. J. A. Fleming which has some novelty in design for use as a workshop instrument. The coils and electrical portions are all contained in a stout teak box 20in. by 8in. by 5in., provided with recessed box handles. The top and the bottom of the box are not screwed on, but recessed and held in place by turn-button bolts, so that by simply turning four buttons the top of the box can be at once removed, carrying with it the whole of the bridge mechanism. In the case of the ordinary patterns of Wheatstone bridge the opening of the box to repair a damage involves procuring a screwdriver and taking out about a dozen little screws.

In Dr. Fleming's pattern of bridge there is no exposed ebonite or metal work except three pairs of terminals. The resistance coils, which are arranged on the dial pattern, are formed as follows:—

Two hollow half-cylinders of thin sheet copper (Fig. 1) are constructed, each having a lug, and two of these half-cylinders are put together with a thin separating piece of ebonite and bound together with a thin silk tape. This constitutes the bobbin. The resistance wires of manganin are then cut the proper length, and the two ends of the wire are soldered to the two lugs of the copper half-cylinders (Fig. 2), the remainder of the wire being wound non-inductively on the bobbin and tied in position by a thin silk tape. The wire is therefore so arranged that it quickly gets rid of any heat, and no paraffin wax is used to overlay the wire or coils.

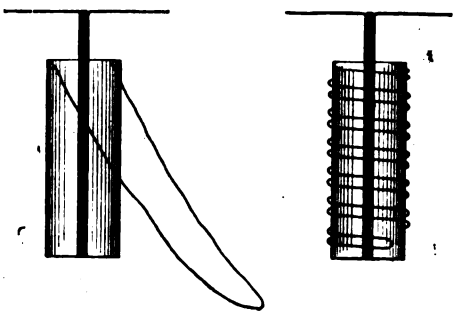

FIG. 2.—Method of Winding.

The measuring arm of the bridge consists of three sets of coils—units, tens, and hundreds—each set consisting of nine coils interposed between 10 brass blocks, which are arranged in a circle and carried in a sort of ebonite tray fixed on the underneath side of the teak lid of the box. These blocks are

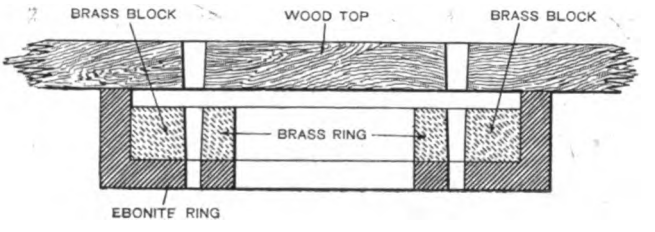

FIG. 4.—Section of Dial.

interconnected as required with a central brass ring by means of a travelling plug. A diagram of the bridge is given in Fig. 3, and a section of the dials in Fig. 4. The plugs resemble bradawls, except in their lower extremities, and have a substantial handle; they are kept when not required

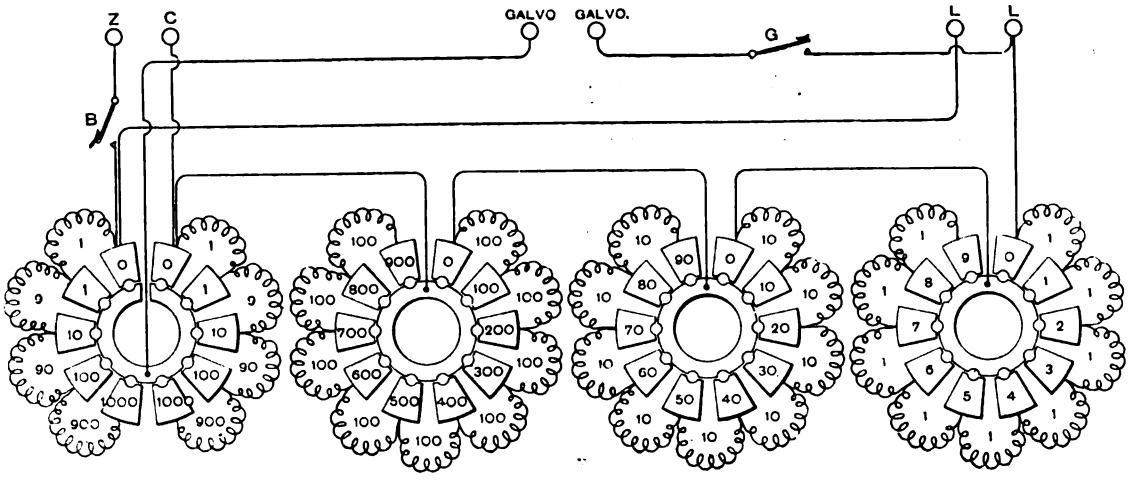

FIG. 3.—Diagram of Bridge.

in a sort of umbrella stand attached to the box, seen in the general view of the instrument, Fig. 5. These plugs are inserted into interconnecting holes between the brass blocks, and the common ring through small holes bored into the lid of the box. Hence the outer surface of the box exhibits only sets of small holes arranged in circles and which are marked respectively units, tens, hundreds.

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In order to prevent dust getting into the holes between the brass blocks, there is an ingenious contrivance in the form of a self-closing shutter. On the underneath side of the lid there are a series of circular discs of thin ebonite, which are perforated by holes corresponding with the holes for the plugs in the lid of the box. These circular shields move round a central pivot, and by means of a spring are kept so turned that the holes in the shield do not normally coincide with the holes in the box lid. Hence all these box lid holes are closed as it were by a small shutter, but when once opened and a plug inserted in the hole the plug prevents the shutter from closing. The circular shutters can be turned round by means of a common bar and finger pin protruding through the lid, so that, in order to insert the first plug when commencing his test, the user presses back the pin and thereby opens all the shutters. But the moment all the plugs are withdrawn from their hole, the shutter under the lid springs back and closes all the holes belonging to that dial.

The ratio arm of the bridge is formed of a series of coils which are arranged dial fashion, and which are therefore not 1, 10, 100, 1,000 ohms as usual, but 1, 9, 90, 900. Two plugs are therefore provided for the ratio arm dials, and the ratio arm dial is furthermore marked in such a manner that the user has no difficulty in discovering the number by which he must multiply and the number by which he must divide the ratio arm resistance to get the resistance of the circuit

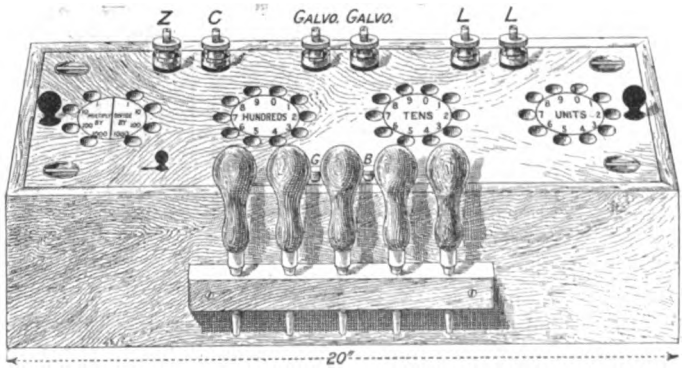

FIG. 5.—General View of the Bridge.

measured. The shutter closing the holes of the ratio dial is independent of the others, and is not provided with a finger pin for opening. The spring which keeps the shutter of this dial normally closed is not very strong, and the shutter is easily pushed back by the point of the first plug as it is inserted.

The whole of the connections are made under the lid to three pairs of terminals, marked on the outside as in Fig. 5, and in addition two keys are fixed under the lid, which are manipulated by two little ivory buttons, like electric bell pushes, protruding through the lid. There is therefore absolutely no exposed ebonite to deteriorate in insulation, and no lacquered brass, with the exception of the aforesaid six terminals, the handles by which the bridge is carried about, and the plugs. The terminals are constructed with a peculiar kind of lip, which renders it easy to grip in them either a single large wire like a No. 10 wire or a single small wire like a No. 40.

One other point is worthy of notice. In the ordinary patterns of plug bridges the frequent use of the plugs wears them down into a shoulder, so that they no longer fit tightly into the plug holes. In Dr. Fleming's form of bridge the plug has a semi-circular groove turned in it at such a height in the plug that when in place the top of the block is just on a level with the middle of the groove. This device is an effective cure for "shouldering" in the plugs.

It may be mentioned that this pattern of bridge is being constructed for sale by the Telegraph Manufacturing Co. of Helsby.

STORAGE BATTERY PROBLEMS.*

BY E. J. WADE.

(*Continued from page 781*).

PART II.

In the first part of this Paper I have said that the utility of the lead—sulphuric acid—lead peroxide combination appears to be due to the insolubility of the active material of both electrodes under all normal conditions of treatment. This is not, however, the whole matter, for essential as the insolubility of the compounds may be to success, it would probably be insufficient were it not in conjunction with certain properties which are inherent in lead and its compounds and form one of their most marked chemical characteristics.

Lead, like all the metallic elements, unites with other elements and radicles to form normal compounds and salts of a perfectly definite composition, such as the monoxide, peroxide, sulphate, and so forth. It also enters with greater ease than most of the metals into more complex combinations to produce "basic salts" (sometimes termed "sub-salts"), in which it is partly combined with O or HO, as an oxide or hydrate, and partly with some other element or radicle. Usually it is capable of producing not merely one but a whole series of basic salts with each radicle, of which the basic chlorides, nitrates, and acetates are well-known examples. In addition to this, it is almost unique amongst the metals in the facility with which it combines with two or more different radicles, other than O or HO, and gives rise to curious compound salts, such as—

"Lanarkite," $Pb_2\begin{cases}SO_4\\CO_3\end{cases}$ "Leadhillite," $Pb_4\begin{cases}SO_4\\(CO_3)_3\end{cases}$

"Phosgenite," $Pb_2\begin{cases}Cl_2\\CO_3\end{cases}$ Lead Chlorosulphide, $Pb_2\begin{cases}Cl_2\\S\end{cases}$

But besides all its normal, basic, and poly-acid salts and compounds, lead will, under suitable conditions, form others which cannot accurately be represented by any formula at all. The two most important commercial preparations of lead—namely, white lead and red lead or minium, both furnish well-marked examples of this behaviour. The first of these is a basic lead carbonate, whose average composition when prepared by the old "Dutch" process is generally represented by the formula $2PbCO_3, Pb(HO)_2$, or $Pb_3(CO_3)_2(HO)_2$; but this is purely an approximation, as the relative proportions of carbonate and hydrate are found to vary very appreciably in different samples, even if produced under practically identical conditions. By other processes, especially precipitation methods, any number of basic carbonates of indefinite composition may be obtained, in which the proportions of CO_3 and HO vary over a much wider range, and show very little preference for uniting in any simple ratio such as is expressed by the formula just given. Minium also has no fixed or definite chemical composition. Under the action of reagents it behaves as if it were composed of lead monoxide and lead peroxide, and the formula $2PbO, PbO_2$, or Pb_3O_4, most nearly represents its average composition; but samples fully possessed of the fine scarlet colour, its distinctive physical property, have been found to approximate more closely to Pb_6O_7, Pb_4O_5, Pb_2O_3, or to some other degree of oxidisation between these simpler ratios.

Now, Mendelejeff has ascribed some of the peculiarities of lead and its compounds (as also of boron, silicon, and other inorganic elements) to their "polymerisation." That is to say, he assumes that the molecule of lead may sometimes consist of a large but undetermined number of atoms, Pb_x; while, in the same way, the molecule of lead monoxide is not necessarily composed of one atom of lead and one of oxygen, PbO, but of many multiples of these quantities, Pb_xO_x: so also lead peroxide may be Pb_xO_{2x}, and so on. The assumption does not of course affect the percentage composition of the lead compounds as ascertained by analysis, but only their molecular weights, and these cannot be directly determined. This theory is partly based upon and affords a simple explanation of the readiness of lead to form the basic and polyacid salts just referred to. Some of the atoms of lead in the complex molecule combine with one radicle and some with another; and if, purely for the purposes of illustration, we suppose that there are 12 atoms of lead present, or that the molecule of lead monoxide from which they are derived has a composition $Pb_{12}O_{12}$, some of them may be expressed in the following formulæ:—

Basic hydrates—$Pb_{12}\begin{cases}O_4\\(OH)_8\end{cases}$ $Pb_{12}\begin{cases}O_6\\(OH)_{12}\end{cases}$

Basic chlorides—$Pb_{12}\begin{cases}O_6\\Cl_{12}\end{cases}$ $Pb_{12}\begin{cases}O_8\\Cl_8\end{cases}$ $Pb_{12}\begin{cases}O_6\\(OH)_6\\Cl_6\end{cases}$

Basic carbonates—$Pb_{12}\begin{cases}(CO_3)_6\\(OH)_{12}\end{cases}$ $Pb_{12}\begin{cases}(CO_3)_8\\(OH)_8\end{cases}$

Sulpho-carbonates—$Pb_{12}\begin{cases}(SO_4)_6\\(CO_3)_6\end{cases}$ $Pb_{12}\begin{cases}(SO_4)_3\\(CO_3)_9\end{cases}$

But the theory also equally well explains the real nature of the lead compounds of variable and indefinite composition. Their behaviour

* Paper read before the Institution of Electrical Engineers, March 22.

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has always seemed somewhat puzzling, and they were generally regarded as not being chemical compounds at all; merely intimate mixtures of other and simpler compounds. Thus, white lead was a mixture in varying proportions either of normal lead carbonate and lead hydrate, or of some definite basic carbonate with an excess of normal carbonate:—

$$2PbCO_3 + Pb(HO)_2 = Pb_2(CO_3)(HO)_2 + PbCO_3.$$

Red lead was a mixture of lead monoxide with lead peroxide, or possibly of lead sesquioxide with an excess of monoxide:—

$$Pb_3O_4 = 2PbO + PbO_2 = Pb_2O_3 + PbO.$$

It will be evident, however, that we have only to assume a sufficiently complex molecular structure, and any number of true compounds between lead and a given set of radicles become theoretically possible: compounds of such closely allied composition that their physical and chemical properties grade imperceptibly from each one to the next, and so defy isolation. No doubt in many instances the whole series of compounds will be so unstable and so easily resolved into their proximate components that chemically they do appear to be nothing more than mixtures of them. In other cases only the combinations in simple ratios may possess much stability; but in every case the latter will probably be somewhat more stable and more readily formed than the remainder, which need suitable conditions for their production.

The manufacture of red lead furnishes a good example of the application of the theory, and a suggestive instance of the way in which a series of compounds is brought about and of the relationship of its various terms to each other. The further oxidation of litharge by roasting at a temperature not so high as that required for its own formation does not appear to consist in the conversion of successive molecules of PbO direct to Pb_3O_4, or some other definite oxide, but in the gradual absorption of oxygen by each molecule, which takes it up, atom by atom, and passes through a whole series of oxides of gradually increasing richness, the action proceeding more or less simultaneously and uniformly at all parts of the mass, according to the relative adequacy of the air supply. Again, supposing the constitution of the monoxide to be $Pb_{12}O_{12}$, the series of compounds obtained may be represented as follows; but fully to account for the observed facts, its molecular composition would have to be far more complex, so as to provide numerous other oxides between each of the terms shown:—

$Pb_{12}O_{12}$	$12PbO$	PbO
$Pb_{12}O_{13}$	$11PbO + PbO_2$	—
$Pb_{12}O_{14}$	$10PbO + 2PbO_2$	Pb_6O_7
$Pb_{12}O_{15}$	$9PbO + 3PbO_2$	Pb_4O_5
$Pb_{12}O_{16}$	$8PbO + 4PbO_2$	Pb_3O_4
$Pb_{12}O_{17}$	$7PbO + 5PbO_2$	—
$Pb_{12}O_{18}$	$6PbO + 6PbO_2$	Pb_2O_3

The first column gives the assumed molecular composition of the oxides, the second expresses it in terms of separate molecules of monoxide and peroxide as they would appear under analysis, and the third merely shows the simplest proportional composition. Most commercial minium comes somewhere between Pb_4O_5 and Pb_3O_4, prolonged roasting generally being required to bring it quite up to the latter proportions; but as samples are occasionally found to be still further oxidised, the series is extended to the sesquioxide, Pb_2O_3. Here or hereabouts the extreme limit to which the oxidation can be pushed by roasting is reached, because the temperature necessary to carry it to this stage is nearly as high as that at which the deoxidation of the sesquioxide by heating commences. The two opposing tendencies balance each other, and the absorption of oxygen then comes to an end.

I now propose to make use of this "polymerisation" theory in dealing with the various phenomena observed in lead cells, for it enables us to reconcile their physical and chemical aspects, and to give a more consistent and satisfactory account of the changes taking place than can otherwise be done; and it is with a view to making the application of the theory as clear as possible that I have felt it advisable to set out the foregoing considerations regarding the lead compounds in general and minium in particular at such length. In the first place, I assume that the fully formed active materials, electrolytically prepared at both electrodes, are not Pb and PbO_2, but Pb_x and Pb_xO_{2x}; that is, they are allotropic or polymeric modifications, or they have a complex molecular structure—whichever term or phrase we please. On closing the external circuit, the molecules of lead at the negative begin to combine with SO_4 from the electrolyte; not, however, breaking up into independent molecules of normal lead sulphate, $PbSO_4$, round a nucleus of uncombined metal, but the molecules as a whole taking part in the combination, and, as the discharge proceeds, passing through a continually changing series of sub-sulphates, without any rupture of their molecular complexity. At the positive the reactions, though different, take place in an exactly similar manner. Oxygen is gradually abstracted and SO_4 substituted in its place, a sequence of compounds of sulphate and peroxide being produced. Still keeping to our imaginary twelve atoms of lead to the molecule, these two series of compounds may be represented as follows:—

Pb_{12}	$Pb_{12}(O_2)_{12}$
$Pb_{12}(SO_4)$	$Pb_{12}(O_2)_{11}(SO_4)$
$Pb_{12}(SO_4)_2$	$Pb_{12}(O_2)_{10}(SO_4)_2$
$Pb_{12}(SO_4)_3$	$Pb_{12}(O_2)_9(SO_4)_3$
$Pb_{12}(SO_4)_4$	$Pb_{12}(O_2)_8(SO_4)_4$
$Pb_{12}(SO_4)_5$	$Pb_{12}(O_2)_7(SO_4)_5$
$Pb_{12}(SO_4)_6$	$Pb_{12}(O_2)_6(SO_4)_6$

But neither of these series is continued until the active material is fully sulphated and the compound $Pb_{12}(SO_4)_{12}$ reached. Just as the oxidation of litharge by roasting is necessarily arrested at some stage before it is fully converted into peroxide, so here a limit is presently attained; and a little consideration will show that some such limit is not merely probable but inevitable, and that a direct cause, partly physical, partly chemical, can be assigned for it. We know that both lead and lead peroxide possess a very considerable electrical conductivity, but that, on the other hand, pure lead sulphate is practically a non-conductor. Both the negative and positive active materials must therefore undergo a great change of resistance in the course of their sulphation—a change either spread more or less uniformly over the whole discharge, or else occurring abruptly at some special stage. The latter appears to be what really happens, for although our information regarding the changes of resistance in lead cells is extremely vague and meagre, we know that there is not much variation throughout the main portion of the discharge, but that the resistance begins to rise considerably towards the end. The exact point of change is immaterial to the present argument, but I believe that when the active materials approach a proportional composition Pb_2SO_4 and $Pb_2O_2SO_4$ respectively, the rate of increase of their resistance experiences a rapid acceleration, and their resistance itself goes up enormously. The fact of importance is that wherever and whenever such a change of resistance takes place, it must necessarily terminate the discharge and bring about all the phenomena which do occur.

Just as fast as the resistance of the active materials, and therefore the internal resistance of the cell, rises, the potential difference at its terminals will fall away; and by the time the internal resistance has become very large in proportion to that of the external circuit, the potential difference will be reduced practically to zero. Or, to put it another way, just as fast as the resistance of the active materials rises, more and more of the electrical energy they would otherwise liberate is expended, so to speak, in their own molecules, until, when the rest of the resistances in circuit become relatively negligible, equilibrium is nearly established and the liberation of energy almost ceases. This is why it is impossible to push the discharge of a cell further even by short-circuiting it; and yet on breaking the circuit—*i.e.*, increasing the external resistance to infinity—the E.M.F. rapidly rises to nearly its original value, thereby showing that the chemical affinities are neither exhausted nor saturated.

The aggregate results of the chemical changes at each electrode during a complete discharge are expressed in their simplest terms in the following equations—

At the negative—

$$\left\{\begin{matrix}Pb\\Pb\end{matrix}\right\} + SO_4 = \left\{\begin{matrix}PbSO_4\\Pb\end{matrix}\right\}.$$

At the positive—

$$\left\{\begin{matrix}PbO_2\\PbO_2\end{matrix}\right\} + H_2 + H_2SO_4 = \left\{\begin{matrix}PbO_2\\PbSO_4\end{matrix}\right\} + 2H_2O.$$

But augment the E.M.F. of the discharged cell ever so slightly from an outside source, and the point of equilibrium is passed; the active materials begin to absorb energy instead of liberating it, and incipient reversal commences. In fact, in primary battery language, the cell has polarised; but unlike other cells, at both electrodes. (I am here assuming that the negative and positive electrodes contain equivalent amounts of active material, and both discharge under such equal conditions as regards maintenance of acid supply at their pores, &c., that they polarise or reverse at the same time.) If the applied E.M.F. is sufficient to maintain a current through the cell, a kind of double reaction now goes on at both electrodes. At the negative the lead still continues to sulphate, but at the same time the sulphate already there begins to peroxidise: at the positive the peroxide still undergoes reduction to sulphate, but at the same time the sulphate already there further reduces to lead. Although the preceding statement probably gives a better idea of the real nature of the changes taking place, we may also put it more simply and say, as regards the net results only, that on the one side lead is directly peroxidised, and on the other side peroxide is directly reduced to metal, the proportion of sulphate in both cases remaining constant throughout. These reactions will continue until all the lead is peroxidised and all the peroxide reduced; and the two series of compounds through which the active materials may be supposed to pass are given below, commencing with the two last terms of the previous series,

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which represented their composition at the end of a complete discharge :—

$Pb_{12}(SO_4)_6$	$Pb_{12}(O_2)_6(SO_4)_6$
$Pb_{12}(O_2)(SO_4)_6$	$Pb_{12}(O_2)_5(SO_4)_6$
$Pb_{12}(O_2)_2(SO_4)_6$	$Pb_{12}(O_2)_4(SO_4)_6$
$Pb_{12}(O_2)_3(SO_4)_6$	$Pb_{12}(O_2)_3(SO_4)_6$
$Pb_{12}(O_2)_4(SO_4)_6$	$Pb_{12}(O_2)_2(SO_4)_6$
$Pb_{12}(O_2)_5(SO_4)_6$	$Pb_{12}(O_2)_2(SO_4)_6$
$Pb_{12}(O_2)_6(SO_4)_6$	$Pb_{12}(SO_4)_6$

In this way the composition of the two active materials is exactly transposed without the proportions of sulphate present being further increased. At the same time their molecular structure is maintained throughout the reversal, so that, although the internal resistance is far higher than at any period during the discharge or recharge, the conductivity of the active materials is never really interrupted. The following equations give the sum of the reactions during a complete reversal in their simplest terms :—

At the negative—

$$\left\{\begin{matrix}PbSO_4\\Pb\end{matrix}\right\} + \begin{matrix}SO_4\\SO_4\end{matrix} + 2H_2O = \left\{\begin{matrix}PbO_2\\PbSO_4\end{matrix}\right\} + 2H_2OS_4$$

At the positive—

$$\left\{\begin{matrix}PbO_2\\PbSO_4\end{matrix}\right\} + \begin{matrix}H_2\\H_2\end{matrix} + H_2SO_4 = \left\{\begin{matrix}Pb\\PbSO_4\end{matrix}\right\} + \begin{matrix}2H_2O\\H_2SO_4\end{matrix}$$

The symbols are arranged in double lines, to indicate the probable dual nature of the reactions to which I have just referred.

	−	+	
DISCHARGE	Pb	Pb_{12}	$Pb_{12}(O_2)_{12}$	PbO_2
		$\left\{\begin{matrix}PbSO_4\\Pb_{11}\end{matrix}\right\}$	$\left\{\begin{matrix}PbSO_4\\Pb_{11}(O_2)_{11}\end{matrix}\right\}$	
		$\left\{\begin{matrix}Pb_2(SO_4)_2\\Pb_{10}\end{matrix}\right\}$	$\left\{\begin{matrix}Pb_2(SO_4)_2\\Pb_{10}(O_2)_{10}\end{matrix}\right\}$	
	$PbSO_4$ 3Pb	$\left\{\begin{matrix}Pb_3(SO_4)_3\\Pb_9\end{matrix}\right\}$	$\left\{\begin{matrix}Pb_3(SO_4)_3\\Pb_9(O_2)_9\end{matrix}\right\}$	$PbSO_4$ $3PbO_2$
		$\left\{\begin{matrix}Pb_4(SO_4)_4\\Pb_8\end{matrix}\right\}$	$\left\{\begin{matrix}Pb_4(SO_4)_4\\Pb_8(O_2)_8\end{matrix}\right\}$	
		$\left\{\begin{matrix}Pb_5(SO_4)_5\\Pb_7\end{matrix}\right\}$	$\left\{\begin{matrix}Pb_5(SO_4)_5\\Pb_7(O_2)_7\end{matrix}\right\}$	
	$PbSO_4$ Pb	$\left\{\begin{matrix}Pb_6(SO_4)_6\\Pb_6\end{matrix}\right\}$	$\left\{\begin{matrix}Pb_6(SO_4)_6\\Pb_6(O_2)_6\end{matrix}\right\}$	$PbSO_4$ PbO_2
REVERSAL		$\left\{\begin{matrix}PbO_2\\Pb_6(SO_4)_6\\Pb_5\end{matrix}\right\}$	$\left\{\begin{matrix}Pb\\Pb_6(SO_4)_6\\Pb_5(O_2)_5\end{matrix}\right\}$	
		$\left\{\begin{matrix}Pb_2(O_2)_2\\Pb_6(SO_4)_6\\Pb_4\end{matrix}\right\}$	$\left\{\begin{matrix}Pb_2\\Pb_6(SO_4)_6\\Pb_4(O_2)_4\end{matrix}\right\}$	
	PbO_2 $2PbSO_4$ Pb	$\left\{\begin{matrix}Pb_3(O_2)_3\\Pb_6(SO_4)_6\\Pb_3\end{matrix}\right\}$	$\left\{\begin{matrix}Pb_3\\Pb_6(SO_4)_6\\Pb_3(O_2)_3\end{matrix}\right\}$	Pb $2PbSO_4$ PbO_2
		$\left\{\begin{matrix}Pb_4(O_2)_4\\Pb_6(SO_4)_6\\Pb_2\end{matrix}\right\}$	$\left\{\begin{matrix}Pb_4\\Pb_6(SO_4)_6\\Pb_2(O_2)_2\end{matrix}\right\}$	
		$\left\{\begin{matrix}Pb_5(O_2)_5\\Pb_6(SO_4)_6\\Pb\end{matrix}\right\}$	$\left\{\begin{matrix}Pb_5\\Pb_6(SO_4)_6\\PbO_2\end{matrix}\right\}$	
	PbO_2 $PbSO_4$	$\left\{\begin{matrix}Pb_6(O_2)_6\\Pb_6(SO_4)_6\end{matrix}\right\}$	$\left\{\begin{matrix}Pb_6\\Pb_6(SO_4)_6\end{matrix}\right\}$	Pb $PbSO_4$
		$\left\{\begin{matrix}Pb_7(O_2)_7\\Pb_5(SO_4)_5\end{matrix}\right\}$	$\left\{\begin{matrix}Pb_7\\Pb_5(SO_4)_5\end{matrix}\right\}$	
		$\left\{\begin{matrix}Pb_8(O_2)_8\\Pb_4(SO_4)_4\end{matrix}\right\}$	$\left\{\begin{matrix}Pb_8\\Pb_4(SO_4)_4\end{matrix}\right\}$	
	PbO_2 $3PbSO_4$	$\left\{\begin{matrix}Pb_9(O_2)_9\\Pb_3(SO_4)_3\end{matrix}\right\}$	$\left\{\begin{matrix}Pb_9\\Pb_3(SO_4)_3\end{matrix}\right\}$	3Pb $PbSO_4$
		$\left\{\begin{matrix}Pb_{10}(O_2)_{10}\\Pb_2(SO_4)_2\end{matrix}\right\}$	$\left\{\begin{matrix}Pb_{10}\\Pb_2(SO_4)_2\end{matrix}\right\}$	
		$\left\{\begin{matrix}Pb_{11}(O_2)_{11}\\PbSO_4\end{matrix}\right\}$	$\left\{\begin{matrix}Pb_{11}\\PbSO_4\end{matrix}\right\}$	
RECHARGE	PbO_2	$Pb_{12}(O_2)_{12}$	Pb_{12}	Pb
		+	−	

As soon as all the lead has been oxidised at the one electrode and all the peroxide reduced at the other, the reversal is finished, and the back E.M.F. of the cell rises rapidly; but as at the same time the proportion of sulphate begins to diminish in both active materials, their internal resistance falls with equal suddenness, and the end of the reversal is consequently not marked by so much increase in the potential difference required to maintain the flow of current as might be expected.

The next stage is equivalent to the recharge of a cell which ordinarily follows on a discharge, except that the direction of the current and the composition of the two active materials are reversed; but in either case the reactions are exactly the same, and consist in the gradual abstraction of sulphate from both active materials until they are finally brought back to lead and lead peroxide, just as they existed at the commencement of the discharge.

The series of compounds through which this is effected will be similar to those of discharge, but now occurring in the converse order, and they are shown as the last stage of the two series given below. These represent the whole of the changes experienced by the active materials during their passage through a complete cycle consisting of discharge, reversal, and recharge; or, by passing from the one series to the other along the diagonal lines connecting similar terms in the two series, the more usual cycle of discharge and recharge only.

The hypothetical molecules containing 12 atoms of lead are still presumed, and the terms in the first two stages—discharge and reversal—are of course the same as those already given, but with the chemical symbols now arranged slightly differently. The formulæ on the other side show the simplest proportional composition of the active materials, as they would appear under analysis, at some of the intermediate points. The total effects of the recharge, expressed im their simplest terms, are as follows :—

At the negative—

$$\left\{\begin{matrix}PbSO_4\\Pb\end{matrix}\right\} + H_2 = \left\{\begin{matrix}Pb\\Pb\end{matrix}\right\} + H_2SO_4.$$

At the positive—

$$\left\{\begin{matrix}PbSO_4\\PbO_2\end{matrix}\right\} + SO_4 + 2H_2O = \left\{\begin{matrix}PbO_2\\PbO_2\end{matrix}\right\} + 2H_2SO_4.$$

To make the account of the charging reactions complete, it would be necessary to consider the production of persulphuric acid, $H_2(SO_4)_2$, the exact constitution of the lead peroxide when thoroughly desulphated, and, closely connected with these, the abnormally high E.M.F. obtained towards the end of the charge and the first few minutes of discharge; but as they are none of them directly related to the main reactions, I do not propose to deal with them here.

Probably, of all the phenomena observed in storage cells, the least studied, but the most interesting and important theoretically, are those of reversal. Quite apart, however, from their direct bearings on storage battery problems, the electrolytic conversion of electro-positive lead into electro-negative lead peroxide and *vice versa*, and the molecular mechanism by means of which these results are effected, well deserve further study for the light it may throw on the relationship between the chemical and electrical forms of energy as well as on other problems of chemical physics. I cannot recall ever having seen any definite chemical theory of reversal propounded, but believe the general idea is—it certainly was mine for a long time—that at both electrodes the active materials have to be fully converted into lead sulphate before they can undergo further oxidisation or reduction. Indeed, if the usual explanations of the discharge reactions are adopted, this seems to be the only possible procedure, but one which at the same time brings out most strikingly the discrepancies between fact and theory. The view no doubt appears to derive support from the very evident "sulphating" that so frequently accompanies the reversal of electrodes and may if they contain large masses of active material, lead to their entire disintegration in its endeavours to make room for itself; but this is due to excessive local action, as will be explained later. On the other hand, any type of electrode in which the active material is distributed in thin layers may be reversed without showing the slightest trace of sulphate throughout the operation or suffering any loss of capacity, provided a sufficiently heavy current is maintained. Fortunately one piece of evidence exists, which to my mind lends strong confirmation to the views I have put forward as to the real nature of the reactions of reversal, and that is the appearance of lead peroxide on the surface of the negative active material towards the end of its complete discharge; but although the fact has frequently been cited in explanation of the rapid fall of voltage, I do not think its full significance has hitherto been realised. As Mr. Swinburne once pointed out, it seems almost impossible to suppose that the peroxide can be produced by the cell's own unaided energy, and no doubt in practice it is brought about by a reinforcement of its potential difference from other cells in series with it and not so fully discharged. However this may be, it does not affect the value of the observation itself, which lies in showing that the formation of peroxide sets in before the active material is fully sulphated and in indicating how the reversal commences. I am not aware that uncombined lead has ever been detected in the active material of an exhausted positive; but given a cell whose negatives have the larger capacity, so as to ensure the positives being thoroughly run down, and I think some indications of it might be found if discharged under suitable conditions. More probably, though, no test can be devised to which the metal will respond with the same ease as its peroxide and before it is reoxidised by local action.

(To be continued.)

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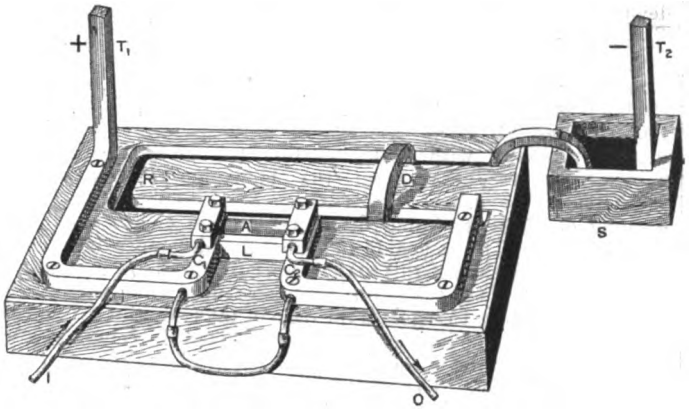
AN EXPERIMENTAL RESEARCH ON SOME STANDARDS OF LIGHT.*

BY J. E. PETAVEL.

(Continued from page 749.)

On the Fusion of Platinum by an Electric Current.

From the considerations that have just been enumerated, the advantages of an electric method of heating the metal are at once apparent. In the preliminary experiments a number of different forms of electric furnace were tried. In some cases the electric arc



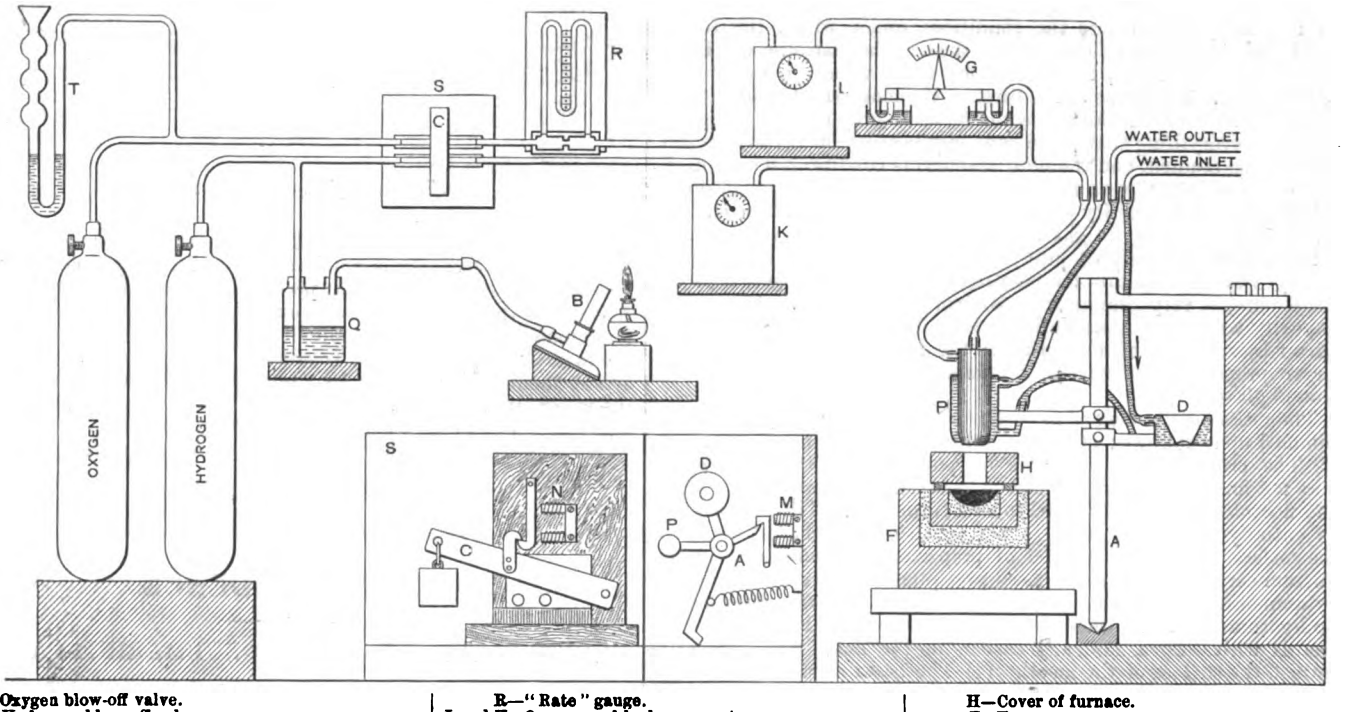
A—Platinum bar.
C_1, C_2—Copper clips in which the platinum is held.
L—Lime trough which supports the fused metal.
D—Copper short-circuiting piece.
R—Mercury trough serving as a variable resistance.
S—Mercury switch.
T_1, T_2—Massive copper leads to the battery terminals.
I & O—Water inlet and outlet.

FIG. 5.—Apparatus for the Fusion of Platinum Bars by an Electric Current.

was used, in others the crucible was surrounded with a layer of graphite, through which the heating current was passed. It is well known that at high temperatures platinum combines with carbon forming a carbide, and thus the use of graphite crucibles was out of itself. The apparatus shown in Fig. 5 was designed for this purpose. Some 40 large secondary cells were, by aid of the mercury switch, connected in parallel on to two 'bus bars. The current was carried by massive copper leads to the terminal T_1, and from there by a 1 sq. in. bar to the clip C_1, passing through the platinum bar A to the clip C_2. R is a U-shaped mercury trough serving as a variable resistance. The copper short-circuiting piece D could be slid along the U so as to increase or diminish the effective length of the mercury. The clips C_1 and C_2 were hollow, and kept cool by a water circulation. A rapid flow of water was also maintained over the surface of the mercury. The electric circuit was completed through the mercury switch S and an amperemeter.

With this arrangement currents up to 2,000 amperes could be maintained for several hours. The platinum was supported by a trough, L, of some refractory material which was carefully cut to fit the metal bar. From the first it was evident that the principal difficulty would be to find a suitable material for this support. The weight of the molten metal acting on the supporting material gradually causes the shape of the trough to alter, and in a comparatively short time the cross-section of the metal becomes very irregular. The platinum then superheats in the place where the cross-sectional area has been most reduced, a spark occurs, and the molten metal thrown aside by the explosive force of the discharge freezes before it has time to flow back into position. It is of course easy to re-weld the platinum, but the same difficulty will recur time after time and at more frequent intervals as the shape of the trough becomes more and more distorted. Some 20 bars of different shapes and sizes were used, with the same result. Had it been possible to use larger bars, any small distortion of the trough would probably not have affected the experiments. However, as already stated, 2,000 amperes was the maximum current available, and with this current it was found impossible to melt bars of much more than 70 sq. mm. in cross-section. The length of the span between the edges of the clips was usually 70mm., but in some cases this length was reduced to 40mm. Lime, alumina, and magnesia were the materials used for the troughs. It became evident that small platinum bars could not be maintained for any length of time in the molten state when supported on the ordinary refractory materials, and it was decided to make use of metal supports.

The question of cost excluded the use of the metals of the platinum group, and in default of a better material the trough was made of nickel. A number of nickel plates insulated from each other by



T—Oxygen blow-off valve.
Q—Hydrogen blow-off valve.
S—Automatic device for cutting off the gas from the blow-pipe (seen also in elevation in small inset figure at bottom).
R—"Rate" gauge.
L and K—Oxygen and hydrogen meters.
G—"Ratio" gauge.
P—Blow-pipe.
D—Diaphragm.
H—Cover of furnace.
F—Furnace.
A—Axis which supports the blow-pipe and diaphragm.
M and N—Electromagnets.

The plan of the automatic device for replacing the blow-pipe by the diaphragm is shown in the right-hand small figure at bottom.
N.B.—This figure is a purely diagrammatic representation of the apparatus, and is not drawn to scale.

FIG. 6.—Apparatus used for Fusing Platinum with the Oxy-Hydrogen Blow-Pipe.

the question. It is unnecessary to give further details, as the experiments were not successful. No material could be found that would resist the high temperature of the arc and the chemical action of the incandescent carbon, and at the same time not affect the purity of the platinum. It was then decided to fuse the platinum by passing the current directly through the metal

* Paper read before the Royal Society.

mica were bolted together so as to form a solid block. In this block a cylindrical groove was cut, its axis being perpendicular to the direction of the laminations. The nickel plates were 1·8mm. in thickness, every alternate plate projecting 5mm. on the sides and 6mm. below. Through the channels thus formed a rapid circulation of water was maintained. The platinum bar was semicircular in cross-section and deeply grooved on the lower side where it came in

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contact with the nickel. The shape was much the same as would be obtained by cutting an ordinary bolt in two along its axis, the edges of the V-shaped thread bearing on the nickel. In this manner the somewhat anomalous experiment of fusing platinum in a nickel crucible was successfully carried out. Needless to say that the anomaly is only apparent: the molten platinum did not come in contact with the nickel, but was supported in a shell of solid platinum. The cooling was so efficacious that the nickel crucible never once became red hot. When the metal is fused in this manner the quantity of heat lost is very considerable, and the effective cross-section of the bars had to be greatly reduced. The cross sectional area, as measured from the bottom of the grooves, did not exceed 30 sq. mm. At the surface of the bar the central channel of molten metal was not more than 2mm. in width. If the current were forced so as to melt a larger surface, the bottom of the threads softened sufficiently to allow the fused platinum to run through, thus causing the bar to break. Even when this occurred the platinum was found to freeze rapidly enough to prevent it alloying with the nickel support.

If the above experiments were made on a larger scale some valuable results would certainly be obtained. By the use of a large welding transformer there should be no difficulty in fusing bars of 10 or 20 times the cross-section of those used in the present instance. As will be seen below, good results can be obtained when the ordinary oxy-hydrogen flame is used to fuse the platinum; but, taking everything into account, the electrical method, if carried out on a sufficient scale, would not only be more simple, but would afford a more ready means of varying the rate of cooling.

On the Fusing of Platinum by the Oxy-Hydrogen Blow-Pipe.

The object of the following researches was to repeat the work done some years ago by Violle, and to determine what are the best experimental conditions. It is a somewhat curious fact that, although Violle makes no mention of having encountered any special difficulties, his experiments have never been repeated with success. Even under the best conditions (such as are obtainable, for instance, at the Reichsanstalt) the results have not proved satisfactory. Under these circumstances it seemed hardly advisable to attempt any further research in this direction. But the theoretical advantages of the Violle standard appeal strongly to anyone who has studied the standards of light now in practical use, and it was thought that, whatever the final result, the time spent in this study would not be lost. The preliminary experiments occupied some considerable time, and nearly six months passed before the conditions under which the fusion should take place were clearly established. The platinum was fused several hundred times, the conditions being varied in every conceivable way. The shape of the furnace, the material of which it was made, the form of the blow-pipe, the relative proportion of the gases —in fact, everything that could have any bearing on the final result was in turn studied, and the most favourable conditions determined. The slightest impurity on the surface of the platinum has a considerable effect on the quantity of light emitted. When cold the surface always appears fairly bright and clean, but there is a temperature between a white and red heat at which the smallest impurity is clearly visible. At this temperature the platinum ingot, if it be quite pure, is very similar to a pool of molten glass. Any small impurity will cause a slight haze, resembling that produced on a mirror by a breath of moist air: if the impurities are present in a larger proportion the surface becomes very similar to a sheet of ground glass.

The necessary conditions to ensure a pure surface may be briefly summed up as follows: (1) The platinum must be chemically pure. (2) The crucible must be made of pure lime. Pure magnesia does not form a sufficiently coherent mass, and, alumina being light and flocculent, allows the metal to sink through it. The lime should be entirely free from silica, $\frac{1}{4}$ per cent. being sufficient to spoil the surface. The best method of preparing the lime is to ignite calcium carbonate which has been precipitated from calcium nitrate by ammonium carbonate.* (3) The hydrogen burned must contain no hydrocarbons. At these high temperatures platinum combines readily with carbon, and any carbon in the flame would rapidly tarnish the surface of the metal. (4) The gases should be burnt in the ratio of four volumes of hydrogen to three of oxygen. All the best results were obtained when using the gases in the above-mentioned proportion. The temperature of the flame is then but little above the melting point of platinum, and the metal does not superheat to any great extent. When the platinum is considerably superheated it slowly distils, the drops condensing on the brick forming the cover of the furnace; the metal then drips back into the crucible carrying with it some of the silica which the brick contains, and thus contaminating the surface which is under observation. An excess of oxygen in the flame is also favourable, inasmuch as it oxidises any impurity that the platinum may contain.

Finally, it is important that the blow-pipe should be so constructed as to ensure a thorough mixture of the two gases. The most favourable conditions being established by these preliminary experiments, the necessary apparatus had now to be designed. It may be thought that the instruments are unnecessarily complicated, but it must be borne in mind that a single experimenter had not only to make all the observations, but also to regulate the flow of the gases, the electromotive force on the terminals of the standard lamp, and the current of water passing through the diaphragms. Most of the apparatus had therefore to be made automatic in its action. The instruments serving to regulate the supply of gas are shown in Fig. 6. The gas supply is stored in large cylinders at a pressure of from 100 to 200 atmospheres. S is a device worked by an electric current from a key placed under the photometer head. When the key is pressed the chopper C falls, compressing the indiarubber tubes and cutting off the gas from the blow-pipe. (This device is shown in elevation at the bottom of Fig. 6, on the left side.) The hydrogen escapes through a valve to the burner B, where it is ignited; the oxygen blows off through the water trap T. When the chopper C is up the gases, after passing through the meters provided with scales reading to one hundredth of a cubic foot, are burnt from the blow-pipe P. On one of the circuits the gas is forced through a diaphragm with an opening of about one-hundredth of the normal cross-section of the rubber tubes. The gauge R indicates the difference of pressure between the two sides of this diaphragm. By the aid of this gauge R the rate of flow of the gas can be kept constant at any desired value. The gauge G serves to regulate the ratio of the two gases. Two bells float in mercury, the interior of one being placed in communication with the oxygen inlet of the blow-pipe, the interior of the other with the hydrogen inlet. The apparatus is merely a balance, the two quantities weighed being the pressures of the two gases. The point of support is empirically adjusted so that the system is in equilibrium when the gases are flowing in the desired ratio—viz., four volumes of hydrogen to three of oxygen. The instrument is very easy to construct, and its accuracy is amply sufficient for the purpose in view. The blow-pipe is of a somewhat peculiar shape, and is shown in Fig. 7. About half the oxygen passes through the central nozzle N, which is surrounded by a platinum nozzle P. The supply of hydrogen is led in at C, and flows down between these two tubes. The entire arrangement is surrounded by a gun-metal case, which is cooled by the water circulation W. Half the oxygen flows down between the gun-metal and platinum tubes, entirely surrounding the hydrogen where it issues from the platinum nozzle, thus ensuring its perfect combustion.

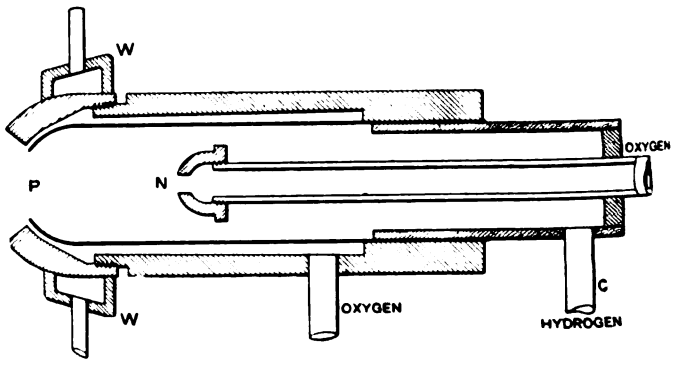

Fig. 7.—Blow-pipe. (Scale, $\frac{3}{4}$ full size.)

(To be continued).

* This method was suggested by Dr. A. Scott, to whose kind advice the solution of many of the chemical problems involved in the present work is due.

CORRESPONDENCE.

ELECTRIC TRAMWAYS AND SUBMARINE CABLES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It seems difficult to believe that the explanation suggested by Prof. Jamieson of the cable disturbances at Cape Town caused by stray currents in the sheathing is the correct one. Mr. Sayers is, I think, perfectly right in maintaining that electromagnetic induction under the conditions considered is practically impossible. The signalling current returns partly along the sheathing and partly through the surrounding sea water. The return circuit of the current therefore consists of a conducting mass whose inner boundary is the inner boundary of the sheathing. Nobody will dispute the fact that a current flowing along the sheathing produces no magnetic force in the space within the sheathing. Hence there is no magnetic induction anywhere in the space between

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the two conductors (core and sheathing + water) forming the circuit along which the signalling currents are transmitted. It appears pretty plain that electromagnetic induction under such conditions is impossible. In the experiments described in the discussion on Prof. Jamieson's Paper, and referred to in his letter, electromagnetic induction is due simply to the position of the *return* part of the circuit.

The following explanation is, I think, sufficient to account for the observed facts. The effect produced by a varying stray current in the sheath is the same as that which would occur if the portion of the sheath along which such a current is flowing were to become the seat of a varying E.M.F. Let us, then, suppose (Fig. 1) that at a certain point of the sheathing a varying E.M.F. is interpolated. The arrangement then becomes equivalent to that shown in Fig. 2, and, since the

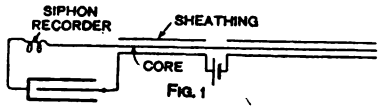

FIG. 1

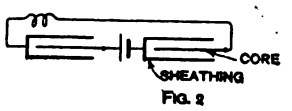

FIG. 2

whole capacity of the cable comes into play, it is not difficult to see how even small changes in the E.M.F. may cause disturbances large enough to affect an instrument so delicate as a siphon recorder.—Yours, &c., ALFRED HAY.

University College, Liverpool, March 28.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: With reference to the discussion and Prof. Jamieson's interesting letter on the above subject, printed in your last issue, it seems reasonable to suppose that the theory propounded by him as to the inductive action being the effect of the sum of the differences of the fields of the primary currents at the centre of the conductor—which sum must necessarily alter with each change in intensity of the currents producing it—is probably correct; and in any case, failing a better theory, it satisfactorily accounts for the phenomena observed. There are one or two points, however, touching his experiments with twin-cored cables, which it may be of interest to note.

Firstly, it has been proved, by a series of experiments analogous to his own, that twin parallel cores are as efficacious in overcoming the induction effect as twin twisted cores. This fact is of course only interesting from a theoretical point of view, as for practical reasons the twisted cores are to be preferred.

Secondly—and this is a more important point—the disturbing currents are only shown in his experiments as entering the sheathing of the cable at points embraced by the anti-inductive twin core. Should, however, the leakage currents from the tramway rails cut the cable sheathing beyond the anti-inductive shore end, does Prof. Jamieson maintain that there would still be no disturbance to a delicate instrument interpolated between the two cores, one of which is earthed to the sheathing of the cable within the area affected by the leakage currents? And if not, by what data and experience is he guided when he recommends, as he did in his original Paper, a certain length of anti-inductive cable as a sure remedy in a certain case?

It is more than probable that the area disturbed will vary in every instance, depending upon the relative positions of the cable end, power house, and rails, the strength of the currents employed, and the nature of the soil, sub soil, and geological strata at the place affected; and it would be interesting to hear from Prof. Jamieson whether he has up to the present formulated any theory dealing with this part of the subject which enables him to forecast with a reasonable degree of certainty the length of anti-inductive cable which would be required in any given case.—Yours, &c.,

MICROFARAD.

PARLIAMENTARY INTELLIGENCE.

ELECTRICITY BILLS IN PARLIAMENT.

A new group of bills has just been formed by the Committee of Selection of the House of Commons, which comprises all the important electricity supply schemes deposited in the Private Bill Office for consideration during the present session. The group consists of the Durham (County of) Electric Power Supply Bill, Tyneside Electric Power Bill, Lancashire Electric Power Bill, South Wales Electrical Power Distribution Bill, and the Shannon Water and Electric Power Bill.

The time fixed for the first meeting is Thursday, May 3, when the Durham, Tyneside, and Lancashire Bills have first place for hearing. The committee consists of Sir Jas. Kitson (chairman), Sir A. Scoble, Mr. Bartley, Mr. Ashton, Mr. Howard, Mr. Billson, and Col. Long.

CITY OF LONDON CORPORATION (VARIOUS POWERS) BILL.

On Wednesday Mr. Littler, Q.C., opened the case for Part VI. of this bill, under which power is taken, subject to the consent of the Board of Trade, to construct service works in and under the streets of the City for the purpose of carrying the pipes, mains, and wires of the various companies, in order to prevent the frequent interruption to traffic arising from the opening up of the streets. Counsel said that many of the City thoroughfares were exceedingly narrow, and owing to the enormous cost that would be entailed, it was impossible to widen them. There was hardly a single foot of any important street that was not occupied by some sort of appliance for the public service—gas pipes, water mains, electric wires both for light and energy, hydraulic power for lifts, and the National Telephone Co. Last of all, the Postmaster-General was a very large occupier of the streets with his telegraph lines. The bill did not present to the committee certain works for certain streets, but tentative powers were sought by the Corporation for the construction of subways which would not be used recklessly. The term "public service work" included culvert, tube, or receptacle for pipes and wires, and it was proposed to construct such works as might be expedient through and across all underground cellars and vaults as might be found *en route*. Where such works were constructed the Corporation would have power to require the removal into them of any existing pipes or wires, providing such works were convenient for their reception. It was alleged that the bill would prejudicially affect the Charing Cross and Strand Electricity Co. The Corporation, owing to the crowded state of the City streets, had opposed the entry of the company, but Parliament had overruled their opposition, and it was this fact among others that had driven the Corporation to the present proposal. The Corporation asked for these powers for the purpose of protecting the public in their use of the streets.

Mr. Wm. P. BICKNELL, clerk to the Public Health department of the Corporation, said notices had been received from the Postmaster-General for the laying of telephone wires which would entail interference with 480 streets. Under their Act of last year the Charing Cross Co. might require to go into all the streets of the City.

Sir J. WOLFE BARRY, K.C.B., consulting engineer to the Corporation, said the Corporation recognised their obligations to construct such works as would be fitted for the reception of the pipes and mains. It was proposed to deposit plans and sections of works with the Board of Trade, delivering them first to the companies concerned. Then, in case of difficulty, the decision of the Board of Trade would be taken. It was impossible for the Corporation to proceed beyond a little bit at a time. Subways might be constructed to carry only the electric cables and small mains and telephone and telegraph wires. It might be that a subway or gallery would be constructed for the electric lines only. The Corporation would have to bear the cost of the removal of wires already laid into the subway. He did not think it likely that the Corporation would construct works to carry the lines of the Charing Cross Co., which were not already made. They might deal with the lines of both the electric companies.

Sir BENJAMIN BAKER, K.C.M.G., said he had 40 years' experience of the construction of underground works in the City. The difficulty was a constantly increasing one, and his latest experience in carrying out the works at the Royal Exchange showed that the difficulties had of late increased tenfold. The guarantee to the companies concerned against any vexatious exercise of the powers of the bill was that the works would be very costly to the City. Therefore, whilst it was necessary to take general powers, the operations would be done very gradually.

Mr. EDWARD WILMOT SEALE, secretary to the Charing Cross and Strand Electricity Supply Corporation, said his company was in competition with two other companies, and under the bill of last year were put under obligation to provide a separate generating station for the City, and to lay mains in certain streets within two years. The generating station had been constructed at Stratford, and they were in Parliament this year with a bill to get powers to lay the necessary mains and bring the supply into the City. The present proposal before the committee would enable the Corporation, if they chose to do so, to lay the whole of the conduits or pipes and casings, and by doing so to obtain possession of practically half the company's undertaking. The City by laying the conduits would have the sole control in the selection of the conduit, and inferentially of the system of supply to be used. The culverts were generally dependent on the system of supply, but by this bill the system of supply would be made dependent on the style of the culvert used. The City would have the right to decide the position and manner in which the pipes and wires should be placed in the public service works, their size and arrangement, and the method in which they should be brought into and taken out of the works. On all occasions when they went

to test their service or lay service mains they would be controlled by the Corporation. The Corporation would also be enabled to dictate the insulation to be employed, and the system to be used in laying the cables. That was a matter that had never been undertaken by any local authority in the history of electric lighting. The receptacle provided by the City under the bill might be one small enough to only convey his company's lines not yet laid.

Mr. LITTLER, Q.C., said the Corporation desired to be reasonable, and would insert anything that would protect the Charing Cross Co.

WITNESS (continuing) said he should say that the subways would not facilitate the laying of his company's cables. The County Council's subways were of sufficient capacity to make it convenient to use them. But if the subways were put down say 14ft. below the level of the ground, as was the case in some of the existing County Council's subways, the cost of the service would be simply prohibitive. They would have to come up with the wire and travel along the pavement until they came to the house to be served. He objected to the control of the Corporation over the access to the proposed subways, as the company would have to give notice each time they wanted to test the mains. The practice of the County Council was that notice had to be given and fees paid on every occasion that they came to the service boxes. The present bill would introduce the new principle of departmental legislation in place of the legislation of Parliament.

Yesterday Mr. SHIRESS WILL, Q.C., on behalf of the Charing Cross Co., said the City Corporation had attached to their assent to the Charing Cross Co. laying their lines in the City the condition that the works should be carried out subject to the proposed Act relating to the public service works in the City of London. The legality of the condition was disputed by his company, who were under the obligation of laying their mains within the next two years. His company were opposed most strenuously last year by the City Corporation, their attempt to bring competition into the City not having found favour with the Corporation, and they were bound to see that undue difficulties were not put in their way. The present position of the company in regard to subways was that they were bound to make use of them where they existed. If what was to be constructed under the bill were subways of a like description they would be content. If the bill were passed as it stood, his company would have to go to the Board of Trade with reference to each piece of subway constructed, and that would cause great delay, and where competition existed it was necessary to work expeditiously to secure custom. The fact of the matter was that the Corporation had with perfect honesty granted to the existing company an exclusive right to supply electricity in the City as far as they were able to do so, and he would submit that the position of the City was that, with no idea of revenge because Parliament had upset their bargain, they did not desire to assist or make it easy for a competing company. Under the bill the Corporation had power to put a tube or gallery instead of a subway, and that must mean anything in point of size. The convenience of entering such a structure for the purpose of repairing wires was not comparable with that of entering a subway.

Mr. BALFOUR BROWNE, Q.C., for the City of London Electric Lighting Co., said it was now proposed to ask a private bill committee to delegate the powers of Parliament to the Board of Trade. His company were treated worse in the bill than the gas and water companies were. By clause 15 provision was made for the continuance of their supply, but under the bill the supply of his company could be cut off and their business ruined. His company objected to the removal of their mains, which had cost some £500,000 to lay, and they asked the committee to reject this proposal.

Mr. FRANK BAILEY, engineer to the City of London Electric Lighting Co., said in consequence of the clause in their Provisional Order of 1890 they had laid some of their wires in subways of the Corporation. The mains and pipes of the company in the City were laid down with particular care. They had adopted a system of conduits and manholes which enabled cables to be inserted and withdrawn without breaking up the streets. The company had some 500 miles of tubes or subways laid in the City, mostly under the footpaths, only about 50 miles being under streets. To some of the existing subways where the company had laid wires there was considerable objection. In Victoria-street, for instance, no laterals had been provided, so that, once in the subway, there was considerable difficulty in getting out again, and in order to supply a new consumer it became necessary to pierce the side of the subway. Another difficulty arose where the subways were too short. If the company could lay their mains under footpaths they could do their work more expeditiously, and the mains would be more under control than if laid as suggested. In addition to the mileage mentioned, the company had laid a large number of spare pipes and conduits to meet future requirements, the whole of which would be wasted if the proposals of the Corporation were adopted. The company's conduits already laid had suitable chambers for inspection and draw-boxes, so that the cable had simply to be inserted and slipped through. If the whole system were transferred to a subway the company could still provide similar draw-boxes inside the subway, but without any convenience attaching to their use. The present method was more convenient than the proposed one would be, because under it the large drums on which the cables were placed stood on the footways, whereas as now proposed they would probably have to stand in the roadway, and so interfere to a greater extent with the traffic. His company would be content with the proposals of the Corporation if they were granted the exemption clause contained in the London County Subways Act of 1893. By the company's provisional order the licence of the company to supply could be revoked if they failed to supply for a period of one month, no matter the cause; and for default they were liable to a fine of 40s. each day in respect of each default. His company had not saved money by putting the cables in subways instead of laying them in the more ordinary way, because they would have had to protect the cables there by attachments and supports. His company occupied the space under the footways, being the first suppliers of electricity in the City; but he had no objection to any other undertakers of electricity supply having facilities also to lay their pipes.

By the CHAIRMAN: If subways existed when he was originally laying electric mains, he should put the distributing mains under the footpaths, but the trunk mains in the subways. The distributing main was the one from which the services were tapped off, and therefore necessitated the provision of service boxes, which it was more convenient should be on the footpaths. The trunk main had nothing to do with connections or services, and could therefore be easily placed in a subway. If there was a good run of subway it was well to lay the trunk main in it; but in the City the subways were so short that it would not pay to go into them unless compelled.

This concluded the evidence.

The CHAIRMAN said the committee had decided that the preamble of the bill was proved, but that they would have to deal very carefully on clauses with the points raised by opponents. They thought there should be protection for the continuous supply of electricity conceded to the electric companies, in the same way as protection had been afforded the gas and water companies. They also thought there should be an extension of the arbitration clause so as to give the companies more protection than at present.

Consideration of the clauses was postponed.

STOCKPORT TRAMWAYS BILL.

On Thursday last a House of Commons committee, presided over by Sir S. Hoare, considered this bill. Power is sought to construct a number of new tramways in the borough in conjunction with the existing tramways. It is proposed to carry animals and goods at certain hours. The only petitioners were the Stockport Rural Council and the Parish Councils of Norbury, Torkington, Bramhall, and Bosden, who objected chiefly to the proposals of the bill that the Stockport Corporation should be empowered to supply electricity to tramways in their districts.

Mr. PEMBER, Q.C. (for the promoters), said that the borough had purchased the tramway lines of the Stockport and Hazel Grove Co. on the basis of eleven years' beneficial occupation. He dwelt upon the importance of the proposed tramways, which really established through routes for a large residential area to the city of Manchester. The two lines now running in Stockport were owned by the Manchester Carriage and Tramways Co. and the Stockport and Hazel Grove Tramways Co. There were 22 new lengths of tramways to be constructed. The longest of these extended to the confines of Bredbury. Another went into Reddish, and others were extensions within the borough, chiefly opening up districts at present sparsely populated. The total length of the new double lines proposed is five miles, and the length of single line five miles. As to the supply of electrical energy to tramways, the Corporation only took power to supply where other people had no power to do so.

Mr. WEBB (mayor of Stockport), said that clause 38, which was the one principally objected to, gave the Corporation power to supply electrical energy to tramways within and without the borough. The Stockport and Hazelgrove Co. had no power to use electric traction, but the Corporation had the power. They only sought powers to supply electrical energy in districts where the local authorities were not supplying at the time.

Mr. CHARLES HOPKINSON (Hopkinsons and Talbot) spoke of the great opening there was in Stockport for better means of locomotion, and of the unsuitability, owing to the nature of the gradients, of horse traction. An adequate supply of electric tramways would be of great advantage to the town and neighbourhood. The proposals of the promoters were suitable for the service of the town.

The committee considered the preamble proved, and afterwards went though the various clauses, which were altered in some minor details. The bill was then ordered to be reported to the House.

HUDDERSFIELD CORPORATION TRAMWAYS BILL.

This bill came before a Select Committee of the House of Commons, presided over by Mr. Jeffreys, on March 15. Power is sought to convert the present tramway system at Huddersfield from steam to electric traction, and to extend the system both within the borough and in districts adjacent thereto. The opposition of owners and occupiers had been withdrawn, the only opponent appearing by counsel being the Lancashire and Yorkshire Railway Co., who alleged that the proposed extensions would set up a competition with their railway and damage their property.

Mr. BALFOUR BROWNE, in opening the case for the promoters, said the conversion from steam or other traction to electricity which was proposed in the present bill had been effected in a very large number of cases, including those of Glasgow, Leeds, Sheffield, Liverpool, Manchester, Halifax, and Bradford. There was no doubt that electric traction was an enormous improvement on the old system. In Leeds some of the tramways were being worked by the old locomotives, whilst others were running by electricity. The latter were not only quieter but proceeded at a faster rate.

In the course of the evidence tendered for the bill Mr. Kenneth F. Campbell, civil engineer, examined by Mr. Ram, Q.C., said it was necessary that the tramway should be on an electric principle, and he had arrived at that opinion by studying the facts in other places in which electric tramways had been introduced. After full investigation, the Corporation had decided to adopt electric traction. He had ascertained that in other places where electric tramways had been established, or where old tramways had been converted into electric lines, they had proved financially successful. In the case of the tramway between Stockton and Middlesbrough steam had been tried, and the tramway had

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not been able to maintain itself, but now that it had become an electric undertaking the capital had been doubled and the concern was financially sound. The same thing had happened in Sunderland and elsewhere, the revenue having been increased by the adoption of electricity. He was not aware of any electric scheme which had been a failure. The electrical equipment of the tramways covered by the bill would cost £399,350. Other expert evidence was given to the effect that electric traction was more economical than steam and would be desirable in the interests of the Corporation.

Mr. JOS. POGSON said he had been for fifteen years manager of the tramways of the Huddersfield Corporation. Taking all the routes together, the cost of running the system by steam was 10d. per mile. The experience of other towns showed that the cost of running by electricity was 4½d. to 5d. per mile. This difference was partly due to the fact that they could keep an electric car running more continuously than a steam engine, which had to stop from time to time for coal, water, &c. At present the charge was 1d. per mile in the first class saloon, and 1d. for 1½ to 1½ miles in the second class, but the rate in the electric cars would be slightly less.

Mr. LITTLER, Q.C., addressed the committee for the Lancashire and Yorkshire Railway Co., and Mr. POPE, Q.C., called evidence in support of the contention that the bill would establish a system of through tramways, and would practically mean competition between the ratepayers and the railway company. Communal competition of this kind, it was urged, would destroy private enterprise. The railway company was one of the greatest ratepayers in Huddersfield, and if the bill passed they would be paying money to cut their own throats.

The CHAIRMAN of the COMMITTEE said: The Government has given notice of motion to appoint a joint committee of both Houses of Parliament to inquire into the whole matter of municipal trading. This committee cannot grant such a large and extensive system of tramways outside the borough area, but are willing to grant the alterations and additions asked for within the borough area.

Mr. RAM (for the promoters) said: That will include the power of borrowing money to convert the tramways from steam to electric traction? and the chairman replied in the affirmative.

AIRDRIE AND COATBRIDGE TRAMWAY BILL.

The Select Committee of the House of Commons presided over by Mr. Jeffreys had this bill before them on Tuesday. The measure originally contemplated the construction of an electric tramway through Airdrie and Coatbridge, but owing to a question of expense the Coatbridge local authority withheld its assent, and the Airdrie part of the scheme only was dealt with. The opposition came from the North British and the Caledonian Railway Companies, who submitted, through Mr. Pope, Q.C., that as the bill was promoted by eminent financiers, of whom Baron Emile Beaumont d'Erlanger was one, they were endeavouring to insert the thin edge of the wedge, having in contemplation the development of a long through route in the direction of Glasgow which would compete with the railways.

Mr. I. EVERSON WINSLOW was called for the promoters, and said he had a large experience of the overhead trolley system of electric traction. Electric tramways were more expensive to lay than ordinary tramways, requiring heavier rails and a more substantial permanent way, as well as the provision of somewhat costly traction appliances.

Mr. FITZGERALD, Q.C. (for the promoters): And would anyone incur the expense of laying down this expensive machinery if they were liable to be bought out by the local authority in 21 years on the terms mentioned in the Tramways Act of 1870?—No, it would be impossible, for they would not be able to get their money back.

Take the case of the Norwich tramways, with which you are connected. The purchase clause of the Act of 1870 was applied, but I think the period allowed you was 50 years, was it not?—Yes.

And I think I may say that since these electric tramways have been introduced there is no case in which they have been granted by the local authority and taken up by a company on the terms mentioned in the 43rd section of the Tramways Act of 1870.—I could not say, but I am not familiar with a case.

The committee, after hearing further evidence for the bill and the speech of Mr. Pope for the North British Railway Co. (acquiesced in by Mr. Claude Baggallay, Q.C., for the Caledonian Railway Co.), passed the preamble of the bill.

HASTINGS TRAMWAYS BILL

This bill, to incorporate the Hastings Tramways Co. and to empower them to make and maintain tramways and work the same electrically, was considered by Mr. Hobhouse's Select Committee of the House of Commons on Tuesday, Wednesday and yesterday.

Mr. J. E. WALLER, M.I.C.E. (Kincaid, Waller and Manville), said he had considerable experience of laying out tramways, and had been connected with the Brighton Tramway Bill, sanctioned last week. The case of Brighton was very similar to that of Hastings. The scheme was the best that could be devised for the town. Its main feature was the complete circuit the line would cover. He had had a number of cases in which there were much worse gradients than on the lines in this scheme. The gradients were not in thickly populated districts, and in the busy parts no difficulty would be experienced from narrow roads. A considerable portion of the line would be on country roads. The promoters proposed to erect a generating station on the Bexhill road, just outside the borough. The total length of the lines would be over 11 miles, and the cost of construction was put at £68,000, which included cost of widenings and acquisition of land for generating station. The cost of equipment would be £109,000, including the generating station, sub-stations, &c. The capital would be £300,000, and there were borrowing powers for £100,000.

Mr. W. M. MURPHY said he was connected with the Cork Tramways Co. and other tramway undertakings. His first Hastings scheme was published in 1898. He had known the town for a long period, and had formed the conclusion it was a place eminently suited for electric tramways. He gave his assent to the conditions imposed by the Corporation last October, and was prepared to carry them out. He was prepared to give the Corporation the same guarantee as he did in Dublin, where he paid £10,000. The wayleave for the first four years was £350, and £525 for the next five years. The object of the agreement with the Corporation as to the sea front was to enable a line to be made there at a future time if the Corparation desired, so as to connect with the Bexhill and St. Leonards light railway, if constructed. The Bexhill light railway would be an electric tramway of the same sort as he proposed to construct under the present bill. His total estimate of the cost of the two undertakings when amalgamated was £400,000. He estimated that the gross receipts would be £41,000 a year, and, allowing for the higher price of coal in the South, he estimated that the profit would be £18,500 a year.

Ald. Dr. BAGSHAWE and Councillor Dr. ALLFREY gave evidence against the scheme, on the ground that it would be prejudicial to the town, and that the trams would be a nuisance and tend to keep visitors away.

Yesterday the CHAIRMAN stated, at the conclusion of the evidence, that the committee would pass the preamble of the bill subject to their approval of the electrical clauses, which will be considered to-day (Friday).

KINGSTON CORPORATION BILL.

The bill of the Kingston-upon-Thames Corporation, empowering them to construct and work tramways and for other purposes, came before a Select Committee of the House of Lords presided over by Lord Clifford on Monday. Several petitions were presented against the bill, including the Surrey and Middlesex County Councils, the Surbiton District Council, &c.

Mr. HUTCHINSON (for the promoters) said the tramways were practically the only opposed portion of the bill. In 1871 the population of Kingston was only 15,000, whilst to-day it was 24,000, with an area of 1,120 acres and a rateable value of £176,000. The total length of the proposed lines was about 5½ miles, and of the eleven tramways eight were within and three outside the borough. A portion of the tramway passed over Kingston bridge, which district would have an advantage in two ways: one that the road on the north of the river was much wider, and the second that their tramway would connect up with the proposed light railways of the Middlesex County Council. The tramways would be constructed from the designs of Mr. J. Kincaid (Messrs. Kincaid, Waller and Manville).

Mr. JOS. KINCAID said the tramway scheme had been prepared under his supervision. In his opinion it occupied the best routes, and was likely to prove a successful undertaking. It would hardly have been possible to have accommodated the traffic before the introduction of electricity, as horse traction would have been too costly. Kingston was at present lighted electrically, and the present generating works could provide power for the cars. The gauge would be the ordinary tramway gauge, 4ft. 8in. It would be a combined system of single and double lines, as the width of the streets would not allow a double line to be laid throughout. He thought the provisions of the Tramways Act by which the promoters were responsible for the maintenance of the roadway from 18in. on either side a fair arrangement. To ask them to do any more would not be a reasonable arrangement. The whole system would be 5 miles, 3 furlongs, 540 chains, part double and part single. If the whole line was single it would amount to about 7¾ miles of single line. There were no lines of tramway at present in the borough. In his opinion it was far better to make all the necessary lines at once than to do the work piecemeal. It was very desirable that a system of electric lines should be laid out in a comprehensive manner, and that all should be in the same hands.

Evidence was also given on behalf of the promoters by Mr. T. Lyne, chairman of the Tramways committee; Mr. M. G. Mowatt, mayor of Kingston; Mr. W. H. Webb, a member of the Council; Ald. G. Bedford Marsh; Mr. J. J. Collings, vice-chairman of the Electric Lighting and Tramways committee; and Mr. F. C. Bell, deputy clerk to the Surbiton District Council.

For the opposition it was urged that there was no traffic along the Surbiton-road or the Portsmouth-road to justify the annoyance the tramway and its poles and wires would cause to the residents.

After a short consultation, the CHAIRMAN stated that the committee found the preamble of the bill not proved.

WIDNES AND RUNCORN BRIDGE BILL.

The Select Committee of the House of Commons presided over by Sir T. Gibson-Carmichael on Tuesday passed the preamble of an electric traction undertaking similar to that to which the assent of Parliament was given some days ago for the construction of a bridge at Newport. The bill provides for the construction of a "transporter" bridge across the Mersey and Manchester ship canal near Runcorn. The bridge will consist of a high girder, pendent from which will be a large platform, and on this horses, vehicles, and foot passengers will be carried across the river. The traction will be supplied by two duplicate electric motors, and the cradle will be in charge of two men stationed in the car. It was at one time thought that the electrical works necessary for the bridge would work injury to the system of the National Telephone Co. in the neighbourhood, but at the hearing of the bill the opposition resolved itself into one in the interest of the salt brine industry, which was saved by a special provision.

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LEGAL INTELLIGENCE.

National Telephone Co. v. the Constables of St. Peter Port, Guernsey.

The arguments in this Appeal to the Judicial Committee of the Privy Council from a judgment of the Court of Judgments (Guernsey) affirming a decision of the Royal Court were heard by the Lord Chancellor, Lords Macnaghten, Morris, Shand, Davey, Brampton, and Robertson, and were reported in our issue of Nov. 24 last.

Judgment was delivered on Saturday by Lord DAVY, who said that the action was brought by the appellant company against the Constables of St. Peter Port for £250 damages because they had "mal-à-propos et contre droit" cut or caused to be cut the telephone wires belonging to the company which had been erected across the high road in the parish of St. Peter Port. Respondents pleaded (1) that by an agreement of March 25, 1896, between the Postmaster-General and appellants, the right to carry on their business was restricted to "exchange areas," of which, at the date of the action (June, 1896), Guernsey was not one; (2) that the appellants' memorandum of association gave them no power to carry on business in Guernsey; and (3) that appellants had no right by custom to carry wires over the street without respondents' permission, which had been refused. Those exceptions were allowed by the Royal Court and the action was rejected with costs, and that judgment had been affirmed by the Court of Judgments. The appellants did not contest the first and second exceptions. The appellants, however, denied that the constables had by law the powers claimed by the third exception, and pleaded that, if there were any rule of law which required previous consent for stretching wires across the streets, it did not follow that the constables had a right to take the law into their own hands and at their own discretion cut the wires, for which proceedings appellants contended a special power must be shown. Their lordships now held that there was not sufficient evidence to enable them to say that the constables had not such a discretionary power as was claimed and was declared by the Guernsey Court to be vested in them. Such a power was not expressly conferred by the "Ordonnance Générale relative aux Routes rues et Chemins" of 1840, unless it were contained in the general power of surveillance of highways; but their lordships did not think it necessary, in the view which they took of the case, to express any opinion on that point. Complainants alleged a statutory right to place their wires across the street, and complained of interference by respondents with this statutory right. The defence pleaded by the first exception was that the appellants had no such right. If so the action failed. It was true the declaration averred that the wires were cut, but there was no charge of unnecessary damage to the wires in removing them, and the action did not appear to be so framed as to enable the complainants to recover for unnecessary damage. Their lordships therefore considered that an action would not lie against respondents for the mere removal of appellants' goods from a public place in which they had no right to be. Appellants had not brought forward any rule or practice in the Guernsey system of pleading which would justify them in putting on the pleadings any interpretation different from that which the court seemed to have adopted. Their lordships would therefore humbly advise her Majesty that the appeal should be dismissed, and the appellants would pay the costs

Liability for Telephone Interruption by Snowstorm.

At Bournemouth County Court, last week, the National Telephone Co. sued a local tradesman for telephone rent. Defendant set up a counter-claim for damages owing to interruption of service caused by the recent snowstorm. Judge Philbrick held that, although inconvenience and loss had doubtless been sustained through the breakdown, it was one of those occurrences arising from natural causes, and for which in point of law there was no remedy. Judgment was therefore given for the company on both claim and counterclaim, with costs.

Goldberg and Sons (Ltd.) v. Corporation of Liverpool.

In the Court of Appeal on Wednesday, before the Master of the Rolls and Lords Justices Rigby and Vaughan Williams, Mr. Neville, Q.C., applied on behalf of defendants for a stay of proceedings pending the hearing of an appeal from a decision of the Vice-Chancellor of the County Palatine of Lancaster, who had granted plaintiffs a mandatory injunction. Counsel said the Corporation of Liverpool, under an Act of Parliament, were now engaged in laying down a system of electric tramways throughout the city. They had laid over 40 miles of lines, and there were about 70 miles still to lay. The overhead trolley system was adopted, and this involved the support of the cables along the various streets either by upright posts or by rosettes affixed to the premises of frontagers. The Corporation had no powers compulsorily to fix these rosettes, but plaintiffs had refused permission to have them affixed to their premises. The Corporation had therefore erected a post, and had also fitted a fuse box. Plaintiffs complained of the inconvenience caused by the erection of the post and had brought an action for a mandatory injunction. The Vice-Chancellor had found against defendants, and defendants had entered an appeal. The defendants urged that the matter was of much greater importance than the mere removal of one post, because this was in the nature of a test case, and if the Court decided against them they might have to remove a great many posts in other parts of the city.

Lord Justice RIGBY asked if the trams were now running?—Yes. The post in question had been up about a year, and at the trial no evidence of damage was given; but that the post was an inconvenience must, he thought, be admitted.

Lord Justice RIGBY: What was the ground on which the learned judge based his decision?—The learned judge went to see the post, and after hearing expert evidence came to the conclusion that another position would be better for it, although admittedly it could not be altered without causing greater inconvenience to the public generally. The judge said that, inasmuch as the public took the benefit of the tramways, it was only reasonable that they should put up with the burden, and that in this case the convenience of Messrs. Goldberg should be preferred to that of the public.

The MASTER OF THE ROLLS: Where was it suggested the post should go?—Into a lane where the pavement was only 5ft. wide, whereas in its present position the causeway was 12ft. wide. Owing to the Liverpool regulations, the Corporation could not place the posts right at the edge of the pavement.

Lord Justice VAUGHAN WILLIAMS: Is it not a mere question of money?—Not at all. They were bound to have a support for the cables, and their Act gave them the right to put on, over, or under the surface of the streets such works as might be necessary for the purpose of adapting tramways to mechanical traction. His clients would consent, supposing the appeal failed, to an inquiry as to any damage which the plaintiffs had sustained from the date of the trial to the date of the appeal.

The hearing of the appeal was then fixed for Tuesday next.

City of London Electric Lighting Co. (Ltd.) v. the Lord Mayor, Corporation, &c., of London.

In the Chancery Division on Tuesday Mr. Danckwerts mentioned this case to Mr. Justice Farwell. Counsel stated that the action was a very important one, and in the natural course of things would be heard in a few days. Mr. Cripps, Q.C., one of plaintiffs' counsel, had been unfortunately taken ill, and under the circumstances it was asked that the case should not be taken until next sittings.

Mr. JUSTICE FARWELL assented to the application.

Rutter v. Ashwell and Nisbett (Ltd.).

This case came before Mr. Justice Lawrance and a special jury on Monday and Tuesday last, and was an action by Mr. Thornton Rutter, civil engineer, for damages against defendants for alleged wrongful dismissal.

Mr. MARSHALL HALL, Q.C., said plaintiff was a civil engineer, and had confined his attention chiefly to electric lighting and heating, and had been employed as London manager to defendants, whose principal place of business was at Leicester. The defendants' business had belonged to plaintiff's uncle, a Mr. Phipson, whose executors sold it to defendants. Plaintiff took an appointment with defendants at £250 a year and a sum to be paid as commission, to be determined after a year's experience, and then to be retrospective. This contract was dated July 4, 1898, but the year was not to terminate till June 30, 1899. In Nov., 1898, when he had obtained £20,000 worth of contracts for defendants, and there had not been a word of complaint, plaintiff had to bring an action against a Mr. Bolt, for whom he had obtained an introduction to another person, and he recovered £500 commission. Plaintiff's name appeared in the papers, and on that account he was told that his services would no longer be required. Plaintiff was offered a month's salary in lieu of notice, but refused it and brought the present action.

In the result judgment was given for plaintiff for £300, to include commission due.

Smeeton and Another v. Williams.

This case came before Mr. Justice Kennedy, in the Commercial Court, and was a claim by plaintiffs, a firm of electrical engineers, for balance of account for work done under contract.

Mr. RUFUS ISAACS, Q.C., did not think there was any substantial difference as to the questions of fact. The case arose out of the building of some large flats in Harley-street, London. Plaintiffs were entrusted by defendant to do certain electrical work. Under the contract the architect had power to certify in the usual way, he being sole judge of what was necessary and ought to be ordered. He ordered certain things, and certified altogether for an amount of £379. 14s. Defendant had paid £275, and the architect's final certificate was delivered on Jan. 5 for £104. 14s. Deducting discount, the balance was brought to £94, which was now claimed. Defendant said the contract only included work for electric wiring and electric bells, and that part of the amount which was included in the architect's certificate for £379 was work relating to fittings, and therefore not within the authority of the architect to certify and not within the contract. Defendant also said he had discovered that in paying the £275 he had paid £15 too much, and counterclaimed for that amount.

After hearing the parties, his Lordship gave judgment for plaintiffs for £40. 19s. 6d., with costs, and dismissed the counterclaim, with costs.

Turner and Sons v. Brinsmead.

This case was mentioned last week, before Mr. Justice Mathew. The case came before his lordship sitting with an assessor in January, the plaintiffs seeking to recover the amount due for the erection of an electric automatic lift. Particulars of the action were given in our issues for Jan. 26 and Feb. 9. Defendant admitted the claim, but brought in a counter-claim for damages for breach of contract. His lordship said the assessor, Prof. A. B. W. Kennedy, would give his opinion on the technical question (the efficiency of the lift), and would communicate with the parties. As a result of the assessor's report his lordship advised a settlement of the case, and it was accordingly adjourned in order that terms might be arranged.

Mr. BANKES now said the parties had tried to settle the case, but had been unable to come to terms. He had therefore to ask that the case should again come into the list. He had further to ask to be allowed to see the contents of the assessor's report, so that the parties could ascertain whether any further witnesses were needed.

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His LORDSHIP said he did not know whether it would be necessary to call on the assessor again. He had settled his remuneration at 75 guineas, to be paid in equal moities by both parties. When this sum had been paid he would give the parties a copy of Prof. Kennedy's report.

In re River Plate Electric Light and Traction Co. (Ltd.).—Guinness v. the Company.

This matter came before Mr. Justice Cozens-Hardy recently, on a motion for judgment in a debenture-holder's action. Mr. Vernon said there had been default in the payment of interest on the debentures, and although there had not been six months' default, the company appeared and consented to judgment. Judgment was entered in the ordinary form in a debenture-holder's action.

TRADE NOTES AND NOTICES.

[Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.]

TENDERS INVITED.

The *Glasgow* Corporation invite tenders for telephone cables (including drawing into conduits and jointing) and telephone instruments (wall and table). Specifications, &c, may be obtained from the telephone engineer (Mr. A. R. Bennett), City Chambers, Glasgow, and tenders must be lodged with the town clerk (Sir J. D. Marwick) on or before Wednesday, April 18. An advertisement gives further particulars.

The *Wimbledon* District Council invite tenders for 5,000 16 c.p. and 1,000 32 c.p. incandescent electric lamps. Further particulars are set out in an advertisement, and tenders must be delivered to the clerk (Mr. R. H. Butterworth) not later than April 9.

The *Maidstone* Corporation require tenders for the supply and erection of steam and water pipes and valves for their electricity works. Tenders to town clerk (Mr. Herbert Monckton) by 10 a.m., April 3.

The directors of the *Lancashire and Yorkshire Railway* invite tenders for various stores for twelve months ending April 30, 1901, including signal and telegraph fittings, signal, telegraph, and electric light wires, copper tubing, glass, oil, screws, &c. Tenders to the secretary (Mr. R. C. Irwin), Hunt's Bank, Manchester, by 10 a.m., April 9.

The *Salford* Corporation invite tenders for an ash conveyer and two electrically-driven travelling jib cranes. Tenders to town clerk (Mr. L. C. Evans) by 10 a.m., April 9.

The *Edinburgh* Corporation desire tenders for the supply of (1) steam coal; (2) arc lamp carbons; (3) cast-iron pipes, pavement boxes, frames, &c., for the Corporation's electricity supply stations. Tenders to Mr. Thomas Hunter, W.S., town clerk, City Chambers, Edinburgh, by April 7.

The Visiting Committee of the *Northumberland* Lunatic Asylum, near Morpeth, invite tenders for an electric lighting installation. Tenders to the clerk (Mr. H Vassall), Market-place, Morpeth, by April 9.

The *Colwyn Bay* District Council invite tenders for erecting electricity station buildings and chimney shaft. Tenders to clerk by April 10.

The *Merthyr* Electric Light and Traction Co. require tenders for the erection of a power station. Applications to Messrs. J. P. Jones and Rowlands, 58, Wind-street, Swansea, by 28th inst.

The *Wolverhampton* Tramways committee invite tenders for the supply of steel rails, fish-plates, joints, and crossings. Tenders by May 5.

The clerk to the *Dunmanway* (Cork) District Council has been instructed to invite tenders for electric lighting, to be in by May 3.

The *Barking* District Council invite tenders for the construction of an electric railway, with bonding, &c. Tenders by May 7.

The *Devonport* Corporation require tenders for erecting a chimney stack at their electricity works. Tenders to town clerk by April 2.

The *Metropolitan Electric Supply Co.* invite tenders for ten 100 kw. transformers.

The *Buxton* District Council invite tenders for the supply of electricity meters. Tenders to Mr. J. Taylor, clerk, Town Hall, Buxton, by April 4.

The *Dublin* Electric Lighting committee invite tenders for the supply and erection of electric lighting plant. Tenders to town clerk, City Hall, Dublin, by 4 p.m., April 26.

Tenders are required for electric lighting of Victoria Concert Hall, *Halifax*. Tenders to W. C. Williams, 29, Southgate, Halifax, by April 7.

The *Southampton* Harbour Board invite tenders for a motor transformer with accessories. Tenders by April 7.

Tenders are invited until April 12 by the *French* Post and Telegraph Authorities for 460 tons of copper or bronze wire. Tenders to le Sous-Secretariat d'Etat des Postes et des Telegraphes, 103, Rue de Grenelle, Paris.

The *Berga* (Spain) Municipal Council require tenders for an electric lighting concession for 20 years. Tenders by April 16 to el Secretario del Ayuntamiento de Berga (Barcelona).

The *Roumanian* Post and Telegraph Administration invite tenders until April 10 for 20,000 large and 20,000 small porcelain insulators.

TENDERS RECEIVED AND ACCEPTED.

The Hastings Town Council have accepted the tender of the General Electric Co. for the supply of 100 electricity meters (10 and 20 amperes) at £5. 5s. each; and the tender of the Tudor Accumulator Co. for a storage battery of 510 ampere-hours capacity, and maintenance of same for two years, at £345.

The Bournemouth Corporation have accepted the tender of Messrs. Cecil Cooper and Co. for the supply of cables and arc lamps, and for wiring the pleasure grounds, at £395. 10s. The Brush Co. tendered at £460, and two other tenders were informal.

The Hull Corporation received the following tenders for two steel Lancashire boilers :—

Clayton, Son and Co. (*accepted*)	£1,305 15 0	Yates and Thom	£1,744
		Tetlow Bros.	1,480

The St. Annes on-Sea District Council have accepted the tender of the Tudor Accumulator Co. for the supply of storage batteries in connection with their electricity supply scheme, that of Messrs. Venner and Co. for Hookham meters, and of the Reason Manufacturing Co. for Wright demand indicators.

The tender of Mr. T. Godwin, Hanley, has been accepted by the British Electric Traction Co. for the erection of a power station at Wolstanton (Staffs.) at £10,097. 10s.

The Greenock Parish Council have accepted the tender of Messrs. R. Paterson and Co. for wiring the Council's offices.

The tender of Mr. Cutler has been accepted for wiring the Banqueting Room and the Old Council Chamber, Bath, for £176. 12s. 6d.

The Gloucester Council have accepted the tender of the National Electric Wiring Co. for wiring and fitting the Guildhall at £720. 5s. The tenders of Messrs. Bevan and Sons for wiring the public baths at £256, and that of Messrs. Alger and Sons for wiring the electricity works at £92, have also been accepted.

APPOINTMENTS VACANT AND FILLED.

The Sheffield Electric Light committee require an engineer to take charge of their electric light and power undertaking. Commencing salary £500 per annum. Applications to town clerk (Mr. Henry Sayer) by April 2.

The Islington (London) Vestry require a qualified mechanical draughtsman and a skilled mechanician for their electricity department. Further particulars are given in advertisements, and applications must be sent to the Vestry clerk (Mr. Wm. F. Dewey) by noon of April 9.

The Bexhill District Council require a fitter driver, a stoker, and a mains superintendent for their electricity works. An advertisement contains further particulars, and applications must be sent to the resident electrical engineer (Mr. W. T. Le Feuvre), electricity works, Bexhill-on-Sea, by April 7.

Mr. Sidney L. R. Price, of the Ayr Corporation electricity works, has been appointed resident electrical engineer at the electricity works of the Pembroke (Dublin) District Council.

The Barrow-in-Furness Electric Lighting committee have selected, out of 23 applicants, Mr. C. M. Davis, of the Scarborough Electric Supply Co, for the position of mains superintendent.

Mr. G. Ratcliffe Hulme, secretary of the Blackheath and Greenwich Electric Light Co., has been appointed district superintendent of the British Electric Traction Co. for the North Lancashire district.

Mr. A. C. Healey has been appointed charge engineer at the Gloucester electricity works.

BUSINESS NOTICES.

The old-established business of Mr. John Bellamy, tank and boiler works, Byng street, Millwall, London, E., has been for family reasons converted into a limited liability company. Particulars of the registration are given in another column. The business will be conducted as heretofore under Mr. Bellamy's personal supervision.

The Stewart Electrical Syndicate (Ltd.), importers and exporters of electrical plant, lamps and general supplies, have removed from No. 5 to No. 57, New Compton-street, Charing Cross-road, London, W.C.

Messrs. Handley and Shanks have opened a branch at Newton-chambers, Cannon-street, Birmingham, under the personal supervision of Mr. D. Shanks. The firm forward us a long list of electric lighting contracts recently carried out by them.

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Messrs. Max Hankin and Hy. Harris (trading as Hankin and Harris), electrical engineers and contractors, 64, High-street, Whitechapel, London, have dissolved partnership.

Messrs. A. E. D. Gould and C. A. Vandervell (trading as Vandervell and Co), electrical engineers, Thorpe Works, Cambridge-gardens, London, S.W., have dissolved partnership. Debts by Mr. Vandervell.

The Epstein Electric Accumulator Syndicate (Ltd.) have granted to Messrs. W. O. Rooper and Robins the sole licence to manufacture and sell Epstein accumulator plates and storage batteries. The firm will manufacture the plates by Mr. Epstein's original process with the assistance of many of his staff at their new works at Stafford.

BANKRUPTCIES, LIQUIDATIONS, &c.

A second dividend at the rate of 3s. in the £ is being paid in the matter of the Faraday Electrical Engineering Co. (Ltd.) (in liquidation). The liquidator (Mr. J. A. Bowes, C.A.) regrets that he cannot advise creditors to value their claims in this liquidation at more than 17s. 6d. in the pound, as the liquidation of Pattison's (Ltd.) is likely to result in a smaller dividend than was at first anticipated.

The examination of Arthur Reginald Earle, electrician, Theatre-street, Norwich, took place last week. Gross liabilities £104. 0s. 10d., expected to rank £925. 14s., deficiency £917. 19s. 4d. Debtor was formerly a solicitor's clerk, and in January, 1896, started business as an electrical engineer, having no experience other than that gained by private study. In twelve months he was compelled to execute a deed of assignment. His uncle paid a composition of 7s. 6d., and he resumed business immediately, but recently found he had a deficiency of over £900. He attributed his failure to loss on contracts, and in having to pay wages to workmen when idle. His assets were £7. Examination closed.

Claims against S. G. Trehearne and A. H. Crump (trading as Trehearne, Son and Crump), electrical engineers, and contractors, 155, Fenchurch-street, London, E.C., must be in by April 9. Mr. B. T. Norton, 9, Old Jewry-chambers, E.C., is trustee.

Claims against the respective separate estates of J. H. Clarke, 30, Bold-street, Southport, and B. Wild, 52, Forest-road, Southport, hitherto trading in partnership as electrical and general engineers under the style of Wild, Rothwell and Co., must be in by April 7. Mr. N. Yates, 4 and 6, Wood-street, Bolton, is trustee.

Creditors of Gutta-Percha Corporation (Ltd.) must send particulars of claims to the liquidator (Mr. E. Hayes), 28, Basinghall-street, London, E.C., by April 30.

A first and final dividend of 4¼d. in the bankruptcy of E. B. Pym, electrical engineer, 29, Brambam-gardens, South Kensington (late Bar-chambers, Scarborough), is payable at Bankruptcy-buildings, Carey-street, W.C.

An application for the discharge of J. A. Hirst, electrical and mechanical engineer (trading with James Fletcher as Fletcher, Hirst and Co.), Oak Cottage, Upton, Cheshire, and Curzon-street, Burnley, will be heard on May 17, at the Court-house, Burnley.

The adjourned public examination of F. B. de Foe Paynter, electrical engineer, 2, Faversham-road, Catford (late of Chiswick), will be held at Carey-street, London, W.C., on April 6. The proceedings have been transferred from the Greenwich County Court.

At a private meeting of the creditors of the Leeds Electrical Supply Co. on 19th inst. it was decided, subject to consent of creditors not represented, to accept upon certain conditions a cash composition of 8s. The liabilities are returned at £537, and assets £260. The creditors include :—

Veritys Ltd.	£65	Edison and Swan Co.	£22
Vandam and Co.	39	Van Hinden Electrical Co.	18
Baxendale and Co.	23	Heaton and Smith	13

Plant for Sale.—Messrs. Albright and Wilson (Ltd.), Oldbury, near Birmingham, have a Willans-Crompton steam dynamo for sale. See advertisement.

Messrs. A. Verey & Co., Dover, advertise some electrical instruments, arc lamps, wire, switches, &c., for sale.

Land for Sale.—Mr. Peter Newton, 4, Albert-street, Derby, has for sale about 20 acres of freehold land, conveniently situated and suitable for the erection of electrical or general engineering works. See advertisement.

B. T. H. Plant.—Pamphlet No. 43 issued by the British Thomson-Houston Co. deals with magnetic blow-out controllers for electric cranes, hoists, launches, and for general traction purposes. Three types of these controllers are illustrated. Pamphlet No. 37 deals with inclined-coil measuring instruments, several excellent examples of which are shown.

Westinghouse Plant.—Circular No. 1,018 issued by the British Westinghouse Co. deals with alternating-current switchboards for polyphase circuits for 100 to 600 volts. Circular No. 1,020 describes and illustrates alternating current switchboards for polyphase circuits. Circulars No. 1,021 and 1,022 are devoted to alternating current switchboards for polyphase circuits and to standard switchboards respectively.

Kelvin Instruments.—From Messrs. James White, of Cambridge street, Glasgow, we have to acknowledge the receipt of a well-executed catalogue of Kelvin instruments, some of which are of the well-known types, while many are quite new instruments, and the remainder show improvements on the older types. Dimensioned sketches of most of the instruments are given, showing over-all sizes, terminals, fixing holes, &c. The catalogue is very well arranged, and a general outline of their construction and use accompanies the illustrations.

Oilless Trolley Bushes and Wheels.—The rapid extension of the overhead trolley system of electric traction has called for various appliances designed to overcome the action of the atmosphere. Not a little trouble was in the early days occasioned by the difficulty of lubricating the little wheel and bush which is the point of contact with the aerial conductor on overhead systems. Oil proved a defective method of lubrication, as it was thrown off almost as soon as applied and ran down the pole, with consequent injury to the clothing of passers-by. Graphite was used, but wet or damp deteriorates its lubricating properties. Messrs. Fleming, Birkby and Goodall, of Woodfield Mills, Liversedge, Yorks, have recently placed on the market "oilless" trolley bushes and wheels, which we understand are giving general satisfaction. They are claimed to be truly self-lubricating, as the lubrication is constant, and consequently saves much wear and tear. They are impervious to the weather—an important feature with this class of device. We understand that the lubricant used is not graphite, although similar in appearance, being, in fact, the same compound as is used in the "oilless" loose pulley bushes and bearings manufactured by this firm, and known as "Entwistles." Many of these loose pulley bushes and bearings of large size have been working for ten years or more, in many cases, we learn, without the least sign of wear.

Electric Light and Traction Castings.—A useful show card of electric light and electric traction castings is sent out by Messrs. Rowland Carr and Co., of 6 and 8, Lime-street-square, London, E.C. Copies can be obtained by the trade on application.

"Magnolium."—Occasion was taken of the recent stay of the German Emperor at Hubertusstock to submit to his Majesty some samples of the new alloy "magnolium." The Emperor expressed the hope that the new metal might prove of great service in ship-building.

"Allan" Accumulators.—Messrs. Allan and Adamson (Ltd.) have just issued a new list describing and illustrating various types of Allan accumulators.

Circular Junction Boxes.—Messrs. Hayward-Tyler and Co. forward a leaflet describing an improved form of circular junction box for electric conduits. The boxes are made in three sizes—3½in., 4½in., and 6½in. The rim and cover are so turned that the box can be made perfectly watertight.

Dead-Beat Moving Coil Instruments—Messrs. O. Berend and Co., Basinghall-avenue, London, E.C., have just issued a new price list of Messrs. Hartmann and Braun's permanent magnetic dead-beat iron-cased moving coil instruments. Several types of these instruments are priced and illustrated. Copies of the list can be obtained by the trade only. The list is No. 26, section vi.

"General" Electric Progress.—Leaflet No. 25 issued by the General Electric Co. deals with small power motors, the "Byng" telephone, and an electric sealing-wax heater for bookbinders, printers, &c.

Fittings and Accessories Catalogue.—We have received from the Electrical Sundries Co. a fully-illustrated catalogue of electrical fittings and accessories. A varied assortment of fittings are shown, to which the illustrations do but scant justice.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from March 21 to March 27, with the ports of destination :—

Africa—Alexandria, £113 (telegraph material); Cape Town, £94; Durban, £1,247 (including £524 telegraph material); East London, £174; Port Said, £24; Port Elizabeth, £281 (telegraph material); Zanzibar, £96. *Argentina*—Buenos Ayres, £245 (including £178 telegraph material). *Australasia*—Adelaide, £30; Christchurch, £35; Melbourne, £2,348 (including £2,228 telegraph cable); Rockhampton, £80 (telegraph material); Sydney, £543; Wellington, £1,037 (including £470 telegraph material). *British Guiana*—Demerara, £261 (telegraph cable). *Ceylon*—Colombo, £91. *Channel Islands*—£100. *China*—Shanghai, £143. *Cochin China*—Saigon, £30. *Denmark*—Copenhagen, £108 (including £47 telegraph material). *France*—Boulogne, £22; Rouen, £65. *Holland*—Amsterdam, £150. *Hong Kong*—£480. *India*—Bombay, £37; Calcutta, £501. *Japan*—Hiogo, £190; Nagasaki, £144; Yokohama, £231. *Madeira*—£25. *Malta*—£21. *Peru*—Callao, £3,360 (telegraph cable). *Spain*—Barcelona, £55; Cadiz, £270. *Straits Settlements*—Singapore, £87. *Sweden*—Stockholm, £209 (telegraph material). **Total £12,935, against £7,481 in the corresponding week last year (March 22 to 28).**

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MUNICIPAL, FOREIGN, AND GENERAL NOTES.

Asylum Lighting.—The new Hendon Asylum, which was opened yesterday (Thursday) is lighted electrically. The installation was provided by Messrs. Hampton and Sons to the specification of Messrs. Owen Lucas and Pyke. The plant is in duplicate, and consists of two 60 I.H.P. Willans compound central-valve engines, working at a pressure of 115lb. to 125lb., and two 37 kw. dynamos by Messrs. Easton, Anderson and Goolden, capable of working at a voltage of 110 to 140 volts. The accumulator battery consists of 90 E.P.S. K27 type cells and 10 central station cells. The engine-room main switchboard and the main switches were supplied by the General Electric Co. The wiring is carried out on what is practically a three-wire system, the object being that after a certain hour one side can be cut off from the engine-room, thus cutting out half the lights throughout the building, the remainder being put on to the battery for light at night. The distributing system is, however, so arranged that any ward can have its full light on by the change over of a fuse on one side of the three-wire arrangement to the other, each ward having its own fuse box in the corridor adjoining. The whole of the mains are run in iron barrel in concrete trench provided for the purpose, and the wire generally is surface wiring in casing. There are about 1,000 8 c.p. and 16 c.p. lamps installed. A complete telephone service on the intercommunication system has also been provided.

Barking.—The statement of accounts presented by the Lighting committee at the last Council meeting showed that the profit on private lighting was £62. 6s. 8d., but on street lighting there was a loss of £34. 13s. 7d.

Bath.—At a meeting of the Electric Lighting committee last week it was reported that the tenders for smokeless steam coal showed such an enormous advance upon the price at present paid that it was estimated if they were accepted it would mean an additional expenditure for the year of £2,000. It was decided not to enter into contracts, and to consider the advisability of adopting mechanical stokers and forced draught.

Bermondsey.—The Vestry recently decided to demolish 46 houses in order to clear a site for its proposed electricity station, and consequently about 300 persons have been dispossessed. As the Vestry do not possess powers for carrying out a re-housing scheme, it proposes to give sums varying from £2 to £10 to each householder as compensation for disturbance, and to pay the cost of the tenants' removal. These terms have excited considerable opposition, and a meeting was held at the Town Hall on Tuesday, when a resolution condemning the action of the Vestry, and calling upon the Local Government Board to hold an inquiry was carried.

Bristol.—An inquiry was held here last week into the application of the Corporation to borrow £145,150 for electric lighting. It was stated that the present electricity works had been in successful operation for seven years. During the last six years the demand for current had increased from 14,000 to 81,100 8 c.p. lamps. The increase last year (18,100 lamps) was larger than in any previous year, and part of the present loan was for additional plant for the Temple Back station and for acquiring adjoining property. They could not obtain sufficient land for extensions at Temple Back at a reasonable price, and 9½ acres of land had been secured at the Avonbank estate. The Local Government Board had sanctioned the borrowing of money for the purchase, and a large proportion of the present loan was for the erection of buildings and plant. The undertaking would not be a charge to the ratepayers, because it was working at a profit. The receipts for the year ended 25th March were £26,223, expenditure £13,592, credit balance £12,630. If they deducted the £6,301 profit on public lighting, the net profit amounted to £6,329 ; and after paying sinking fund instalments, interest, &c., they had £2,000 clear in hand. The extension which took place last year would continue, and they had now made provision for sufficient plant for three years. The whole of the present loan was to be expended upon plant which would supply current to private and not to public lamps. The city electrical engineer (Mr. H. Faraday Proctor) gave technical particulars of the scheme. The piling of the site and the underground work would cost about £16,000. The extension at Avonbank at present proposed would have a capacity of 1,840 kw., equal to about 60,000 lamps. The cost worked out at a fraction under £80 per kw. The chairman of the Electric Lighting committee (Ald. Pearson) said the undertaking was no charge upon the rates at all, and had not been for the past five or six years. He found Bristol considerably handicapped in the conduct of its business owing to the shortness of the term the Local Government Board had thought right to put upon Bristol for repayment of capital borrowed. The position at Bristol was that they had spent nearly £199,000 up to March last, and had repaid up to last year £64,000, while he found that Glasgow, with a far larger capital, paid back a much smaller sum annually. He suggested to the inspector, as representing the Local Government Board, that the hardship of which he complained applied to a number of English towns, because, on the basis of Glasgow, instead of charging 5d. per unit for electricity as Bristol did, they could supply it at 4d. This interfered with the extension of their works by keeping aloof those who felt justified in paying 4d. but not 5d. The borrowing terms granted in London by the London County Council were more favourable than those given to the provinces. During the next 12 months Bristol would spend large sums of absolutely unremunerative money, and the charge upon that money would have to be earned from the consumers of electricity to-day. The committee could not tamper with the present price of current with the knowledge they must provide for sinking fund on the new outlay before it had become remunerative. The inspector suggested that several of the largest cities owning electricity works should combine to represent these matters to the Local Government Board.

The Corporation are recommended to submit the plans of the new electricity station at Avonbank to Sir William Preece for report.

Cardiff.—The mains superintendent (Mr. H. Pengelly) has tendered his resignation, and a successor is to be advertised for at £150 per annum.

Celebrations.—In celebration of the silver wedding of Mr. J. W. Edmundson, managing director of the Sunbeam Lamp Co., a complimentary entertainment was held at Gateshead on Saturday last. The mayor of Gateshead presided, and was supported by a numerous and influential gathering. On behalf of the employés, Mr. T. J. Grainger, secretary, presented Mr. Edmundson with a framed illuminated address, and to Mrs. Edmundson a silver-mounted dinner gong, as a token of goodwill and respect. The company were entertained by Mr. T. H. Harrison with a display of electrical effects with vacuum tubes, and at the conclusion of an interesting entertainment Mr. and Mrs. Edmundson invited the company to supper.

Charge for Electric Current in the City of London.—The City of London Electric Lighting Co. announce that from the dates when the meter readings for the March quarter are taken and until further notice the following revised rates of charge will be made for electric energy supplied from either the alternating or continuous current mains : For motors, 2½d. per unit (as hitherto) ; for lighting up to 12 units per annum per 8 c.p. lamp fixed or its equivalent, at the rate of 8d. per unit ; in excess of such 12 units, 2d. per unit. It is explained that 12 units per annum per lamp is approximately equivalent to one hour's daily use of an 8 c.p. lamp, and that the object of the company in making these changes is to benefit consumers who use their lamps for long hours. In cases of mixed installations of many long-hour and a few short-hour lamps arrangements will be made upon application so that consumers may derive the full benefit of the scale in respect to their long-hour lamps.

Chatham.—A sub-committee has been appointed to confer with the directors of the Chatham, Rochester, and District Electric Light Co. on the purchase of the company's undertaking by the Council.

County of London Co.—The following statement of electricity generated, sold, &c., in 1899 has been issued by this company :—

	City-road Station.		*Wandsworth.*
Units generated	1,199,094	...	1,068,230
Units sold	920,094	...	846,421
Units used on works	29,584	...	26,301
Total accounted for	949,678	...	872,722
Unaccounted for	249,416	...	195,508
Maximum supply demanded	1,290 kw.	...	781 kw.

Dublin.—An inquiry was opened on Friday last into the application of the Corporation to borrow, among other sums, £254,000 for electric lighting extensions. After an application for a postponement of the inquiry had been refused, the town clerk (Mr. H. Campbell) gave formal evidence, and the city accountant (Mr. J. Kerrigan) gave particulars of the financial position of the Corporation. Mr. Macinerney (for the Corporation) called Prof. Silvanus P. Thompson, who stated that he had considered the scheme prepared by Mr. R. Hammond, and regarded it as an excellent one. It involved the superseding of the machinery in the present station, which could not be used for distributing purposes. He thought the Pigeon House site an excellent one for a generating station. It was the modern practice to have large generating stations outside large centres of population. He believed that a site equal to the Pigeon House could not be had so cheaply at any other suitable place. They had at the Pigeon House the great advantage of being close to the sea. Among other advantages arising from that fact he mentioned that they would save the cartage of coals. Speaking generally, he approved of the system proposed to be adopted. There would be no difficulty in combining the present single-phase with the proposed three-phase system in Dublin. Under all the circumstances he thought the system was the best that could be introduced. All experience pointed to the economy of having only one station, and small stations were being given up. Ald. Meade, chairman of the Electric Lighting committee, stated that the idea was to have the best possible system of electric lighting in the most economical way. Until last session the Corporation had not power to borrow money in order to comply with their provisional order to supply citizens with electric current. The Corporation would be able to generate and supply electric current cheaper than anyone else could do

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it. Mr. Robert Hammond, consulting engineer to the Corporation, said he had carried out electric lighting schemes in different parts of the kingdom to the value of £2,000 000 sterling. In the earlier days of electric lighting Fleet-street, Dublin, would have been looked upon as a very good site, but the demand for current for lighting and other purposes had so increased that that site was entirely occupied now and some alternative site must be found. Any difficulty of distance between the centre of generation and the area of distribution had been got over, and economical generation was now more important than economical distribution. The Pigeon House site was about three miles from Fleet-street. In the Deptford (London) scheme the generating station was five miles from the distribution area. There was an extensive scheme for Brighton (Sussex), three miles from the point of supply. Access to coal and water were important desiderata, and at the Pigeon House there was cheap and easy access to sea-borne coal: the sea water was not going to be used in the boilers—they would use Vartry water—but they would use the sea water for condensing purposes. There was also ample space for extension, and it would not be a nuisance or annoyance to anyone by smoke or vibration. He looked forward to the time when combustion within a city would be deemed illegal. The scheme was designed to give a supply of current to the equivalent of 100,000 8 c.p. lamps. The electricity would be transmitted at 5,000 volts to Fleet-street, from Fleet-street it would be transmitted to 19 sub-stations as three-phase current of 5,000 volts, and it would be there transformed down to proper pressure for the working of incandescent lamps. Mr. Hammond referred to Mr. Arthur Wright's new scheme at Brighton, for which Parliamentary powers are being sought. He said that Mr. Wright's present cost of distribution was 1·68d., and Mr. Wright said he could immensely economise by being allowed to have a generating station in the outskirts. Witness believed they could distribute electricity in Dublin at 1½d. per unit. Under his scheme the total annual earnings were estimated at £38,500 and the gross profits £21,969. The scheme was so devised that by a little extension they would largely increase their profit, bringing it up to £34,800. Witness next explained the various items of expenditure in detail. With regard to the supply to the present restricted area, he proposed to convert a certain quantity of the current at Fleet-street from three-phase to single-phase, and to distribute it over the present high-tension feeders. There would be no difficulty in working the old district in that manner as part of the new scheme, and thus preserve all the present carefully-spent money. In cross-examination by Mr. Healy, Q.C., who opposed on behalf of some ratepayers, Mr. Hammond said he was told that the Pigeon House Fort was available, and he was quite aware it was situated outside the jurisdiction of the Corporation. The Corporation could build generating works, but must get leave to lay mains. He knew it was in the county of Dublin, but it was going to be put into the city by the Corporation extension bill. Witness was examined at some length in reference to a number of towns in which the continuous-current system of supply had been adopted. There was nothing like the proposed Dublin installation anywhere in this kingdom, but in many American towns high-pressure alternating current was adopted. In all places where the continuous-current system of supply was established they were either old towns or small districts which could be worked by low pressure. There was a controversy as to whether continuous-current arcs or alternating arcs were better. He had provided a sufficient sum to have either. His present opinion was in favour of utilising an alternating current, but it was entirely open, and he had not specified for either yet. The result of brilliantly lighting a city at night was to put down crime and reduce the number of police—an arc lamp was equal to a policeman. In reply to the inspector, Mr. Hammond said he did not think the success of the scheme depended on the passage of the Boundaries Bill. A big city's lighting must be laid down on such a basis that it would extend. One way of getting the wayleave for those mains outside the jurisdiction of the Corporation was by the consent of the local authority; another way was to lay the mains, and then, he understood, the local authority could not legally take them up again. He then gave some particulars of the Montreal electricity station. The power was generated at the Lachine rapids on the St. Lawrence, and transmitted to Montreal. They were feeding at the present time about 1,500 polyphase motors, which were supplied from the lighting circuit at low pressure. At New York the system proposed for Dublin was also in successful operation. Mr. S. Z. de Ferranti said that he had considered Mr. Hammond's scheme fully, and had been over the ground and over the site of the proposed generating station. He approved of the scheme, and considered it capable of supplying current to the city on the best commercial basis. The reasons for having generating stations outside large centres of population were sound and practical, and that course was being followed all over the world. The present Fleet-street site was suitable for distribution, but not for generation. To his mind the system was absolutely as good as any other, and broadly speaking, it was the most economical way of supplying the city with light and power. The three-phase system was better for power and lighting where there was a large area. With a three-phase tramcar motor they would require a double trolley wire overhead, and he would like to know where they would be if they had their present system of cobwebs doubled. The cost of generating at present must be very much higher than it would be under the new plan. He thought it would take about two years before the Pigeon House system could commence to run. Mr. W. B. MacCabe, the assistant waterworks engineer to the Corporation, and Mr. Mark Ruddell, electrical engineer and electrical superintendent for the Corporation, also gave evidence.

Yesterday (Thursday) the witnesses for the Corporation included Mr. Spencer Harty, city engineer, and Mr. H. Hellins, resident engineer of the main drainage works. Mr. T. M. Healy, M.P., opened the case for the opposition, on whose behalf Mr. Arthur Wright gave evidence and was under cross examination by Mr. Seymour Bushe when the inquiry was adjourned.

The Dublin United Tramways Co., under date 26th inst., have repeated their offer to the Dublin Corporation of November, 1897,* to undertake to supply current to the Corporation for the electric lighting of the city. The company now offer to deliver to the Corporation at Ringsend, at all hours of the day and night, all the electric energy required for public and private lighting and for motive power. The company consider that, with the exceptional advantages they possess, they could with profit to their shareholders deliver current to the Corporation at a price below Mr. Hammond's estimated cost of civic production. The following are the terms offered by the company:—

For a consumption of—		Cost under Mr. Hammond's scheme, including loss on tranformation—
660,000 units	2½d. per unit.	..... 4·55d. per unit.
1,300,000 do.	2¼d. do.	..... 3·15d. do.
2,600,000 do.	1⅞d. do.	..... 2 45d. do.

Under this proposal it is urged that the Corporation would retain the entire monopoly and control of the electric lighting of Dublin, and would deal exclusively with consumers, while the Tramway Co. would be employed solely as manufacturers of current. If the Corporation should be disposed to entertain an offer from the Tramway Co. to undertake, under civic regulation and control, the entire business of distributing as well as generating electric energy for light and power in the city, the company would be prepared to contract on the following basis:—

1. The company to take a transfer of the lighting order and of all the electric lighting property of the Corporation.
2. The company to assume the existing liabilities of the Corporation, and the repayment of the loan with interest.
3. The company to supply electric energy for all purposes at a price calculated not to exceed an average for the first million units of 4½d. per unit, for the second million units 4d. per unit, and for all in excess of the second million units 3d. per unit. The company to hand over to the Corporation any surplus which they may realise in excess of the foregoing average prices.
4. Electric energy for public lighting, included in the above average prices, to be supplied at 2½d. per unit.

Dundee.—The amount of electricity rental in February was £170. 19s. 8d., making £6,033. 16s. 7d. for the past ten months, an increase of £1,107. 6s. 11d. over the corresponding period last year.

Electricity in Mining.—At a recent meeting of Hannan's Mount Ferrum Gold Mines (Ltd.), the chairman (Mr. J. Head) said they began their boring operations with steam power, but found that caused so great a strain on the boilers that electric power was finally introduced, and with that their machinery had been working satisfactorily and boring had been going on at a reasonably rapid rate.

In a circular issued by the joint managing director of the Hampton Plains Estate (Ltd.) it is stated that the electric power station for the Victorian Deep Leads properties (in which the company is interested) has been completed and the whole of the generating plant installed, and is ready to supply power to the various shafts. The whole of the pumping and hoisting plant will be run by electric power.

Electricity in the East End.—Some time ago the County of London Co., which possesses electric lighting powers for the districts of Limehouse, St. George's in the East, and Mile End, gave formal notice to the local authorities of these districts that they proposed to put their provisional order into force. The two first-named authorities approved the company's proposals, but objection was taken by the Mile End Old Town Vestry, who appealed to the Board of Trade, as no steps had been taken to put the order into force within the period specified (two years). When the matter came before the Board of Trade the Vestry's objections were, however, confined to the lack of information contained in the notice and plans submitted by the company; and we understand that the Board of Trade have decided in favour of the Vestry on this technical point, and accordingly fresh notice will have to be given by the company.

A conference was held yesterday (Thursday), at the Board of Trade, to consider the applications of the Vestries of Mile End Old Town and St. George's-in-the-East for provisional orders. The County of London Co. already possess electric lighting powers for these districts.

Exhibition.—An exhibition is now running at Bingley Hall, Birmingham, described as the sixth exhibition of engineering and

* See *The Electrician* for Dec. 3, 1897, p. 206.

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general trades. The exhibitors include a number of leading firms of engineers, and the exhibition is noticeable for a more than usually complete show of gas engines. An attractive feature is the display of electrical apparatus, chiefly for domestic installations.

Hanley.—Sanction to a further loan of £5,019 for electric lighting extensions has been obtained, and application is to be made for a loan of £9,500 for refuse destructor works.

Hornsey (London).—A meeting of ratepayers was convened by the District Council last week to discuss whether expenditure should be incurred in opposing the bill of the North Metropolitan Electric Supply Co. Mr. C. F. Cory Wright, J.P., who presided, said the Electric Lighting committee had before them the report of an expert with regard to their electric lighting order. The committee had invited the companies who had applied for powers to supply the district with current to submit tenders. A resolution was carried to oppose the North Metropolitan Co.'s bill.

Horsham.—Fifty-nine firms have tendered for the supply of electricity generating plant recently advertised, and these tenders have been referred to the consulting engineer (Mr. W. C. C. Hawtayne) for analysis and report.

Ilford.—Formal sanction to a loan of £70,000 for electric lighting and electric tramway purposes has been obtained by the Council.

Lancaster.—At a meeting of the shareholders of the Lancaster Tramways Co., on Saturday, the offer of the Corporation to purchase the tramway between Lancaster and Morecambe in order to work it in conjunction with the projected system of municipal electric tramways which they propose to construct at a cost of £70,000, was rejected. The company's lease has 11 years to run, and the offer of the Corporation is 15s. per ordinary share (£1 each) and £1 for the preference shares (also £1 each). The shareholders decided to entertain no offer under £1 per share. The Corporation have now dropped the purchase clause of their Bill.

Light Railways.—The inquiry into the application to construct a system of light (electric) railways in the county of Middlesex was resumed on Monday, when the Earl of Jersey said that on Saturday the Commissioners went over the proposed routes, and would not sanction line No. 4 (North Finchley to Hampstead); and the same comment would apply to part of No. 8 (No 4 to Hendon station). Mr. Carrington, for the promoters, said that under the circumstances he withdrew No. 7, which was for a line to run from Stanmore. He also withdrew No. 5 from Hampstead to Neasden and the remainder of No. 8. Evidence as to the Finchley portion of the scheme was taken, and the inquiry was again adjourned.

An inquiry was held at Barnet on Wednesday into the application of the Herts County Council and the Metropolitan Tramways and Omnibus Co. for an order authorising the construction of light electric railways in Hertfordshire.

The Battersea Vestry on Wednesday decided to support the application of the London County Council for powers to construct light railways Nos. 1 and 2 (in Clapham, Wandsworth, &c) at the forthcoming inquiry by the Light Railway Commissioners.

London County Council.—At Tuesday's meeting a report was presented from the Finance committee on an application by the Shoreditch Vestry for a loan of £96,000 to cover cost of erecting and equipping a new electric generating station. The building works required £32,098, but as drawings were not yet completed, the committee recommended that sanction be given for only £28,000. The engineering works would require £63,905, but as the type of boiler to be adopted and the arrangement of steam and other piping had not been settled, the committee proposed that only £42,000 should be sanctioned. The recommendations were agreed to.

The recommendations of the Improvements Committee to contribute a sum up to £11,750 for the widening of West-hill, Wandsworth, on condition that the Wandsworth Board of Works did not oppose the Council's scheme for the construction of a light railway from Clapham to Putney, or any similar scheme, met with some opposition, Mr. Cohen, M.P., expressing the view that the Council would not so glibly vote money for improvements if it were not for the tramway scheme. The vote was agreed to.

It was agreed, on the recommendation of the Highways committee, that the Council should take proceedings against the London Electric Supply Corporation in respect of "failure to maintain a proper supply of electric current" within the area of the Greenwich District Board of Works.

London County Council Loans to Local Authorities.—A conference of London Vestries interested in electricity supply was held at Islington on Thursday last, to discuss the method of procedure adopted by the London County Council in connection with loans to local authorities. The Islington, Fulham, Hammersmith, Hampstead, Newington, St. Pancras, Shoreditch, and Whitechapel Vestries were represented. Mr. G. S. ELLIOTT, L.C.C., presided, and explained that matters were almost at a deadlock at the electric lighting works of the Islington Vestry in consequence of the refusal of the Council to sanction the full amounts required for developments. At the outset he thought the Council was right, but upon making further inquiries he found that the Vestry had supplied every necessary detail. The Council agreed to sanction loans for £10,000 and £38,000 in place of £13,200 and £56,261 asked for, and the Vestry had declined to accept the Council's offer. Mr. W. F. DEWEY (vestry clerk of Islington) read the correspondence with the Council, and Mr. DRYDEN (chairman of the Islington Finance committee) moved—

That this conference of representatives of local authorities in the metropolis who are also electric lighting undertakers is of opinion that the procedure of the London County Council in connection with sanctions to loans for electric lighting purposes is not warranted by statute or by the practice of other sanctioning authorities, and that such procedure tends to undue delay in the carrying out of important works, as well as to unnecessary expense and waste of official time on the part of the local authorities engaged in such works.

Mr. T. GREEN (Fulham) seconded, and after discussion the resolution was adopted with only one dissentient, but several delegates not voting. Dr. SMITH (St. Pancras) said the Islington Vestry appeared to have tied their own hands by passing a resolution not to commence any work without the sanction of the County Council. Had St. Pancras waited for the sanction of the Council before they proceeded with different works, the electric lighting of the parish would probably not have been completed now. The CHAIRMAN said that sec. 183 of the Metropolis Local Management Act said nothing beyond the granting of sanction in writing, and that was the only reference in the whole of the Act to the matter. Mr. R. GORDON (Islington) moved—

That, in the opinion of this conference, the practice of the Local Government Board of holding a public inquiry in the locality by a competent inspector, at which opportunity is afforded to ratepayers who may object to attend and state their objections, and where, in the absence of such objections or other special circumstances, the *ex parte* evidence of the officials and experts of the authority applying for the loan is accepted as sufficient to justify the application, should be followed by the County Council.

On a show of hands the voting for this proposal was equal, and the motion dropped. On the motion of Dr. ROBINSON (Shoreditch) a resolution was agreed to:—

That the London County Council be requested, in their forms for detailed particulars, to follow the Board of Trade forms, so as to harmonise with the bookkeeping system in which electricity accounts are bound to be kept.

Manchester.—A special sub-committee has been appointed to visit Berlin and Hamburg, to report upon the administration of the tramway service in those cities. The committee will consist of Councillors D. Boyle (chairman of Tramways committee) and W. H. Wainwright, Dr. Bishop, and J. M. McElroy (general manager of the tramways department).

Mangotsfield (Bristol).—The Parish Council are considering the question of improving the lighting of the district, and information as to the cost of electric and gas lighting is being collected by the chairman (Mr. Latrobe).

Marylebone (London).—A conference was held at the Board of Trade last week in connection with the application of the Marylebone Electric Lighting Co. for a provisional order. Opposition was offered by the Metropolitan Electric Supply Co. (who already possess powers for the district), the Marylebone Vestry (who are anxious to obtain powers, and who have endeavoured to obtain possession of the Metropolitan Co.'s undertaking in the district), and by the London County Council (whose representative supported the views of the Vestry). After hearing the arguments of the various parties, Sir Courtenay Boyle, K.C.B., reserved decision.

Newbury.—The Council have decided to call in an electrical expert to report upon the question of putting their provisional order into force.

Newcastle-upon-Tyne.—Application has been made for sanction to borrow £10,000 for the electric lighting of thoroughfares through which the tramways will run. Nearly 200 arc lamps will be erected.

Opposition to Electric Power Schemes.—At the present time local authorities are doing their utmost to procure the rejection of the bills now before Parliament for powers to generate and supply electric current in bulk. Judged by the proceedings at a recent public meeting at Moss Side no very great alarm is felt by the general public at the prospect of these bills being passed, as at the conclusion of an ordinary meeting of the Council a public meeting was held to confirm a resolution that the Lancashire Electric Power Bill and the Manchester Corporation Tramways Bill should be opposed. No member of the public put in an appearance, but a formal resolution, sanctioning the opposition, was proposed by the chairman and carried.

The Glamorgan County Council have declared in favour of the main principles of the South Wales Electrical Power Distribution Bill, and opposition is to be confined to the insertion of clauses for safeguarding the Council's interest in roads, bridges, and thoroughfares under their control.

Paisley.—The financial statement of the electricity department for the year ended Dec. 31 gives the loan capital at £60,000, of which borrowing powers have been exercised to the extent of £51,520. The working expenses amounted to £1,475. 3s. 7½d., interest to £1,039. 11s. 4d., and with £681 for sinking fund made a total of £3,195. 14s. 11½d. The revenue amounted to £1,307. 14s. 1d. —£1,037. 13s. 7d. for private and £270. 0s. 6d. for public lighting.

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The deficit was £1,888. 0s. 10½d., and is chargeable to the Gas Corporation. The accounts have been passed.

The Council have arrived at an understanding with the Glasgow District Tramways Co. as to the construction of electric tramways. The company acquire the right to lay, electrically equip, and work tramways within the burgh for 42 years, the Corporation retaining the right of purchase at 25 or 35 years upon a valuation. The company are to pay a rent of £400 per annum for the first five years and £500 per annum after. Current is to be taken from the Corporation.

Para (Brazil).—A considerable improvement in the tramways system of this city is taking place as electric traction is superseding the old horse lines. Nearly all the locomotion in this city is performed by the tramways.

The shipments of india-rubber from Para during 1898-99 totalled 25,246 tons, of which 14,029 tons were "fine." This compares with 22,218 tons in 1897-98 of which 12,337 tons were "fine." The State of Para was responsible for nearly 10,000 tons of the 1898-99 crop.

Poplar (London).—On the recommendation of the electrical engineer (Mr. A. Blackman) it has been decided to light 13¼ miles of side streets with two 8 c.p. incandescent electric lamps upon each existing lamp-post. The additional cables are to be supplied and laid by the British Insulated Wire Co. in extension of their present contract at a *pro rata* charge. The Board's surveyor will, however, execute the necessary street work. Tenders are to be invited for the conversion of the existing lamp-posts in accordance with the design prepared by Mr. Blackman, and application is to be made to the London County Council for a further loan of £16,150 to defray the cost of the proposed extensions.

Private Bill Legislation.—The City and South London Railway Bill was read a third time in the House of Commons on Friday.

The Glasgow District Tramways Bill was considered by the House of Lords Standing Orders committee on Monday. The object of the bill was to authorise two systems of tramway, one on the south and the other on the north side of the Clyde. The County Council of Dumbartonshire had refused consent, and the promoters had to strike this portion out of the bill. The bill, shorn of this portion, was allowed to proceed.

A House of Lords committee has passed the Ipswich Corporation bill authorising the borrowing of £153,000 for the construction of electric tramways and carrying out improvements.

The Burnley Corporation Tramways Bill has been passed by a House of Lords committee.

Rickmansworth.—The Works committee are considering the proposals submitted by Mr. F. J. Warden Stevens for the erection of electricity works.

Rotherham.—An inquiry was held here on Wednesday into the application of the Corporation to borrow £26,969 for electric lighting. The assistant town clerk (Mr. Thurgarland) supported the application, and gave particulars of the assessable value of the district and of the steps taken in connection with the undertaking. Contracts to the amount of £15,138. 1s. 8d. had been conditionally let. The arc lighting section had, however, been deferred. Mr. B. M. Jenkin, partner of the consulting engineer (Prof. Kennedy), gave technical details. He said the station would supply current for public and private lighting, and the system of supply would be the continuous current three-wire at 230 volts. The plant would be capable of supplying current to the equivalent of 10,000 8 c.p. lamps wired for private lighting. The total capacity of the generating station would be slightly over 200 kw., and two storage batteries, each of a capacity of 250 ampere-hours, would be provided. The mayor (Mr. G. Gummer) also gave evidence in support of the application, which was unopposed.

Runcorn.—In a report recently prepared for the Council, the consulting engineer (Mr. T. L. Miller) recommends the erection of electricity works capable of supplying current to the equivalent of 2,500 8 c.p. lamps alight at one time, or 4,100 8 c.p. lamps fixed in consumers' premises, at a total estimated cost of £20,500. The report states that, assuming the scheme for the construction of an electric tramway between Weston and Warrington and the bridge between Runcorn and Widnes to be successfully carried through, and the Council had the contract to supply electricity, as was proposed, a handsome return would be made on the capital expended. The most suitable system of distribution was the direct current three-wire, with 230 volts pressure at consumers' terminals. The maximum demand system of charging—7d. per unit for one hour's maximum, and 2d. per unit afterwards—was also recommended. The report has been discussed by the Council, but it has been decided to take no action at present.

St. Pancras.—At a meeting of the Vestry on Wednesday it was reported that the accounts of the electricity undertaking for the past year, which were very satisfactory, would be presented at the next meeting by the Electricity committee, when certain reductions in the prices charged for current would be recommended. An expenditure of £473 for extensions of mains in Allcroft-road and King's Cross-road has been sanctioned.

The salary of Mr. J. T. Baron, resident engineer at the Regent's Park station, has been increased from £300 to £310 per annum, with apartments, coal and light, and with annual increments of £10 to a maximum of £350.

Salford.—An inquiry will be held on April 5 into the application to borrow £227,392 for electric tramway purposes.

Shanghai.—Dr. Cassirer and Co., of Charlottenburg, Berlin, recently obtained an order for the supply of about 20 kilometres of telephone lead cable, with paper and air insulation, in connection with the scheme for the erection of a telephone exchange at Shanghai.

Ship Lighting.—The new Cunard royal mail steamer "Ivernia" has been provided with electric lighting plant by Mr. Marsden, Glasgow. A small electric motor has been erected in the hairdresser's shop for hair brushing, and ventilation is effected by means of electrically-propelled ventilating fans.

Smethwick.—It has been decided to engage an expert to report upon the terms of the Midland Electric Corporation for Power Distribution for supplying electric current in the district.

Smoke Nuisance.—At the Westminster Police Court, on Tuesday, the Westminster Electric Supply Corporation were again summoned for smoke nuisance on three different days at their Millbank-street station. For the defence Mr. Fowler, solicitor, said the directors regretted the offence, but they could not help themselves: they had paid 40s. a ton for coal, some of which was not smokeless, and they had tried many expensive appliances. They were now erecting a large fan to increase the draught. Mr. Horace Smith said he must see the law, as it stood, was not broken, and fined the Corporation £30 and costs on the three summonses.

Spennymoor.—The Council have accepted the conditions of the North of England Electric Supply Co. for establishing electricity works. The company is applying for a provisional order.

Teddington.—The Council have resolved to apply for a provisional electric lighting order. The application of the Richmond (Surrey) Electric Light and Power Co. has already been abandoned, and that of the Twickenham and Teddington Electric Supply Co. is being opposed.

Telephone Areas.—The secretary of the Walsall Chamber of Commerce (Mr. F. Rathbone) reported at the annual meeting of the Chamber on Monday that he had been in communication with the National Telephone Co, urging that Walsall should be included in the Birmingham area, which included places farther away from Birmingham than Walsall. He had received a reply intimating that the boundaries were fixed by the Post Office, who had control of the trunk lines. In fixing boundaries there were sure to be some anomalies, and there was no likelihood of any change being made. Further steps are to be taken by the Chamber to remedy what is regarded as a grievance.

Telephone Facilities at Pembroke (Dublin).—An agreement has been arrived at between the District Council and the National Telephone Co. in regard to the laying of underground pipes and conduits for the company's wires. The terms are: £10 per annum per mile of trench opened, 10s. per manhole, 12 fire alarms at £3. 10s. per annum each, one exchange wire to the Town Hall free, one drainage works wire free, one electricity station wire free, 1s. per annum per pole for poles, and subscribers to be on the same terms as those in Dublin city.

Telephone in North London.—At the Islington (London) Vestry meeting last Friday a communication was received from the National Telephone Co. asking for an extension of time to retain certain wires, as without this extension they would have to disconnect subscribers. The Works committee deal with the matter.

The Nernst Lamp.—The Allgemeine Elektricitäts Gesellschaft owners of the Continental patents of the Nernst lamp, announce that the manufacture and production of this lamp have been demonstrated, and they hope to be able to place the new lamps upon the market in the autumn. Steps are being taken, in conjunction with the banking house of Rothschild Frères, for the manufacture of the lamp in Paris, and for this purpose it has been arranged to transfer some of the workmen at the Berlin works to the French capital.

Todmorden.—Messrs. Medhurst and Page have been appointed consulting engineers to prepare a report on the proposed electricity supply and traction scheme.

Walker.—Terms have been arranged with the Newcastle-upon-Tyne Electric Supply Co. for supplying electric current for public and private lighting in this district, and opposition to the company's bill has been withdrawn.

Walsall.—An inquiry was held on Friday into the application of the Council to borrow £15,000 for electric lighting extensions. The town clerk (Mr. J. R. Cooper) said the electricity undertaking was making steady progress, and last year (the fourth year of working) there was a profit of £61. The demand for electric current had outgrown the present capacity of the station. Last year the output was 50 per cent. in excess of the previous year, and the Corporation, with

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a view to encourage the use of electricity, had reduced the price of current for motive power, with the result that a further considerable increase in the demand was anticipated. Extensions had therefore become an absolute necessity. The loans already sanctioned amounted to £30,350. Mr. Brownhill (chairman of Electric Lighting committee) and Mr. Alex. Wyllie (borough electrical engineer) gave evidence as to the details of the scheme. There was no opposition.

Electro-Harmonic Society.—A smoking concert (the last concert of the season) will be given this (Friday) evening at the International Hall, Café Monico, Piccadilly-circus, London, W., at 8 o'clock.

COMPANIES' MEETINGS AND REPORTS.

London Electric Supply Corporation (Ltd.).

The ordinary general meeting of the shareholders of this corporation was held at the Cannon-street Hotel, on Wednesday, under the presidency of the Right Hon. LORD WANTAGE, V.C., K.C.B.

The SECRETARY (Mr. H. C. Carter) having read the notice calling the meeting,

The CHAIRMAN said: I am pleased to welcome a good attendance of shareholders to-day. You have come to hear the accounts which your directors will give to you of the company's proceedings during the past year, but before doing so permit me to introduce to you Sir William Preece, who sits on my left, whom we have elected on the board in place of Mr. Roger de Quincey, who resigned owing to ill-health. We are fortunate in having obtained the services of my distinguished friend. The report has probably been read by you, and with the interest it deserves, and I presume that we may take it as read. I shall therefore proceed to make a few remarks in connection with that report and accounts. It will be seen that we have increased our lamp connection during the year by 18,537 lights—an increase of less than half the number we expected and would have obtained (seeing that this increase was obtained almost entirely during the first six months of the year) but for the unfortunate default on the part of our contractors in the delivery of the additional plant we had ordered to meet the requirements of last winter. When I last had the pleasure of addressing you, I gave you particulars of the additions to our plant and machinery which we had arranged and contracted for during the year 1899. The most important of these additions, so far as it affected our general supply, was the contract we had entered into with a high-class firm of boiler makers for six new boilers of 400 H.P. each. This order was given in November, 1898, and delivery was guaranteed on May 31, 1899, under a penalty of £30 per week for every week's delay thereafter. The boilers were not finally completed until the middle of November. In the meantime our lamp connections had increased, in accordance with our estimates, with the result that we were unable to take out the existing boilers for the thorough overhaul which they always receive during the summer and autumn; and as the load increased on the approach of winter, it was with the utmost difficulty, and only with unremitting care, that we were able to fulfil our obligations in the manner we did. Unfortunately, it was not only in the case of the new boilers that we were disappointed, but in every contract we entered into for new work we had the same unfortunate experience. Our new coal transporter, which was contracted to be completed on October 4 last, was not finished until February. The contract we had entered into for the heightening of our chimneys, to give us a better draught and greater economy, was stopped by the County Council, the reason given by them being that the existing chimneys would not carry the extra weight. The water-softening plant, which we had contracted to be completed in the beginning of October, was only finished this month. The explanation we have received from the various contractors as to the cause of these delays has been to the effect that during last year the engineering and allied trades were so congested with orders that they were unable to get the necessary materials to fulfil their contracts. I believe that other companies have experienced similar difficulties. The penalties which we were able to impose for these delays were altogether inadequate to compensate us for the losses we have suffered. The one pleasing feature in connection with our troubles during the past winter is that not one of them was due to electrical causes. They have all been connected with our steam system, and are to be attributed almost entirely to the non-delivery of the boilers. I think it is well to emphasise this fact, as these difficulties were entirely beyond our control, such as might happen in any class of business, and had nothing to do with our system of supply. If you will now turn to the accounts, I will draw attention to them in turn. They are prepared in the form prescribed by the Board of Trade, and are very full and comprehensive. They contain particulars of all our expenditure—both capital and revenue—under almost every heading that can be devised. The first account that I need draw your attention to is the capital account. On referring to that, you will see that during the year we have spent a total of £52,735, while the addition to our loan capital has been £9,870, being the deposit on the issue of £50,000 additional 4 per cent. debenture stock, which, I am pleased to say, was largely over-subscribed. The first item of importance in this account is that of plant and machinery, on which we have expended during the year the sum of £24,056. For this expenditure we have received a new 900 H.P. plant, which was completed in September last; we partly paid for the six new 400 H.P. boilers, we have paid the final instalment on our 2,000 H.P. plant, the final instalment on the condenser, the first instalment on the water-softening plant, the new coal transporter, the new coal storage floor, the new well we are sinking, and the alteration of our furnaces to make them smoke-consuming. The next item is mains, on which we have expended £12,599. For this we have laid 22,251 yards of new mains (trunk and distributing), bringing our total length of mains now laid up to over 106 miles. The next five items—namely, transformers, meters, electrical instruments, and tools—represent the amounts expended on these goods to meet the normal increase of business. The next item is distributing station and offices, on which the sum of £7,066 has been expended during the year. This sum represents the purchase of the lease, with 58 years to run, of the offices and station in Cockspur-street—a most advantageous purchase to the company, considering the value of property in the neighbourhood and that the London County Council has purchased the whole of the property surrounding our station. Had they secured this property in addition, it would have formed one complete block, and we should probably have had to vacate our premises, and the amount we have already expended on the station—a very considerable sum—would have been lost. This has been a most fortunate transaction, and I point to it with pride. It has been carried out by the tact, the discretion, and the careful supervision of my friend on my right, the managing director (Mr. R. Stewart Bain), and we have obtained a most advantageous bargain in purchasing this freehold, which is in close proximity to our station. I consider this transaction is extremely satisfactory, and I desire to draw your special attention to it. We should have had very great difficulty in finding another station which would have suited our requirements in the neighbourhood. The sum I have mentioned includes the cost of entirely remodelling and the addition of a new floor to our offices, of which we were much in need. You will see from the note at the bottom of this account that the total amount which has been written off for depreciation and obsolete plant is £227,555—a very considerable sum, and one which I think it is well we should not lose sight of, in view of our being asked what amounts we have set aside as a reserve fund to meet depreciation. This depreciation, gentlemen, ought to last us for a considerable time. The next account is the revenue account. It will be seen that the gross revenue for the year was £72,901. As the gross revenue for the year 1898 was £67,099, this is an increase of £5,801. The total expenditure, however, rose from £43,265 in 1898 to £51,353 in 1899—an advance of £8,087. This increase is almost entirely in the cost of generation, the advance in that department alone being £8,005, leaving an increase of only about £80 for the year in all other departments. This large advance in the generation cost is almost entirely made up of four items—namely, coal, water, wages, and repairs; and to a very large extent it has been caused by the circumstances I have already explained—namely, the default of our contractors in delivering our new boilers. This reacted on our whole steam system, owing to the existing plant being over-strained, thus causing inefficiency and breakdowns. In addition, however, to this we had other difficulties to contend with. For example, the increase in our coal bill for the year is £4,223. We had great difficulty in obtaining a supply of Welsh coal during the greater part of the winter quarter, owing to the Government having requisitioned almost the entire output of the Welsh coal-fields in connection with the outbreak of war in South Africa. During this period we had to purchase any class of coals we could get, a large proportion being an inferior class of North Country coal, which, being unsuitable for our boilers, caused a much greater quantity to be consumed. The water bill shows an increase of about £1,000. This was caused by our having temporarily to discontinue the use of our own wells, owing to the action of that water on our boiler tubes, and using the water supplied by the Kent Water Co. entirely. The advance in the wages bill is about £1,000, and in the repairs and maintenance about £1,500, this latter increase being almost entirely confined to engines and boilers, and directly attributable to the causes I have already explained. You will probably consider it unnecessary for me to explain in detail the other items in this account, which are set forth in very full detail. The total of all the other departments only shows an increase of about £80 as compared with the previous year, and it only represents ¾d. per unit sold, which shows our company to be one of the most economically managed in the kingdom. (Applause.) The balance carried to net revenue is £21,547, which, with the amount brought forward from last year and the sum received as interest, brings the total to the credit of this account to £25,412. Out of this was paid the interest on the debentures to Dec. 31—namely, £8,000—and as we had earned the interest on our preference shares for the half-year ended June, we thought it would meet your approval if we paid that by way of an interim dividend. This amounted to £7,476, leaving a sum of £9,936 now to be dealt with. You will see that the board propose to deal with this as follows: by the payment of the dividend on the preference shares for the second half of the year at the rate of 6 per cent. per annum, and by making a provision of £1,000 for special rebates. We desire to deal as liberally as we possibly can with those of our customers who were specially affected through our temporarily impaired supply by giving them a special discount off their accounts, and we hope this amount will go a long way towards meeting them. The sum we propose to carry forward—namely, £1,460—is less than last year, but the board considered that you would prefer having the full dividend and carrying forward a smaller amount. I might say here that, considering the difficulties we have had to contend with during the last three months of the year, I should not have been at all surprised if we had been compelled to reduce this dividend. I am glad that it has not been necessary to do this. I must say that this result has been obtained through the unremitting care and energy which have been displayed by our staff and by our officials especially. I think it is only due that I should mention this in the presence of Mr. Bain, who has had a very anxious time, and all those who have so carefully, unremittingly, and so industriously worked under him. (Hear, hear).

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The next account—namely, the general balance-sheet—calls for no special comment. Having now explained these accounts, I hope to your satisfaction, I shall proceed to give you an account of what we propose to do in the way of additions and improvements during the current year. I shall preface this statement by saying that it is our intention to improve the whole of the machinery and the general working of the station during the summer, so as to ensure that our supply during the next winter shall be thoroughly efficient and reliable. We have ordered two new engines of 450 H.P. each from Messrs. W. H. Allen and Sons, of Bedford, by means of which we hope to run the station during the hours from midnight to sunrise, and which will enable us to shut down the whole of our large plant during this period. These engines are to be delivered in June. We are putting down another battery of new boilers, six in number, each boiler being 400 H.P. and of the "Economic" type. These boilers are guaranteed for delivery in May, and in view of the delay which took place in the delivery of the previous six, we have been in communication with the makers, and they inform us that we shall have delivery within the contract time. In addition to these new boilers, we have entered into a contract with the Babcock and Wilcox Co. to rebuild 12 of our old Babcock and Wilcox boilers, which will practically make them as good as new. Our improvements in our steam system do not end here. Our consulting engineer (you will see we have now got a consulting engineer) has designed a complete new system of steam pipes for the whole of the station to replace the existing system, which has been found to be inefficient and extravagant. By means of this new system we shall be able, should we require to do so, to shut down one side of the station, which we are unable to do at present. Again, as the County Council prevented us from heightening our present chimneys, and as it is necessary that we should have more draught for our new boilers, we have placed a contract, which is being proceeded with rapidly, for a new chimney 240ft. high, which will give us all the draught we require for the whole of our boilers and allow for a considerable extension. It will also enable us to a considerable extent, we hope, to get rid of the smoke nuisance, in connection with which you may know there has lately been a considerable amount of agitation. As our water bill is now very great and continually increasing, we are sinking a large well at Deptford, from which we hope to receive the whole of our supply. This will be of a depth of 450ft. It will be within your recollection that we had two tubular wells at the station, which for a considerable time gave us a very good supply and considerably reduced our water bill. Unfortunately, surface water appears to have been gradually making its way into these wells, carrying with it chemicals which have had a deleterious effect on the boiler tubes, and this has decided us to sink a new well to nearly three times the depth and capacity of the tubular wells. In addition to these new works, we are reconstructing some of our large engines, which will considerably increase their capacity and efficiency. You see that the whole of these works are in connection with our steam system, and the only addition which we are making to our electrical system is a new exciter of 75 H.P. These new works which I have described will require additional capital. We have sufficient to carry us on until the autumn, by which time it may be necessary to make a further issue. You will see from the report that a resolution on this subject is to be proposed. The meaning of it is that, while we have the power under our arrangements with our debenture stockholders to borrow up to the extent of one-half the nominal share capital of the corporation, under our articles the limit of the board's borrowing powers is placed at £250,000, and this amount cannot be exceeded without the sanction of a general meeting. This limit now having been reached, the resolution is to ask that the board shall be at liberty to borrow such further sums as they may deem necessary in the interests of the company, so long as the total amount of loan capital does not exceed one-half of the nominal capital of the company.

During the year under review the company was served with a writ for the infringement of a patent in connection with the use of transformers. As the matter threatened to be a somewhat serious one, and as it affected every alternating-current company in the kingdom, the company took immediate steps to defend the action. Every alternating-current company was communicated with, and under the able generalship of your managing director and your solicitor, Mr. Medcalf, these forces were combined for a joint defence. A committee representing about 60 lighting authorities, both municipal and companies, was formed, of which Mr. Bain was chairman, for the purpose of conducting the defence. The action was tried before Mr. Justice Farwell on Jan. 22nd last, and went on until Feb. 1st, and the result was a strong verdict in our favour, carrying costs on the higher scale. Although the action was a somewhat costly one to fight, from the fact that the expenses were spread over so large a number of companies the actual amount each company had to pay was not great considering the interests at stake. I understand that there is an appeal against this decision, which will also have to be fought. I now move the adoption of the report and accounts, and the payment of the dividends therein proposed.

Sir W. H. PREECE, K.C.B., F.R.S., seconded the motion.

In answer to a remark from Mr. Pyke, Mr. STEWART BAIN (managing director) said he thought he had better let the meeting know the exact position in regard to the company's office and station in Cockspur-street. The London County Council had for some time been acquiring all the property in that neighbourhood. The only place in the locality which that body had not been able to buy—very fortunately for the company—was that which now belonged to the company, and it was like a wedge between the property that had been acquired by the County Council. The company had spent over £10,000 in fitting up this station, into which they had brought all their mains from Deptford. To remove from this property now would mean an expenditure on the company's part of not less than £10,000, making £20,000 in all. He had foreseen this in the early part of last year, and had then entered into negotiations with the owner of the property now belonging to the company, and, happily for them, he secured it at a figure which in his opinion was below its value. But it was not its absolute value that had merely to be looked at, but what its value was to the company.

The resolution was then carried unanimously.

The Earl of Crawford was re-elected a director, and the auditor appointed by the Board of Trade was reappointed auditor to the company.

Power was then given by resolution to the directors to borrow such further sums as might be required in the interests of the company.

A vote of thanks to the chairman, directors, and staff was carried unanimously.

The proceedings then terminated.

Direct Spanish Telegraph Co. (Ltd.).

The forty-eighth ordinary general meeting of the company was held on Tuesday, under the presidency of the Most Hon. the MARQUIS OF TWEEDDALE, K.T.

The MANAGER (Mr. Cb. Gerhardi, M.I.E.E.) read the notice convening the meeting and the minutes of the previous general meeting.

The CHAIRMAN then said: Gentlemen, I have now to ask your approval of the report and accounts, which I presume you will take as read. In doing so, I will offer a few remarks on the principal events of the past year. The traffic receipts show a decrease, as compared with those of 1898, of £6,352, which is due almost entirely to the fact that the long Government messages which passed between Spain and her colonies—Cuba and Porto Rico—came to an end when peace was made between Spain and the United States. We have now to depend almost entirely on commercial messages, which, although much shorter, are more numerous and earn, of course, less money. The proof of this is afforded by the fact that our cables carried 25,000 more messages than in 1898. The increase of £598 in the working expenses is nominal, because from this amount must be deducted the sum of £242, being rent of the new premises at No. 75, Gracechurch-street, which we took over at Christmas, 1898, but which were not occupied by tenants until May or June. The portions of these not required for our purposes are now let to responsible tenants on long leases, and this deficiency will therefore not appear in the future. The remainder of the amount is owing to increments in salaries of the company's staff and in telegraph stationery, rendered unavoidable by the increase in the number of messages. On the other hand, there is a decrease of £127 in renewal and repairs of land lines, instruments, and batteries. In the extraordinary expenses there is a substantial reduction, as compared with those of the year 1898, of £2,372. The expenditure on the extension and alterations of the London station, which were completed early in the year, amounted to £181, as against £961 in 1898. Owing to the death of an old and valued servant, Mr. J. F. Mills, the late superintendent of the London station, who had been 25 years in the company's service, changes in the staff had to be made, and the expenses incurred in removing superintendents from one station to another amounted to £180. There will, however, in future be a slight saving in salaries to superintendents, as those recently appointed are receiving somewhat lower salaries than were paid to their predecessors. The renewal of the underground lines at Bilbao, alluded to at the last general meeting, has continued, but has only involved an expenditure of £73. Further renewal will take place this year. On repairs to the land lines in Cornwall a sum of £312 was expended, and they are now in fairly good working order. The break in our Bilbao cable was found to be due to kinks and corrosion. The break was repaired and a considerable quantity of new cable inserted by the Eastern Telegraph Co.'s ship "Mirror." I may mention that this work was done with great promptitude and with entire satisfaction to this company. Our reserve fund now amounts to £56,000, but inasmuch as it would require at least £65,000 to renew the Bilbao cable, not to mention the Barcelona cable, your board consider it prudent to continue for some time longer adding to the reserve fund. We are now able to recommend the payment of a dividend of 4 per cent. on the ordinary shares, but in order to do this we have to draw upon our contingency fund to the extent of £1,161. Our cables are in good order, the increase in the number of messages seems likely to continue, and I think that we may look forward to the present being a prosperous year. I now move the adoption of the report and accounts.

Mr. J. DENISON-PENDER seconded the resolution, which was carried unanimously.

Resolutions approving the dividends recommended by the directors, re-electing the retiring director (the Marquis of Tweeddale), and re-appointing the auditors (Messrs. Deloitte, Dever, Griffiths and Co.), were adopted.

A cordial vote of thanks to the chairman and directors terminated the proceedings.

County of London and Brush Provincial Electric Lighting Co. (Ltd.).

The sixth ordinary general meeting was held on Monday, the Right Hon. LORD RATHMORE presiding.

The SECRETARY (Mr. H. B. Renwick) read the notice convening the meeting, and the report was taken as read.

The CHAIRMAN said: Gentlemen—On the present occasion it will be unnecessary for me to detain you any length of time. You have no doubt studied the accounts, with, I hope, the result that you are well satisfied with the position to which we have advanced since we last met, and also with the prospects which appear opening out to us. In the presence of the substantial dividend which we have recommended to you, and the handsome "carry forward" which accompanies it, I feel that it will not be necessary for me to bespeak your forbearance on this occasion. I shall therefore only refer to a few salient points of our progress in the

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past year. Turning to the capital account, you will see that £155,608 was expended on our London stations. At least 75 per cent. of that was for what we call "street work"—mains, transformers, meters, and so on—and that is a kind of expenditure we never grudge, as we regard it as expenditure which is likely to bring in a prompt and satisfactory return. As to "investments in associated companies," the considerable reduction under that heading is of course due to our having parted with our interest in the Richmond Co. The item of "sundry debtors," is made up of amounts which were due to us at the end of the year, mainly in regard to this sale of the Richmond Co., but also of interest and dividends which had accrued to us from our other associated companies, and moneys then owing to us by customers for current. The bulk of these debts have been since collected. Under the head of "Liabilities" the small balance of the £200,000 issue of debentures last year has since come in, but I would call your attention to one change which we have made in the form of the accounts under this heading, for you will see that the sum of £5,000 which has hitherto appeared under the head of reserve has now been transferred to depreciation, repairs, and renewals, and to that £5,000 has been added £6,500, which we have set aside from revenue account, and another £4,000 from premiums, making altogether £15,000; and having written off £3,584 for 1899, there remains the sum in the balance-sheet under this new heading of reserve for depreciation, repairs, and renewals—£11,915. The reason, gentlemen, we have adopted that change in the form of the accounts is that it is a convenient thing, working such a business as we have, to know exactly where you are with the amount you have to spend on these services—depreciation, repairs, and renewals; and in this way we earmark what we have to apply to that purpose and what we are spending; and the present condition of our company, the amount of assets outside our stations—our mains, and so on, to which this depreciation account is specially applicable and appropriate—does not require, we consider, a separate reserve fund. With regard to the general revenue account, there is the substantial amount of profit that we have derived from our two London stations, which are the main part of our business—the part of our investment which we look to in the long run for our main return in the way of substantial profits. I may say generally that the profits have doubled or more than doubled within the last year. At Dec. 31 the total increase for our two London stations was for lamps connected over 50,000 8 c.p., and there was an increase of over £0,000 in the applications. The units sold had increased by almost 100 per cent. That is shown in the accounts, but since Jan. 1 we have received further applications from our northern districts for the equivalent of 8,185 8 c.p. lamps, and from our southern districts for the equivalent of 6,005, or together 14,190 lamps, while the sales of current show an increase of 75 per cent. above the increase of last year. Some of our expenditure on these northern stations is of course for the present necessarily unproductive, and some of it—as in the case of our expenditure in the new districts of western Holborn, St. Giles's, and Camberwell, where we only commenced the supply in the autumn of last year—has not yet had time to show us what profits we may expect in the future; but so far as we can form a judgment, I think we may say confidently that in these new districts as well as in our old districts our experience is such as to completely fulfil the expectations which we formed when we entered into this more recent expenditure. We have had very few mishaps to seriously interfere with the supply of current; and we have had no complaints at all as to the quality of the light which we supply. Our company is becoming more and more popular with its customers, and that naturally may lead to other customers joining us. It is the fact that the districts which we supply exceed by nearly 50 per cent. the extent of the districts owned by any other supply company within the county of London; and taking the whole of these districts together, we believe that the experience we have hitherto had is as satisfactory and as encouraging for the future as we could reasonably expect. As to our supply of current for power, the figures which we have given in the report show an increased demand during the past year for 253 H.P., and further applications have been received raising the total to a demand for 686 H.P. The electric motor is gradually supplanting other forms of motive power for mechanical purposes, and it is satisfactory that we should have instituted special plant for current for power purposes equal to 2,000 H.P. Our average works costs have been reduced from 3·8d. per unit in 1898 to 2·432d. in 1890, and this notwithstanding the increased cost of fuel, and a still further improvement in that direction may be expected in the current year. When the large mains which we have laid all through our extensive London districts shall have buckled on to them the large number of lights they can supply, and when we shall have received the additional demand for power supply which we have provided and have a reasonable right to expect, our prospects will still further improve. Turning to our business outside London, when this company was first started it was started with a two-fold purpose and policy. One part of that policy was to erect these two great stations in London—one for the north and one for the south side of the river. The plan was to make large stations which would be capable of supplying many other districts than the district of the immediate locality in which these stations were located. That, I may say in passing, is a policy which has been vindicated by time, and throughout the country generally you see it is now generally admitted that it is in the end a wiser and more economical thing to build a big station at first than to try and do the same work by a number of small ones. That, however, was our plan; but the very vastness of our ambition and the greatness of the stations we built, and the amount of capital which it was necessary to put in them, made it inevitable—as anyone who understands these things will realise—that it would be necessary to wait a much longer time for a satisfactory return on the capital expended than if the first start had been upon a more modest scale. But we look to be repaid and rewarded for this by much larger returns at a future time. Another part of our programme and of our policy is indicated in the name of our company: that we should invest a certain amount of our capital—not by any means the greater part of it—in provincial undertakings. Our plan was to acquire an interest in stations which were capable of being improved, and by financial assistance and advice, and also by the assistance of our engineering staff at headquarters, to give these outlying stations a better opportunity than they would otherwise have had of realising speedy success. It was then open to us either to retain the whole of our investment in them and take our reward by the dividends we should receive, or it was open to us to realise the whole or part of the investment which we had made in those companies. We adopted the latter course with respect to the old Bournemouth Co., and it was a most satisfactory arrangement for both parties. We have pursued the same plan in the case of the Richmond Co., of which I have always had a favourable opinion. The price we received for the Richmond Co. was, I think, a fair, but certainly it was not an excessive one. As regards the Dover Co., in which we still hold half the capital, that company has already reached a dividend-paying stage. Altogether I think the prospects of the Dover Co. are very encouraging and hopeful. As to Bournemouth, the applications for current during the 12 months show an increase of 10,364 8 c.p. lamps, compared with an increase of 8,752 for 1898 and compared with an increase of 3,482 for 1897. The equivalent of 44,096 8 c.p. lamps were connected to the Bournemouth mains on 31st December, and satisfactory terms have been arranged for a period of years with the Poole and District Electric Traction Co. for a supply of current for power purposes. The revenue account of the Bournemouth Co. shows substantial progress. Over £2,000 has been placed to reserve, a substantial amount has been set aside out of revenue for depreciation, and a dividend of 5 per cent. (as against only 4 per cent. for the previous year) has been declared, while an increased sum has been carried forward to the next account. We are therefore wise in retaining a substantial interest in the shares of that company; and I believe that that interest will turn out to be a valuable asset, just as our investment in the Richmond Co. has turned out to be, and as our investment in the Dover Co. is turning out to be. During the year Mr. Lawson's resignation as engineer and manager has been accepted, and we have appointed Mr. Charles Sparks, whose services I am glad that we have been fortunate enough to secure, as our chief engineer. We have to regret that Mr. Emile Garcke has found it necessary to leave our board; but we cannot complain. He joined us and gave us the great benefit of his services and ability at a time of some stress and strain in our company, when we badly wanted his assistance. I now move that the report and accounts be adopted.

The DEPUTY CHAIRMAN (Mr. J. B. Braithwaite, jun.) seconded the motion, and said that the increase of 61,564 lamps applied for was equal to an increase of 80 per cent. during the year; and the increase in the net profit was very much larger than that. The profit on the St. Luke's station was nearly four times that of the previous year, and at Wandsworth was considerably more than double. He thought that they had good ground for believing that under the able management of Mr. Sparks the outlook for 1900 was even more brilliant than for 1899.

The motion was carried unanimously, as were resolutions approving the dividends and re-electing the retiring directors and auditors. A vote of thanks to the chairman and directors terminated the proceedings.

W. T. Glover and Co. (Ltd).

The second annual meeting of this company was held at Manchester on Friday, under the presidency of Mr. H. EDMUNDS, who said that the net profit on the year's trading had been £23,333, against £17,103 for the previous year. The increased assets included the sum expended on the new works and the electric lighting and power station at Trafford Park, where the most up-to-date plant for the manufacture of cables was being laid down. The entire expense of the Trafford power and lighting scheme had so far been borne by the company, and the expense was justified because they would be in a position to supply the various works which were growing there with electric power, electric light, &c. The capital in that branch had so far been unproductive; but it was hoped that in the coming year it would earn interest and profit for the company. Orders for cables continued to come in. Though the company had a large stock-in-trade it was not larger than was necessary for the increasing business, and a great deal of the stock which had been acquired during the past year had risen in value in consequence of the rise in the prices of raw materials. He moved the adoption of the director's report and accounts.

Mr. H. P. HOLT seconded the resolution, which was carried.

Resolutions for the following dividends and interest were then approved: 5 per cent. on preference shares, 4½ per cent. on first mortgage debentures, 10 per cent. on ordinary shares, 10 per cent. on new ordinary shares on amounts called up. The directors were voted £200 for their services during the year.

The CHAIRMAN stated that at an early special meeting of the shareholders the board would ask them to approve an increase of the directorate from five to seven members in consequence of increase of business.

A vote of thanks to the chairman and directors terminated the proceedings.

National Electric Wiring Co. (Ltd.).

The annual report of the directors to Dec. 31, 1899, states that the gross profit was £5,648. 11s. 3d., from which has to be deducted administration expenses, provision for bad and doubtful debts, &c., amounting to £3,862. 18s. 1d., leaving £1,785. 13s. 2d. Adding £1,222. 8s. 3d. brought forward makes the total £3,008. 1s. 5d., and deducting depreciation, &c., and provision to cover possible loss on contracts in course of settlement, the balance to be dealt with is £1,782. 17s. 5d. The directors, having regard to the large increase in the business within the last four or

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five months of the year, and generally to the satisfactory way in which orders are coming in, recommend a dividend of 3 per cent. for the year, absorbing £1,501. 16s., leaving £281. 1s. 5d. to be carried forward. The business shows every sign of steady increase. During the year 1,970 installations, with an aggregate of 51,774 8 c.p. lamps, have been completed, of which 838 installations, with an aggregate of 24,654 8 c.p. lamps, were "free" wiring, and the remainder were by contract; while orders in hand numbered 395, with an aggregate of 13,012 8 c.p. lamps. During the year "free" wiring contracts have been entered into with the following Corporations: Gloucester, Rathmines and Rathgar, Pembroke (Dublin), Coventry, Bangor, Greenock, Belfast, Stirling, Crewe, &c.; and also with the Newmarket, Crystal Palace District, Woolwich, Northampton, Salisbury, and other electricity supply companies. Negotiations with other supply authorities are in progress.

EXPLORATION CO. (LTD.)—At the annual meeting the chairman (Mr. H. Mosenthal) said their investments in electric railways, tramways, and traction showed the large increase of £373,101. 3s., due mainly to investments through the Compagnie Générale de Traction in shares of Paris tramway companies. They had been fortunate in securing large interests in electric tramway projects, and holding optimistic views of the future of electric traction, they were very confident of good results from their important investments. The Compagnie Générale de Traction had fully justified their hopes, and now their shares, together with the shares in the tramway companies, stood at a considerable premium; and they had patiently waited for a much longer time than was anticipated for tangible results from the Central London Railway, but they believed they would not have to wait much longer, and that the promise of the past would be fulfilled in the near future.

LIVERPOOL DISTRICT LIGHTING CO. (LTD.)—The annual meeting was held on Wednesday, when the chairman (Col. A. H. Holme) said their position had materially improved since last year. They had entirely wiped off the debit balance and had made a legitimate profit. They had more than doubled the number of the lamps connected in Waterloo since January, 1899, and were still progressing. It was certain that all houses over £60 a year would be lighted by electricity, and even smaller houses would eventually take the light to a certain extent. In Gateacre the increase since the last meeting was something like 50 per cent. They had agreed to sell the Gateacre undertaking to the Garston Electrical Co. He believed this would be found to be a good bargain for the shareholders. The increased price of wages and of coal had been an expensive matter. The directors' report and accounts were approved. An extraordinary meeting was afterwards held, when the transfer of the Gateacre undertaking was approved.

MERSEY RAILWAY CO.—At the half-yearly meeting on Monday the chairman (Mr. J. Falconer) said that owing to the difficulties of the gradients, locomotives of exceptional weight had to be employed to haul an ordinary train through the tunnels, so that during the portion of the day when the traffic was light the receipts were not sufficient to pay for haulage. The traffic had not expanded with the growth of the population of Liverpool and Birkenhead as might have been expected. He considered that the traffic, which was very large, justified the expenditure involved in the construction of the undertaking, while it also warranted the policy of the board in reference to the future working of the line by electricity. Electric traction had the advantage of enabling the weight of the train to be adjusted to the number of passengers that had to be carried, thus making a reduction in working expenses possible. The board were acting under the advice of Sir W. H. Preece and Major Cardew as to the electrical arrangements, and these gentlemen estimated that by the adoption of electric haulage there would be a saving in the working expenses alone of between £11,000 and £12,000 per annum, and that immediately on the adoption of electric traction the receipts would be increased by £18,000 per annum. The result would be an improvement in the net revenue in three years of between £40,000 and £50,000, after due allowance for increased working expenses. Against this had to be put the amount needed to provide interest on capital required to carry out the scheme. They had to satisfy the Liverpool and Birkenhead Corporations that their mains would not be interfered with, and there were other interests which required to be safeguarded. It was proposed to adopt the third-rail system, so that it would be possible to carry goods through the tunnel either by electric or steam power. He believed that within five years from the date of the adoption of electric traction they would be receiving interest as provided under the scheme. The report was unanimously adopted.

NORWICH ELECTRICITY CO. (LTD.)—The annual meeting of this company was held on Friday, Mr. F. W. Harmer presiding. The directors' report stated that the demand for electricity both for lighting and motive power increased steadily, and there were no present signs that it had reached its limit. A large number of new customers had been connected during 1899, and fresh applications were still being received. The increase in the number of new motors was largely in excess of any previous year. The buildings originally erected at Duke-street having become inadequate, it was necessary to make certain alterations and additions, including a new chimney shaft. This provided for some years to come for the probable requirements of the company's business. Further machinery was being erected in the new buildings, and would be brought into use during the present year. Including £275. 1s. 11d. from last year, and allowing for debenture interest, the net revenue account showed a credit balance of £3,433. 10s. 5d., out of which the directors propose to pay a dividend of 6 per cent., tax free, and to carry forward £125. 9s. 10d. The report and accounts were adopted.

NEW COMPANIES, STATUTORY RETURNS, &c.

JOHN BELLAMY (LTD.)—This company was registered on March 19, with a capital of £40,000 in £1 shares, to acquire and carry on the business of tank manufacturer, boiler maker, engineer, and contractor, carried on at Byng-street, Millwall, by Mr. J. Bellamy. The first directors are Mr. J. Bellamy (permanent), F. Beddow, and H. Ledger.

BRYAN, DONKIN AND CLENCH (LTD.)—This company was registered on March 12, with a capital of £120,000 in £10 shares (3,600 first preference and 1,400 second preference), to take over the businesses of Bryan, Donkin and Co. (Ltd.), the Donkin Land Co. (Ltd.), and Clench and Co. (Ltd.), and to carry on the business of mechanical, electrical, and mining engineers, wire workers, ironfounders, &c. The first directors are Bryan Donkin, Edward B. Donkin, Frederick Clench, Harry J. Donkin, and G. McD. Clench.

HERBERT MORRIS AND BASTERT (LTD.)—This company was registered on March 22, with a capital of £30,000 in £5 shares (2,000 preference), to acquire the Loughborough business of Herbert Morris and Bastert, and to carry on the business of mechanical and electrical engineers, manufacturers of lifting and other machinery, &c. The first directors are H. Morris and F. Bastert.

SECTIONAL FIRE TUBE BOILER SYNDICATE (LTD.)—This company was registered on March 16, with a capital of £3,000 in £1 shares, to adopt an agreement with Mr. G. F. G. Des Vignes and Mr. W. A. Cloud, and to manufacture and deal in boilers, steam generators, &c.

CITY NOTES.

MEMORANDA.—Bank rate 4 per cent. (since Jan. 25, 1900). Price of silver 27 $\frac{9}{16}$d. per oz. (Mar. 29). Consols (2$\frac{3}{4}$ per cent.) 101 $\frac{3}{16}$—101 $\frac{5}{16}$ for money, 101 $\frac{1}{16}$—101 $\frac{1}{16}$ for account; 2$\frac{1}{2}$ per cent. 98$\frac{1}{4}$—98$\frac{3}{4}$ (Mar. 29). Stock Exchange Settling Day: Consols, April 4; Stocks and Shares Continuation Day, April 9; Ticket Day, April 10; Pay Day, April 11; Mining Share Carry-over Days, April 6 and 24.

BRIGHTON AND ROTTINGDEAN SEASHORE ELECTRIC TRAMROAD CO—The directors regret they are unable to announce any dividend either on the preference or ordinary shares. The working expenses have been reduced by obtaining electric power from the Brighton Corporation; but the traffic receipts have fallen off by £346. 17s., and the net profit was only £565. 8s. 2d. (against £584. 12s. 5d. in 1898), a sum barely sufficient to pay interest on loans and debentures, which amounted last year to £617. 17s. 7d. The new Marine Palace and Pier, now in course of construction, may be expected to attract numbers to the eastern part of the town, which ought to be of great benefit to the seashore railway.

CALCUTTA TRAMWAYS CO. (LTD.)—During the week this company invited applications for £250,000 (part of a total authorised of £350,000) 4$\frac{1}{2}$ per cent. first debenture stock at 98. The issue is to provide funds for the conversion of the lines to electric traction on the overhead trolley system.

DIRECT UNITED STATES CABLE CO. (LTD.)—The directors have resolved upon the payment of an interim dividend of 3s. per share, tax free (at the rate of 3 per cent. per annum), for the quarter ended 31st inst., payable on and after 26th prox.

EASTERN TELEGRAPH CO. (LTD.)—This company announce the payment on April 12 of dividends at the rate of 3$\frac{1}{2}$ per cent. per annum, less tax, on the preference stock for the quarter ending March 31, and an interim dividend of 1$\frac{1}{2}$ per cent. on the ordinary stock, free of tax, in respect of profits for the quarter ended Dec. 31 last. The transfer books will be closed from April 5 to 12 inclusive.

EASTERN EXTENSION, AUSTRALASIA, AND CHINA TELEGRAPH CO. (LTD.)—Subject to confirmation by the shareholders, the directors of this company have declared a dividend for the quarter ended Dec. 31 of 2s. 6d. per share, together with a bonus of 4s. per share (or 2 per cent.), making a total distribution of 7 per cent. for the year 1899. The dividend and bonus will be paid on April 26. The share register will be closed from April 18 to 25 inclusive.

EVERED AND CO. (LTD.)—The directors' report states that, after providing for debenture interest (£2,416. 13s. 4d.), a net profit of £33,343. 0s. 7d., making, with £6,986. 0s. 2d. from 1898, £40,329. 0s. 9d. to be dealt with. An interim dividend at the rate of 7$\frac{1}{2}$ per cent. per annum to June 30, 1899, has been paid, absorbing £6,402. 18s.; and the directors propose to pay a dividend at the rate of 7$\frac{1}{2}$ per cent. per annum for the remaining six months, which will absorb £6,402. 18s.; to pay a bonus of 5 per cent. per annum for the year (£8,537. 4s.), write off plant £1,000, off buildings £4,000, to place to an equalisation of dividends account £2,000, to reserve £5,000, carrying forward £6,986. 0s. 9d. The business continues to show substantial progress, resulting in increased profit.

FOLKESTONE ELECTRICITY SUPPLY CO. (LTD.)—The report of the directors for the year ended Dec. 31 states that at that date the equivalent of 17,834 8 c.p. lamps was being supplied, against 10,089 in 1898, an increase of 77 per cent. The profit on the revenue account (after charging £220. 18s. 9d. for preliminary expenses) was £2,084. 0s. 11d., which, with £405. 2s. 3d. from last year, left £2,442. 8s. 8d. for distribution. A dividend at the rate of 4 per cent. per annum is recommended, absorbing £1,900, £400 is placed to reserve, and the balance carried forward. During the year the company carried out installation work to the value of £2,709. 16s. 6d., the profit on which (£20. 1s. 6d.) has been brought into

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the year's accounts. The number of units sold to private consumers during the year was 209,931, the revenue received from this source £4,156. 8s. 6d, the average cost per unit to consumer working out at about 4¾d.

GLOBE TELEGRAPH AND TRUST CO. (LTD.)—The financial papers announce that the directors of this company have declared an interim dividend of 2s. 6d. on the ordinary shares.

GREAT NORTHERN TELEGRAPH CO. (LTD.)—A meeting of this company will be held at Copenhagen on April 28.

METROPOLITAN ELECTRIC SUPPLY CO. (LTD.)—This company has this week made an issue of £125,000 3½ per cent. mortgage debenture stock (balance of £250,000 authorised) at 94.

NATIONAL ELECTRIC WIRING CO. (LTD.)—The share transfer books of this company are closed from 29th inst. to 9th prox. inclusive.

ROCKHAMPTON (QUEENSLAND) GAS AND COKE CO. (LTD.)—For some years past this company has possessed a small electric lighting station, which appears to have been treated in a rather stepmotherly fashion, as no attempt has hitherto been made to extend or develop this branch of the company's business. The report for the half-year ended Dec. 31, 1899, states that £30,000 worth of 5 per cent. first mortgage debentures was issued in London, for redeeming the existing debentures, and for alterations and improvements in the electrical plant, and for other purposes. The company's gas operations show a profit of £2,225. 0s. 11d., but the electrical operations show a loss of £149. 3s. 1d. Dividends at the rate of 7 per cent. per annum on the ordinary and 9 per cent. per annum on the preference shares have been declared.

ROME.—The report of Commendatore Pouchain, managing director of the Anglo-Roman Gas Co., states that notwithstanding the reduction in price of gas and the greatly extended use of electricity for lighting, the sale of gas has increased enormously. The company, which also owns the electricity works of Rome, announces that a very large increase in the consumption of electric current has taken place. The local omnibus and tramway company takes its current from the Anglo-Roman Co.'s mains, and has consumed nearly twice the quantity of current compared with 1898, owing to the conversion of several of its lines from horse to electric traction. The company pays 8 per cent. dividend for the year 1899.

RUSSISCHE ELECTROTECHNISCHE FABRIKEN SIEMENS AND HALSKE (ST. PETERSBURG).—The capital of this company has been increased from four to seven million roubles.

STOCK EXCHANGE NOTICE.—The Stock Exchange committee has ordered 12,000 £5 fully-paid ordinary shares (Nos. 1 to 12,000) and £50,000 4 per cent. debenture stock of the *Smithfield Markets Electric Supp'y Co. (Ltd.)* to be quoted in the Official List.

WILLANS AND ROBINSON (LTD.)—The registers of transfers and members are closed from 28th inst. to April 11 inclusive.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	1900	£	£		£	£
*Birmingham Tramways	Mar. 24	3,907	+ 517	12	47,257	+ 2,465
Blackpool Corporation...	„ 22	162	+ 21	51	22,378	+ 4,449
Blackpool and Fleetwood	„ 24	187	+ 13	12	1,872	− 215
Bradford Corporation...	„ 25	350	+ 109	84	28,059	...
Brisbane Trams	Feb. 7	1,886	+ 687	19	39,693	+12,127
*Bristol Trams & Carriage	Mar.23	2,401	+ 79	12	30,994	+ 1,164
*Buenos Ayres & Belgrano	Feb. 25	2,294	+ 93	8	18,854	+ 5,191
City & South London Ry.	Mar. 25	1,353	+ 245	12	14,579	+ 1,230
Dover Corporation	„ 24	137	+ 13	51	9,922	+ 1,027
Dublin United	„ 23	2,826	+ 422	12	33,760	} +3035
Dublin Southern Dist....	„ 23	565	− 36	12	7,008	
*Glasgow Corporation ...	„ 24	8,071	+ 521	...	...	...
*Liverpool Corporation...	„ 17	6,985	+ 772	11	72,943	+ 8,939
Liverpool Overhead Rly.	„ 25	1,219	− 50	12	16,860	+ 1,240
*Sheffield Tramways	„ 25	1,816	+ 770	12	21,715	+ 7,132
*South Staffs. Trams.....	„ 23	607	+ 65	12	7,209	+ 117

* Partly electrical.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, March 21.	Price Wednesday, March 28.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending March 29. Highest	Lowest
			TELEGRAPHS.			£ s. d.			
£110,000	100	4%	*African Direct Telegraph 4% Mort. Deb. (red.)	99 102	100 104	3 17 4	January and July	...	...
26,000	10	...	Amazon Telegraph	3 4	3 4	...	June and December	...	...
£125,000	100	5%	Do. 5 per Cent. Debentures	85 90	85 90	5 11 1	...	...	...
£375,520	Stock	28/6	Anglo-American	63 66	65 68	5 8 7	Feb., May, Aug., Nov.	67	65½
£2,063,240	Stock	20/0	Do. Preferred	116 117	117 118	5 2 7	„ „	117½	116½
£2,063,240	Stock	27/0	Do. Deferred	14½ 15	15 15½	8 14 1	...	15⅝	15
$10,000,000	$100	$2½	Commercial Cable Capital Stock	165 175	165 175	4 12 1	Jan., Apr., July, Oct.	...	...
£1,562,075	Stock	4%	* Do. 4 per Cent. Debenture Stock	103 105	103 105	3 16 8	„ „	101½	...
16,000	10	8/0	Cuba Submarine Ordinary	9 10	9 10	8 0 0	February and August	...	...
6,000	10	10/0	Do. Preference 10 per Cent.	19 20	19 20	5 0 0	„ „	...	...
12,981	5	2/0	Direct Spanish Ordinary	4 5	4 5	4 0 0	April and October	...	...
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference	9 10	9 10	5 0 0	„ „	...	...
£20,000	50	4½%	Do. 4½ per Cent. Debentures	101% 105%	101% 105%	4 5 9	January and July	...	...
60,710	20	3/0	Direct United States Cable	11⅛ 12	11⅛ 12	5 16 8	Jan., Apr., July, Oct.	11⅛	11⅜
£120,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red.)	99 102	100 103	4 8 0	June and December	...	...
£4,000,000	Stock	5%	Eastern Ordinary	155 160	155 160	4 7 6	Jan., Apr., July, Oct.	157	...
£1,795,000	Stock	3½%	Do. 3½ per Cent. Preference Stock	98 101	98 101	3 9 3	„ „	100⅛	99
£1,432,268	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.)	116 121	116 121	3 6 8	May and November	116½	...
250,000	10	2/6	Eastern Extension	16 16⅛	16 16⅛	4 4 10	Jan., Apr., July, Oct.	16⅛	16⅛
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	115 120	115 120	3 6 8	February and August	116½	115½
£6,700	100	5%	* Do. 5% (Austin. Gov. Sub.) Deb., 1900 (reg.)	100 103	100 103	4 17 1	January and July	...	...
£26,600	100	5%	Do. (Bearer)	100 103	100 103	4 17 1	„ „	...	...
£200,000	100	4%	*Eastern and S. African 4% Mort. Deb., 1909	100 103	100 103	3 18 5	February and August	...	...
£200,000	25	4%	Do. 4 per Cent. Mauritius Sub. Debs. (red.)	101% 104%	101% 104%	3 16 10	May and November	...	...
180,227	10	1/9	Globe Telegraph and Trust	11⅛ 12	11⅛ 12	4 7 6	Jan., Apr., July, Oct.	11⅞	11⅝
180,042	10	3/0	Do. 6 per Cent. Preference	15⅝ 16	15⅝ 16	3 15 0	„ „	16	16⅛
150,000	10	5/0	Great Northern of Copenhagen	32 34	32 34	3 13 6	January and July	33	...
£86,200	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb. (red.)	99 102	100 103	4 8 0	...	...	...
17,000	25	12/6	Indo-European	54 58	54 58	4 6 2	May and November	...	...
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904	104 107	105 108	5 11 7	March and September	105	...
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.)	101 104	102 105	3 16 9	June and December	...	...
11,839	8	4/0	Reuter's	7 8	7 8	5 0 0	April and October	...	...
3,381	£100 Cert.	6%	Submarine Cables Trust	126 131	126 131	4 13 5	„ „	128	...
15,609	10	...	West African Telegraph	2½ 3½	2½ 3½	4 9 3	December and July	...	...
£200,000	100	5%	* Do. 5 per Cent. Debentures (red.)	98 101	97 100	5 0 4	March and September	...	...
30,008	2½	...	West Coast of America	⅛ 1	⅛ 1	...	...	...	...
£150,000	100	4%	* Do. 4 per Cent. Debentures	100 104	100 103	3 13 5	January and July	...	...
98,321	10	6d.	West India and Panama	¾ 1⅛	¾ 1⅛	...	May and November	1	...
34,563	10	6/0	Do. 6 per Cent. 1st Preference	9½ 9¾	9½ 9¾	6 3 1	„ „	...	...
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	7 8	7 8	7 10 0	„ „	7	...
£80,000	100	5%	* Do. 5 per Cent. Debentures	104 107	104 107	4 13 6	January and July	...	...
£389,731	Stock	4%	Western & Brazilian 4 per Cent. Debenture Stock	100 104	100 104	3 16 11	June and December	...	...
207,920	10	3/0	Western Telegraph (late Brazilian Submarine)	14½ 15½	14½ 15½	4 11 10	Mar., June, Oct., Dec.	15	14⅞
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1900)	106 109	106 109	4 11 9	June and December	...	...
£158,100	100	6%	*Western Union 6 per Cent. Sterling Bonds (red.)	...	...	5 17 8	March and September	...	...
			TELEPHONES.						
44,000	£5	3/0	Chili Telephone (fully paid)	2 3	2 3	6 13 4	August	...	...
224,850	10s.	0/1½	Consolidated Telephone Const. & Manufacturing	⅛ ¼	⅛ ¼	4 15 3	July	...	...
72,690	1	2½%	Monte Video Telephone Ordinary	⅛ ⅜	⅛ ⅜	5 0 0	November	...	...
96,492	1	1 0	Do. 5 per Cent. Preference	¾ 1	¾ 1	5 0 0	„	...	...
430,000	5	3/0	National	5 5½	5 5½	5 14 3	February and August	5⅛	4⅞
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Preference	14 15	14 15	4 0 0	„ „	...	...
15,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference	14 15	14 15	4 0 0	„ „	...	...
250,000	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref.	5½ 5¾	5½ 5¾	4 10 11	„ „	...	...
2,000,000	Stock	3½%	* Do. Debenture Stock 3½ per Cent. (red.)	97 100	97 100	3 10 0	June and December	99	98½
171,504	1	0/4	Oriental	¾ 1	¾ 1	5 0 0	April and October	...	...
58,000	5	2/6	United River Plate	4¾ 5¼	4¾ 5¼	7 2 10	July	4⅞	...
16,689	5	1/4	Do. 5% Cumulative Preference	4¾ 5¼	4¾ 5¼	4 15 3	June and December	5 1/16	5 1/16
£179,947	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	103 106	103 106	4 14 4	„ „	...	...

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, March 21.	Price Wednesday, March 28.	Rate per Cent. Yielded. £ s. d.	Dividend Due.	Business Done During Week Ending March 28. Highest	Lowest
			ELECTRICITY SUPPLY COMPANIES.						
100,000	1	...	Bl'ckh'th & Gr'nw'ch D'st'ct Elec.Lt.Ord.(fully pd.)	⅝ ⅞	⅝ ⅞	...	...	...	...
6,000	10	7/9⅔	Bournemouth and Poole Elec. Supply Ord.	12 13	12 13	3 0 0	...	...	...
6,000	10	4/6	Do. 4½ per Cent. Cumulative Pref.	10 11	10 11	4 1 10	...	...	...
19,661	5	2/6	Brompton & Kensington Electricity Supply Ord.	7 8	7 8	3 15 0	...	7⅜	...
12,000	5	3/6	Do. 7 per Cent. Preference	8½ 9½	8½ 9½	3 13 8	March and September	8¾	...
20,000	5	...	Calcutta Elec. Supply Ordinary (fully paid)	6½ 7½	7 7½	...	...	...	...
50,000	5	5/0	Charing Cross & Strand Electricity Supply Corp.	9 10	9⅛ 10⅛	4 5 9	February and August	10½	10
20,000	5	2/3	Do. 4½ per Cent. Preference	6½ 6	5½ 6	3 15 0	,, ,,	...	...
34,000	5	2/6	Chelsea Electricity Supply Ordinary	7 8	7 8	3 15 0	March	7⅛	7⅜
£150,000	Stock	4½%	* Do. 4½ per Cent. Debenture Stock (red.)	110 112	110 112	4 0 11	June and December	...	...
$1,200,000	$1,000	5%	Chicago Edison 1st Mort. 5% 30 yr. Gold Bonds (red.)	100 110	100 110	4 10 11	April and October	...	...
60,000	10	7/0	City of London Electric Lighting Ordinary	9½ 10½	10 11	3 3 8	February and August	10⅛	10
40,000	10	6%	Do. 6 per Cent. Cumulative Preference	13 14	13 14	4 5 9	January and July	...	...
£400,000	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	122 127	122 127	3 18 9	June and December	...	...
40,000	10	...	County of London and Brush Prov. Ordinary	9½ 10½	9½ 10½	...	...	10½	...
20,000	10	6/0	Do. 6 per Cent. Cumulative Preference	12⅝ 13⅝	12⅝ 13⅝	4 8 11	March and September	...	...
£200,000	Stock	4½%	Do. 4½% Deb. Stock Certs. (all pd.) (red.)	109 112	109 112	4 0 11	...	...	...
15,000	5	10%	Kensington and Knightsbridge Ordinary	12½ 13½	12½ 13½	4 1 6	...	...	...
10,000	5	6%	Do. 6 per Cent. 1st Preference	7 7½	7 7½	4 0 0	January and July	...	...
110,000	3	...	London Electric Supply Ordinary	1⅝ 2⅛	1⅝ 2⅛	...	...	...	...
48,050	5	3/0	Do. 6 per Cent. Preference	4⅝ 5⅛	4⅝ 5⅛	5 14 3	...	5 1/16	5
£250,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures	100 102	100 102	3 19 3	Mar., June, Sept., Dec.	...	...
85,000	10	5/0	Metropolitan Elec. Supply Ord.	13½ 14½	14 15	3 6 8	April and October	14⅜	...
£220,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage	114 117	114 117	3 16 11	June and December	...	...
£125,000	Stock	24/8	Do. 3½ per Cent. Mort. Deb. Stock (red.)	96 98	96 98	3 11 10	...	9 1/16	96
6,452	10	8/0	Notting Hill Electric Ordinary	15½ 16⅝	15½ 16½	4 4 10	March	16¼	16
10,000	5	5/0	Oxford Electric Ordinary	6⅝ 7	6⅝ 7	3 11 5	,,	...	...
300,000	1	8%	Rand Electric	⅜ ⅝	⅜ ⅝	10 13 4	...	...	...
£130,070	Stock	5%	River Plate El.Lt. & Tr'ct'n, Ltd., 5% 1st Mor.Deb.	75 85	75 85	5 18 0	...	...	...
150,000	$100	$2	Royal Electric Company of Montreal Shares	150 170	150 170	4 14 2	...	...	...
£123,200	100	4½%	* Do. 4½ per Cent. 1st Mortgage Debentures	104 106	104 106	4 5 6	April and October	...	...
40,000	5	9/6	St. James's and Pall Mall Electric Ordinary	14 15	14 15	4 16 8	February and August	11⅜	...
20,000	5	3/6	Do. 7 per Cent. Preference	8½ 9½	8½ 9½	3 13 8	,, ,,	9¼	...
12,000	5	...	Smithfield Markets Electric Supply Ordinary	...	2⅝ 2¾	...	...	...	...
£50,000	Stock	...	Do. 4% Debentures	...	85 95	...	..	...	...
65,000	5	...	South London Electric Supply Ordinary (fully paid)	3⅞ 4⅛	4 4⅛	...	...	...	...
79,900	5	8/0	Westminster Electric Supply Ordinary	13½ 14½	13½ 14½	4 9 8	March and September	14 1/16	14⅛
			ELECTRIC MANUFACTURING, &c., COMPANIES.						
125,000	1	7½d.	Aron Electricity Meter 6 per Cent. Cum. Pref.	11/16 13/16	11/16 13/16	7 7 8	...	...	...
45,000	1	...	British Electric Works Co. Ordinary	⅝ 1	⅝ 1	...	...	...	...
50,000	1	...	Do. 5 per Cent. Cumulative Preference	⅝ 1	⅝ 1	...	...	...	...
£50,000	100	4½%	Do. First Mortgage Debentures	99 101	99 101	...	...	...	...
40,000	5	15/0	British Insulated Wire Ordinary	11 12	11 12	4 3 4	...	...	...
27,500	5	3/0	Do. 6 per Cent. Preference	6 6½	6 6½	4 12 4	...	6⅜	...
100,000	5	...	British Westinghouse 6% Preference	4⅜ 5¼	4⅜ 5¼	...	...	...	...
90,060	2	2/0	Brush Electrical Engineering	1⅝ 2⅛	1⅝ 2⅛	4 14 1	September	2	1 15/16
90,000	2	1/2⅔	Do. 6 per Cent. Pref. Non-Cumulative	2¼ 2⅜	2¼ 2⅜	4 16 0	,,	2⅛	...
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Deb. Stock	108 113	108 113	3 19 8	February and August	113	...
£108,710	Stock	12/1	* Do. 2nd Debenture Stock (red.)	...	103 105	4 5 9	June and December	...	...
20,000	5	5/0	Callender's Cable Construction Ordinary	14½ 15½	14½ 15½	4 16 9	,, ,,	...	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5½ 6	5½ 6	4 3 4	...	...	...
£90,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb. (red.)	111 115	112 116	3 18 5	November and May	...	...
300,000	1	0/9⅜	Castner-Kellner Alkali Co. (fully paid)	1⅜ 1⅝	1⅜ 1⅝	5 16 5	...	...	...
60,000	1	0/7 1/5	Chadburn's Ship Telegraph Ordinary	⅝ 1⅛	⅝ 1⅛	5 6 8	...	...	...
60,000	1	0/7 1/5	Do. 6 per Cent. Cumulative Preference	⅝ 1⅛	⅝ 1⅛	5 6 8	...	...	...
32,098	3	1/9⅗	Crompton and Co. (Nos. 1 to 32,098)	3½ 4	3½ 4	4 10 9	January and July	...	...
£100,000	100	5%	* Do. 5 per Cent. First Mortgage Deb. (red.)	98 101	98 101	4 19 0	,, ,,	...	...
60,000	1	0/3	Davis and Timmins 6 per Cent. Cum. Pref.	¾ 1	⅞ 1⅛	5 6 8	...	...	...
99,261	5	1/9⅔	Edison and Swan United ("A" Shares) (£3 paid)	2 2⅛	2 2⅛	7 3 9	February and August	...	...
17,139	5	2/9⅔	Do. (£5 paid)	3½ 4⅛	3½ 4⅛	6 13 4	,, ,,	3⅞	...
£344,023	Stock	4%	Do. 4 per Cent. Mortgage Deb. Stock (red.)	93 95	93 95	4 4 3	June and December	...	...
26,100	5	5/11¼	Edmundson's Electric Corporation Ord. (fully pd.)	4⅛ 5⅛	4⅛ 5⅛	5 14 3	Half-yearly	...	...
112,100	2	1/2⅝	Electric Construction Co. (Limited)	2⅛ 2⅜	2⅛ 2⅜	4 16 0	January and July	2⅜	...
25,000	2	2/9⅔	Do. 7 per Cent. Cumulative Preference	2⅝ 3¼	2⅝ 3¼	4 6 2	July	...	...
182,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	104 107	104 107	3 15 2	January and July	...	...
91,195	1	...	Elmore's Patent Copper Depositing	⅜ ⅝	⅜ ⅝	...	...	...	...
30,000	5	11 0	Henley's Telegraph Works Ordinary	13½ 14½	13½ 14⅝	3 15 10	February and August	14⅛	...
30,000	5	1/6	Do. 4½ per Cent. Preference	5¼ 5⅝	5¼ 5⅝	3 18 3	,, ,,	...	...
£50,000	Stock	4½%	Do. 4½ per Cent. Mortgage Deb. Stock (red.)	110 114	110 114	3 18 11	,, ,,	...	...
50,000	10	10/0	India Rubber, Gutta Percha, &c., Works	21 22	21 22	4 11 10	,, ,,	21⅜	...
£300,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.) ...xd	101 105	103 103	3 17 6	March and September	102⅝	...
37,350	12	24/0	Telegraph Construction and Maintenance	36 40	36 40	4 9 11	March and July	37⅝	35⅝
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909	102 105	102 105	3 16 2	...	...	...
20,000	5	3/0	Do. Manufacturing Ordinary	9 10	9 10	3 10 0	...	10	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5½ 6	5½ 6	4 3 4	...	...	...
30,000	5	5/0	Willans and Robinson Ordinary	11 12	11 12	3 15 0	April and October	...	...
30,000	5	3/0	Do. 6 per Cent. Cumulative Preference	7¼ 7¾	7¼ 7¾	3 17 5	,, ,,	...	...
£100,000	Stock	4¼%	Do. 4¼ per Cent. 1st Mortgage Debentures	104 106	104 106	4 0 2	May and November	...	...
			ELECTRIC RAILWAYS, TRAMWAYS, &c.						
12,000	10	10/0	Blackpool and Fleetwood Tramways	17 18	17 18	4 8 11	...	...	...
£167,900	100	5%	Brisbane Tramway 5 per Cent. Debentures	104 106	104 106	4 14 4	...	...	...
50,000	10	8%	Bristol Tramways and Carriage Ordinary ...xd	22½ 23½	22½ 23½	...	February and August	...	...
25,000	10	4%	Do. Cumulative Preference (£6 paid)	6¼ 6½	6¼ 6½	...	...	...	...
£100,000	Stock	4%	Do. 4 per Cent. Debentures	117 118	117 118	3 7 3	...	...	...
12,000	10	...	British Columbia Electric Railway 5% Pref.	10¼ 10⅜	10¼ 10⅜	...	...	10 7/8	...
30,000	10	9/0	British Electric Traction Ordinary (Nos. 1 to 30,000)	17 18	17 18	3 6 8	...	17⅜	...
£15,000	10	...	Do. (Nos. 60,001 to 75,000)	16⅜ 17⅜	16⅜ 17⅜	...	...	17⅜	...
30,000	10	6/0	Do. 6% Cum. Pref. (Nos. 30,001 to 60,000)	13 13⅜	13 13⅜	4 8 11	...	13¼	13⅜
£200,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures	126 129	126 127	3 19 1	...	...	...
40,000	5	1/9	Buenos Ayres & Belgrano 6% "A" Cum. Pref.	4⅞ 5⅛	4⅞ 5⅛	5 17 1	...	...	...
27,500	5	...	Do. "B"	4 4⅛	4 4⅛	...	...	...	...
320,000	Stock	5%	Do. 5 per Cent. Debentures	105 108	105 108	4 12 7	...	...	...
213,553	10	3/0	Central London Ordinary	9⅝ 10¼	10 10⅛	2 17 2	June and December	10¼	10
£855,000	Stock	1½%	City and South London Railway Con. Ordinary	66 68	67 70	2 13 11	January and July	70	68¾
37,500	10	...	Do. (Nos. 22,501 to 60,000) (£5. 10s. paid)	4½ 5⅛	4½ 5⅛	...	...	5¼	...
£150,000	Stock	5%	Do. 5 per Cent. Perpetual Preference (1891)	140 145	140 145	3 9 0	January and July	...	...
x200,000	Stock	5%	Do. (1896)	132 137	132 137	3 13 0	...	...	...
£187,701	Stock	4%	Do. 4 per Cent. Perpetual Debenture	125 130	125 130	3 1 11	May and November	125⅛	124⅛
20,000	10	7½%	†Imperial Tramways Ordinary ...xd	23 24	22⅛ 23⅛	...	March and September	23⅜	22⅜
10,000	10	6%	† Do. 6 per Cent. Preference ...xd	15 15⅜	14⅝ 15⅛	3 16 2	,, ,,	15⅜	15⅛
£300,000	Stock	4½%	† Do. 4½ per Cent. Debenture	113 115	113 115	3 17 11	January and July	...	...
30,000	10	1/3	Kidderminster & District E. L. & Tr'ct'n 5% Pref.	10 10⅛	10 10⅛	4 15 3	May and November	...	...
37,500	10	2½%	Liverpool Overhead Railway Ordinary	8¾ 8⅞	8¾ 8⅞	4 4 6	February and August	...	...
10,000	10	5%	Do. 5 per Cent. Preference	13 13¼	13 13¼	3 15 4	,, ,,	...	...
125,000	Stock	4%	Do. 4 per Cent. Debenture	105 107	105 107	3 15 1	January and July	...	...
24,000	5	...	New General Traction Ordinary	3⅞ 4⅛	3⅞ 4⅛	...	...	...	...
30,000	5	6/0	Do. 6 per Cent. Cumulative Preference	5 5⅛	5 5⅛	5 9 1	May	5⅛	...
4,000	10	...	Oldham, Ashton and Hyde Elec. Tramway Ord.	18 19	18 19	...	February and August	...	...
4,000	10	5/0	Do. 5 per Cent. Preference	10⅛ 10⅜	10⅛ 10⅜	4 13 0	,, ,,	...	...
13,334	10	...	Potteries Electric Traction Ordinary	11⅛ 12⅛	11⅛ 12⅛	...	...	...	...
20,000	10	5/0	Do. 5 per Cent. Cumulative Preference	10 11	10 11	4 10 11	...	...	...
£540,000	Stock	3%	Waterloo and City Ordinary	101 104	101 104	2 17 8	June and December	103¼	102½

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.
† The London Stock Exchange Committee refuses to quote these.

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THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,142. [No. 24. Vol. XLIV.] FRIDAY, APRIL 6, 1900. PRICE SIXPENCE (by post, 6½d.). Abroad, 8d., or 15 cents. or 60fr., or 6m.

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NOTES.

Mr. Borchgrevink's expedition to the Antarctic regions is reported to have resulted in the localisation of the south magnetic pole; but the telegram from New Zealand to the *Aftenposten* of Christiania, by which the news has been announced, gives no data for fixing this interesting point on the map. But doubtless corroborative details will be forthcoming; and these should not only serve to fix exactly the geographical position of the pole, but should also make it clear why the definite article has been used in referring to it. We had always supposed there were at least two southern magnetic poles; there have not been wanting, indeed, responsible writers who have even hinted at a second north pole. Be this as it may, we anxiously await further intelligence of Mr. Borchgrevink's discovery, for this should prove a useful contribution to the science of terrestrial magnetism. At present we can only feel sure that the pole he has located is no farther south than 78deg. 50min. latitude, for that is as far south as the expedition has penetrated.

Although there is really nothing new in Mr. Lackie's Paper on "Methods of Charging for Public Supply of Electricity," the abstract printed in another column will no doubt be read with interest. Mr. Lackie works out, step by step, the manner in which the Wright maximum demand system should be made use of, and clearly puts before the reader the method of determining the tariff to be charged. That committees controlling electricity supply undertakings are not always clear upon such matters has been shown by cases in which disproportionate reductions in price have been made—especially at the time of the taking over of a supply works by a municipality—and by the frequent supply of electrical energy below cost to large consumers such as other municipal committees. Of course, even the Wright system does not give the absolutely correct theoretical charge that should be made to each consumer, for, instead of paying the capital part of the charge at so much per unit, the consumer ought by right to pay a sum down in proportion to his maximum demand (whatever his consumption), and then a uniform price per unit consumed corresponding to the second charge on the Wright system; and the system, moreover, does not take account of the fact that each consumer's maximum demand does not necessarily occur simultaneously with the maximum demand on the works. Yet, if the Wright system is chosen, the method set out in the Paper (originally given, we believe, by Mr. Wright) should be made use of.

A simplification of the Wright system, were it not in contravention of the Board of Trade regulations against preferential rates of charging, would be to employ demand meters for a year or two, and, having by their means determined the habits of the various classes of consumers in the town, charge each at a single rate according to a table such as that given near the end of Mr. Lackie's Paper (p. 863). A similar table, but in greater detail, was given by Mr. Gibbings (*The Electrician*, Vol. XLI., p. 76) in his recent series of articles on "The Commercial and Business Aspects of Municipal Electricity Supply." But since the Wright system, as it at present exists, is probably the nearest approach to preferential charging that the Board of Trade would tolerate, such tables will chiefly be of use to canvassers, for, in addition to aiding them in educating the consumer up to the Wright system, they will afford a guide as to which are the most and which the least desirable classes of consumers.

The discussion on Mr. Lackie's Paper was disappointing. Although only a side issue, it would have been interesting to have heard other opinions as to the probability of being able to reduce capital expenditure to the extent and in the manner suggested by Mr. Lackie—at all events, without appreciably increasing the works costs, and Mr. Lackie himself should have given more reasons for the reductions he suggested The £65 per kilowatt in his ideal station is a figure which has

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even been improved upon by some existing stations, but an examination of our weekly analyses of supply works accounts will show that such low capital expenditures have usually been attained by keeping down the outlay on mains considerably below Mr. LACKIE's figure, with the assistance sometimes of abnormally cheap land and buildings. We believe also that the general tendency is to increase the size of batteries, rather than to reduce the expenditure under this head, as suggested by Mr. LACKIE. Attention has been directed very much towards the reduction of works costs independently of capital charges, but it should not be forgotten that the consulting engineer's duty is to deprecate a slight saving in the former, if it be only effected by an excessive initial capital expenditure.

The Electrical Engineers (R.E.) Volunteers.—The first detachment of this corps arrived at Cape Town on Wednesday last on board the R.M.S. "Tagus."

Greenock Corporation Electric Supply Works.—Owing to pressure on our space we are compelled to hold over the publication of an illustrated technical description of these works.

New Postmaster-General.—The Queen has been pleased to approve the appointment of the Marquis of Londonderry, K.G., to be Postmaster-General, in place of the Duke of Norfolk, K.G., resigned.

The American Rumford Medal.—The American Academy of Sciences has awarded its Rumford medal to Mr. Charles F. Brush, in recognition of the important part he has taken in the development of arc lighting.

Borough Polytechnic Institute.—An interesting and instructive exhibition of the work of the students of the institute was held at the Polytechnic on Saturday last, when some excellent specimens of this work were on view.

The Institution of Civil Engineers.—We have received a copy of the pass list of the Institution examinations held in February last. The list shows that 49 candidates have passed the studentship examination, and 80 candidates the examination for associate membership.

A Large New York Power House.—According to the *Railway and Engineering Review*, of Chicago, the power station of the Third Avenue Railroad, New York, will consume, when in operation, 75 tons of coal per hour, or 1¼ tons per minute. The plant capacity will sustain a load of 100,000 H.P.

Electric Boats on the Severn.—A company is being formed for supplying a number of electric boats to work on the Severn at Stourport. The boats will vary in size, the larger ones being constructed to carry about 70 passengers and capable of travelling from eight to ten miles per hour.

Electric Traction on the Underground Railway.—The directors of the Metropolitan and District Railway Companies inspected on Monday last the electric train and electrical equipment of the section of the District Railway between Earl's Court and High Street, Kensington, stations. The Board of Trade inspection took place on the following day.

Big New York Street Railway Amalgamation.—The Metropolitan Street Railroad Co. of New York has taken over the control of the Third Avenue Railroad Co., whose properties are now in the hands of a receiver. As a consequence of this amalgamation, the Metropolitan Co. adds a track mileage of 174·98 miles, making in all a total mileage of 407·05 miles under its control.

South African Association of Engineers.—We have received a copy of Vol. V. (1898–9) of the *Proceedings* of this association, which contains a number of electrical Papers. Among these may be mentioned "Notes on Electric Lighting Supply," "Three-Phase Electrical Transmission of Power," "Notes on the Manufacture of Calcium Carbide," "Visit to Vereenigung Collieries," "Visit to Brakpan Electrical Works."

Registration and Inspection of Boilers.—The Select Committee of the House of Commons on the Registration and Inspection of Boilers was appointed last Monday. The members are: Sir William Arrol, Mr. Crombie, Mr. Emmott, Mr. Fenwick, Sir Fortescue Flannery, Mr. Galloway, Sir Edward Gourley, Mr. Hazell, Mr. Heath, Sir Alfred Hickman, Sir William Houldsworth, Mr. M'Ghee, Mr. Penn, Colonel Pilkington, and Mr. Renshaw.

Power Used in Electro-Chemical Industries.—According to Prof. Borchers, the eminent electro-metallurgist, the world-manufacture of calcium carbide is utilising a power equal to 180,000 H.P.; that of the alkalies and the combinations of chlorine, 56,000 H.P.; of aluminium, 27,000 H.P.; of copper, 11,000 H.P.; of carborundum, 2,600 H.P.; of gold, 455 H.P. To these figures might be added, if it were obtainable, the very considerable amount of power used in the accumulator industries, electrotyping, and electric bleaching.

Cable Interruptions:—	Date of Interruption.
Latakia—Cyprus	June 21, 1899
Cayenne—Pinhieros	Oct. 11, 1899
Tangier—Tarifa	Jan. 3, 1900
Paramaribo—Cayenne	Feb. 16, 1900
Ceara—Maranham	Feb. 20, 1900
Para—Maranham	Mar. 2, 1900
Môle-St. Nicolas—Cap Haitien	Mar. 7, 1900
Emden—Vigo	Mar. 26, 1900
Trinidad—Demerara	Mar. 30, 1900

Photometric Intensities of Arc Lights.—According to the *Engineer*, the relative actinic intensities of the three parts of the electric arc—viz., (*a*) green-tinted aureole, (*b*) a darker mantle of flame, and (*c*) a bright blue-violet nucleus—depend greatly upon the kinds of carbons used. Experiments have been carried out by Herr E. W. Richter, in which a Nicol's prism photometer is employed for comparing the apparent relative intensities, using in some cases carbons with a known percentage of a salt, such as sodic chloride. In one case, using solid carbons 13mm. in diameter, with an arc length of 6mm., 15 amperes and 56 volts, the ratios are—$b:a:c = 1:2·28:3·32$.

Obituary.—We learn with deep regret of the death in Paris on Tuesday last, in his 78th year, of M. Joseph Bertrand, the eminent French mathematician and permanent secretary of the Paris Academy of Sciences. After a very distinguished career in the École Polytechnique, where he was admitted, on account of the considerable promise he gave, at the age of 11, he entered the mining service. He subsequently accepted a professorship at the Collége de France. M. Bertrand was elected a member of the Académie des Sciences in 1856, and of the Académie Française in 1884. He wrote many mathematical works, the principal ones being "Traité d'Arithmétique," "Traité d'Algèbre," and "Traité de Calcul Différentiel et Intégrel."

Electricity in Japan.—In the course of a lecture delivered at the Imperial Institute, on "Our Friends in the Far East," Mr. A. Diosy, F.R.G.S., said that in the application of electricity the Japanese were far ahead of us. It was the motive power used in numbers of their large factories. Electric trams were to be found in the majority of the provincial towns, as well as in Tokio, and each small shop had its telephone. This was owing partly to cheapness, there being numbers of waterfalls in the country, but also to the attitude the Japanese generally adopted towards new inventions. They were not nearly so suspicious of new things as the English, he said, but ever ready to give a fair unprejudiced trial to anything they considered might be an improvement.

Personal.—Prof. Giuseppe Colombo, the distinguished Italian electrician, was on Monday elected president of the Italian Chamber of Deputies. Prof. Colombo was born in Milan in 1836, and obtained the diploma of civil engineer at the University of Pavia in 1856. He applied himself to electric lighting in 1882, when he went to America to see Mr. Edison's installations. On his return he made the plans for the electricity supply station of Milan, which now supplies about 50,000 incandescents and 1,000 arcs to that city. He was for some time general director of the Società Generale Italiana d'Elettricità, which works the station at Milan, and

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has executed numerous installations of electric light throughout Italy. In 1891 he was appointed Minister of Finance, and in 1896 Minister of the Treasury, from which position he retired in July, 1896.

Electrolytic Manufacture of Metallic Carbonates.—The *Electrical World and Engineer* of New York says that in an American patent granted March 6th to J. W. Richards and C. W. Roepper a process is described for the electrolytic manufacture of white lead and other metallic carbonates. The process is based upon the fact that certain substances such as acetic acid can be split up by electrolytic action, and the carbonic acid thus generated placed in such relation to a metal anode as to form a carbonate therefrom. In producing white lead by this process a solution consisting of acetate of sodium and sulphite of sodium is used in the proportion of 10 grammes of the former to ¼ gramme of the latter per litre. With this electrolyte a lead anode is employed, the cathode being of carbon. A very slight addition of nitrate of potassium is made to counteract any effect from liberated nitric acid. A current of 100 to 200 amperes per square metre of anode surface is used.

Moving a Telephone Switchboard.—The *Electrical World* of New York describes an interesting feat in telephone work, recently accomplished at Detroit by the Michigan Telephone Co. The switchboard, serving 6,000 subscribers, was cut in two and moved 15ft. without hindering the service an instant. For ten weeks previously 42 electricians and scores of other workmen had been preparing for the move, and it was accomplished in ten hours. The west wing of the board was first swung round for a distance of fully 20ft., after which the other half was drawn 8ft. towards the centre of the room. The wing was swung by jack screws, and then the other half of the board was drawn by means of wires fastened to the board at short intervals and extending from it to long threaded iron rods, on which large nuts turned by wrenches in the hands of about 20 men slowly drew it forward the entire 8ft., the cables, containing nearly a hundred thousand wires, being slipped under the floor and into the room below.

Electric Traction Progress in France.—The current issue of *L'Industrie Electrique* contains a table of electric traction undertakings in France, similar to that which we issued as a sheet supplement for traction works in the United Kingdom with *The Electrician* of Jan. 26. In consequence of the great extent of the traction enterprises in Europe, their annual table of European electric traction enterprises has been abandoned. The following analysis of the progress of traction work in France during the past year will be of interest to our readers :—

	Jan. 1, 1899.	Jan. 1, 1900.
Total length of lines in miles.....	303	467·2
Do. power in kw.	18,718	28,308
Do. number of cars	758	1,295
Number of trolley lines	42	56
Do. conduit lines	2	3
Do. third-rail systems	1	1
Do. accumulator systems ...	6	6
Do. mixed systems.....	5	6
Total number of lines.....	56	72

Luminosity in Aluminium-Carbon Primary Cells.—A writer in the *Electrical World and Engineer* of New York (Mr. W. S. Andrews) describes some curious phenomena which he observed in the course of some experiments on aluminium-carbon cells. Two of these were connected, in opposition, to a source of alternating E.M.F., the supply voltage admitting of variation. The cells were charged with a saturated solution of Rochelle salt (double tartrate of potash and soda). When the voltmeter reading gave 90 volts, the immersed aluminium plates became faintly luminous. Increasing the P.D. gradually to 120 volts, a number of little stars appeared on the luminous surface, which was now much brighter, and the number continued to increase with the voltage. At about 150 volts a singing noise was heard, probably due to the formation of bubbles on the surface of the aluminium. The same phenomena continued, with increasing magnitude, until the P.D. was 165 volts, when the turbidity of the liquid due to the formation of bubbles rendered any further increase in voltage inadvisable.

A Curious Telephonic Experiment.—M. E. Piérard describes, in the *Bulletin* of the Belgian Society of Electricians, a curious experiment made by himself and M. Banneux. A metallic disc was clamped in a wooden case in the same way as the diaphragm of a telephone. At its centre a piece of platinum was soldered, and a platinum-tipped screw was adjusted at such a distance behind the disc that notes sung into the mouthpiece produced contact between the two platinum surfaces. When the disc and point were connected in circuit with a telephone receiver, without the interposition of a battery, pure notes sung in front of the disc were reproduced in the receiver. Further experiments showed that this was not due to what may be called the string telephone effect, as it ceased on short-circuiting the disc and point, and the intensity of the sound was increased by transmitting through the medium of an ordinary telephone induction coil. M. Piérard considers that the E.M.F. producing the necessary current is merely the contact E.M.F. of two dissimilar metals (the clamped disc and the platinum spot), as the result is considerably affected by varying the metal of which the disc is made, and the effect was repeated after precautions were taken to avoid temperature differences and their consequent thermo-electric effects. It would appear therefore that all that remains is to attribute the phenomenon to a piezo-electric E.M.F.

The London Telephone System of the Post Office.—The engineering department of the Post Office is rapidly pushing forward the work of establishing a telephone system in the metropolitan area to compete with that of the National Telephone Co., and it is anticipated that an exchange may be opened by the end of the year, and that the first district to be completed will be that including the City of London. Although the area of operations is the same as that of the National Telephone Co., this metropolitan area will be divided into Inner and Outer London. "Inner London" will cover about 117 sq. miles and "Outer London" about 600 sq. miles. The central exchange will be in the building now occupied by the Post Office Savings Bank in Queen Victoria-street, and sub-exchanges will be opened at the district Post Office, Ashley-place, Westminster, and at a point near the Natural History Museum, South Kensington. Besides the City, the first districts to be dealt with will be Hammersmith, Chiswick, Putney, Richmond, Wimbledon, and Kingston-on-Thames. A large scale of operations is expected, and in making the preliminary survey two-thirds of the tenants of every street within the city areas were allowed for as probable telephone subscribers. Contracts have already been let for a large portion of the underground work and for the switchboards. The Westminster Construction Co., Messrs. John Mowlem and Co., and Mr. J. Kavanagh are laying the ducts and pipes; cables have been ordered from Messrs. Siemens Bros. and Co., Messrs. W. T. Henley and Co., and the Western Electric Co., the last-mentioned firm being also the contractor for the switchboards. Cast-iron pipes will be employed when not more than five channels are required. Above that number stoneware ducts will be laid. The latter are in sections of one way each, the internal diameter being 8¼in., and externally they are of hexagonal shape. These are laid on a bed of cement strengthened with T-iron, and after the desired number of ways has been built up the whole is buried in cement. On the main lines the manholes and inspection chambers will be about 150 yards apart. The cables will be, in the first instance, mostly 217-pair, paper-insulated and lead-covered. As already announced, the switchboards will be on the central battery system with small incandescent lamps as calling and ring-off indicators. The clearing signal will only be accepted when both subscribers have hung up their receivers. The central exchange in Queen Victoria-street as at present designed will contain accommodation for 14,400 subscribers.

The Akron, Bedford, and Cleveland Electric Railway.—This line, described in a recent issue of the *Electrical Review* of New York, presents some points of interest. The line is laid upon the highway for a distance of 25 miles, and for the remaining 10 miles it is upon the private property of the

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company, the right of way having an average width of 50ft., enclosed by wire fencing. The country through which the railroad passes is of an undulating nature, and several cuttings had to be made and valleys filled in to reduce the grades. The maximum grade is 13 per cent., 980ft. long, and there is another of 8 per cent. on a sharp curve. There are three feeders, two of 300,000 circular mils and one of 200,000 circular mils, whose aggregate length is nearly 26 miles. The trolley wire is Brown and Sharp No. 0000 hard-drawn copper. The main line is laid with 60lb. "T" rails, on white oak ties spaced 18in. between centres, and ballasted with gravel. It is double-track throughout. There are two power houses. One at Bedford, 12 miles from Cleveland, supplies current for 12 miles to the north and nine miles to the south, and the second supplies nine miles to the north and five and a-half miles to the south of Akron. The two power houses are virtually identical in equipment. Steam is supplied at 120lb. pressure by 250 H.P. Stirling boilers to two simple non-condensing 350 H.P. Allis engines, running at 82 revs. per min. and belted to the generators. The two Westinghouse generators at each station are 250 kw., two-phase and continuous-current (double-current) machines, with eight poles and distributed winding. The voltage of the alternating-current side is 380, while that of the continuous-current side is 550. At present they supply continuous current for the traction line, but in the future it is proposed to operate one station by water power, transmitting two-phase current to the second station and discarding the steam engines in both stations. When the hydraulic system is completed the generators now installed can be used as rotatory converters. The generators are provided with three bearings, the pulley having an outboard bearing which greatly stiffens the machine. The field poles are laminated and rigidly held by a circular frame or yoke of cast iron. The revolving armature is of the ironclad type. The speed of the generators is 400 revs. per min. The machines run in parallel, being connected by an equaliser wire, and the power leads pass to the switchboard. The cars have seating accommodation for 42 passengers on cross seats. They are equipped with toilet, ice-water tank, and 20 electric lights. On the side of every seat is a push-button for communicating with the conductor. Electric heaters are placed at the side of the cars. About one-half of the motor cars are built with a baggage compartment, which reduces the passenger accommodation to 32 seats. In order to secure greater adhesion when the car is heavily loaded, and also to provide a pilot truck for the car, two motors are mounted on each truck, which enables a speed of 50 miles an hour to be attained. To remove snow from the track, snow-scrapers are attached to every car. The company has in addition two heavy snow ploughs, equipped with three 50 H.P. motors. During the snowstorms of last winter no trouble was experienced with snow blockades, although there are several deep cuttings on the road.

The Interruptions on the Berlin Tramways.—In No. 6 of the *Centralblatt für Accumulatoren und Elementenkunde*, Herr Zacharias discusses the causes of the breakdowns that occurred on the electric tram lines in Berlin after the heavy snowstorms of last December, and says that as they have been ascribed by some to the system of working employed, and by others to the type of battery used, some effort should be made to ascertain the real cause of the failure. With regard to Herr Albrecht's contention that it was the type of battery which was at fault, and that batteries having grid plates would have given better results than those used in Berlin (which have Planté positives and negatives of the grid pattern), Herr Zacharias says that, owing to the conditions of traffic, this was the only type of battery suitable. The stoppages at the terminal stations are usually of very brief duration, and very frequently the car has to start its return journey at once. Under these circumstances the charging of the batteries has to be effected rapidly, and often from the overhead conductor during the journey. Grid batteries are not suitable for these working conditions, as is evident when we consider the characteristic behaviour of the two types of plate. If two cells are taken which have been discharged to a corresponding extent, the one having Planté positives and the other plates of the Faure type, and start charging them at a constant potential of 2·5 volts, we get a high current density in both cases, owing to the low back E.M.F. of the cells. But whereas in the former the falling off is very gradual after the first sudden drop, in the latter it is very rapid. In the case of the Berlin lines Planté cells having a capacity of 80 ampere hours and a one-hour discharge rate are used. The initial strength of the charging current is 160 amperes, which falls to 100 amperes in the first minute, to 50 amperes in 10 minutes, and then sinks gradually to 7·5 amperes in 60 minutes at the close of the charge. Under similar conditions the behaviour of the grid plate is very different. In the case of a pasted plate of 260 ampere hours capacity with a three hours discharge rate, the current strength at the beginning of charge is 72 amperes, which falls to 25 amperes in 30 minutes, to 18 in 60 minutes, at which strength it remains for 150 minutes. At the end of the charge, after 180 minutes, it has fallen to 10 amperes. During discharge with high current densities, badly conducting lead sulphate is formed on the upper layers of the plate, which must be converted into peroxide before the charging can proceed satisfactorily. The quick charging up with high current densities which street tramway work necessitates is not compatible with good commercial efficiency in the case of grid plates. Comparing the amount of charge taken up by the two types of plate in a given time, the pasted plates had only taken up one-tenth. After running about 25,000 car kilometres the capacity of the negative plates has fallen so low that they require to be charged. With regard to the plant, the following information is available: The batteries used for the large cars consist each of 200 cells with a capacity of 30 ampere-hours in a one-hour discharge. The maximum power required for a 7 kilometre journey under ordinary circumstances is 5·6 units, while the batteries have a normal yield of 10·400 units, so that there is a reserve of about 100 per cent. But as the batteries are really only used for 5·5 kilometres, the actual reserve is increased to 150 per cent. On most routes only five ampere-hours capacity is required for an automobile journey, provided that the batteries have been properly charged, so that there is a capacity available for bad weather which is four or five times that ordinarily required. But for many reasons it cannot be said with certainty that the batteries were properly charged during the disturbances to traffic caused by the snowfall. The charging potential is not the same on all the routes, and differs by as much as 100 volts, and therefore it is not always possible to charge sufficiently during the day journeys, or in the stations in the evening. Further, the potential of the batteries has sometimes fallen so low that it is not possible to charge them again at once. During the December snowfalls it was stated that the charging stations were not always able to keep up the requisite potential in the mains, and therefore the batteries sometimes discharged into the overhead conductor. But the batteries answered all requirements when the snow was cleared rapidly away, and the potential in the mains did not differ much from the normal.

MEETINGS OF SCIENTIFIC AND ENGINEERING SOCIETIES, &c.

(TO-DAY) FRIDAY, April 6th.

INSTITUTION OF CIVIL ENGINEERS.

2.30 p.m. Students' visit to the Works of the India Rubber, Gutta Percha and Telegraph Works Co. (Ltd.), Silvertown. Train from Fenchurch-street at 2.3 p.m.

ROYAL INSTITUTION.

9 p.m. Evening Discourse on "Solid Hydrogen," by Prof. Dewar, F.R.S.

SATURDAY, April 7th.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture V. on "Polarised Light," by the Right Hon. Lord Rayleigh, F.R.S.

TUESDAY, April 10th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Papers to be read and discussed: (1) "The Development of the Manufacture and Use of Rails in Great Britain," by Sir Lowthian Bell, F.R.S.; (2) "The Wear of Steel Rails in Tunnels," by Thomas Andrews, F.R.S.

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BOLTON CORPORATION COMBINED LIGHTING AND TRACTION WORKS.

(*Concluded from page 812.*)

Before describing the continuous-current switchboard, we may give a few particulars of the steam generating plant. The old boiler house, O B, in Fig. 1, contains six Lancashire boilers 30ft. by 7ft. 6in., fitted with Meldrum forced draught and Musgrave superheaters, and the new one, N B, of which a good view is given in Fig. 10, contains three Lancashire boilers 30ft. by 8ft., also fitted with Musgrave superheaters. As seen in Fig. 10, the new boiler house is provided with coal and ash conveyors and Bennis stokers. The conveyors are arranged in a most practical manner. The coal is led down from the bunker by a bucket chain, and thence by a simple chain moving along a trough to the stokers. This same chain, on its return journey, carries the ashes away, and these are hoisted by a third chain straight up to the ash carts.

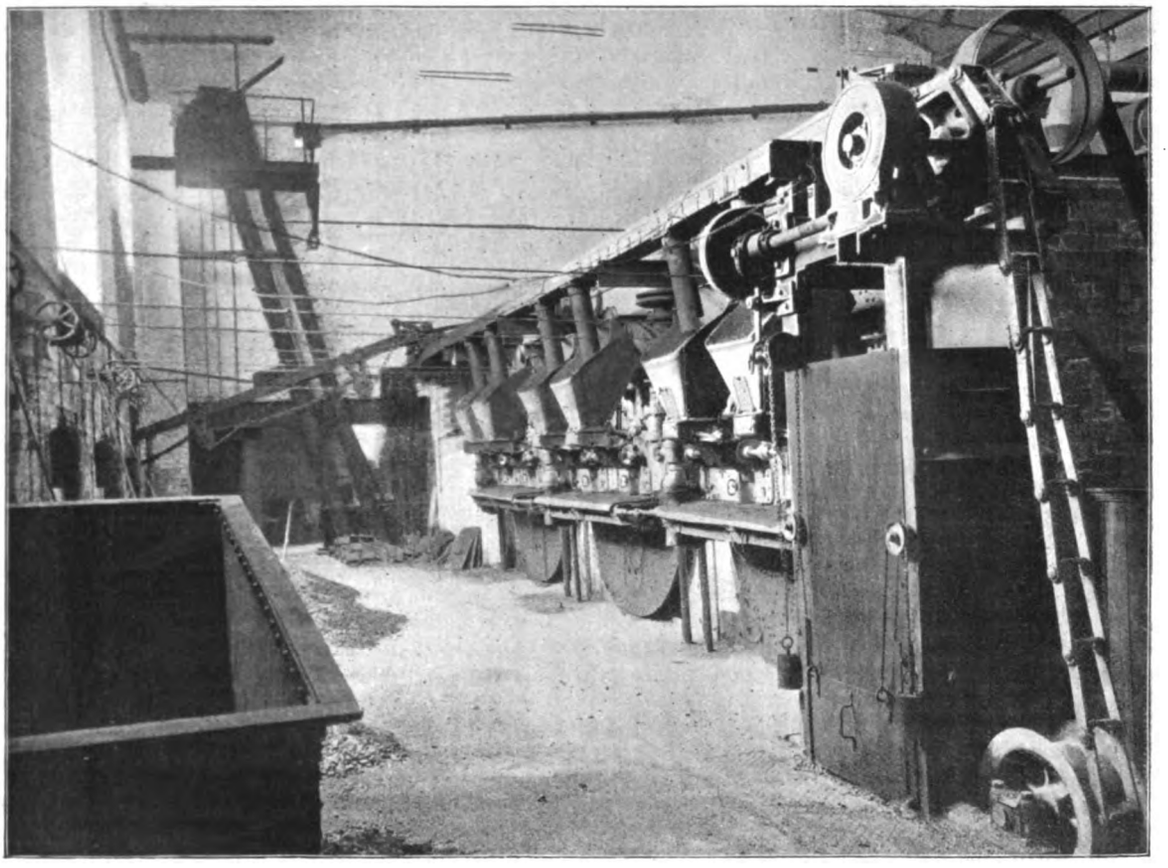

FIG. 10.—NEW BOILER HOUSE.

The old boilers are for a steam pressure of 120lb. per sq. in., the new ones for 160lb. per sq. in. Slack is burnt, costing at present 12s. per ton. The conveyors and stokers are electrically driven by a motor placed in a box at the side of the end boiler. The old boilers are fed by Worthington Admiralty pattern feed pumps and injectors, and the feed water is passed through Berryman exhaust feed heaters. Electrically-driven Hayward-Tyler three-throw pumps are placed at the end of the new boiler house.

The economiser is of Messrs. E. Green and Son's make. It contains 288 tubes, eight in a row, in three groups of 96 tubes each. Each group is coupled together by expansion elbows. The heating surface of the economiser is 2,880 sq. ft.

The continuous-current switchboard has, through exigencies of space, to occupy rather an unfortunate position on the switchboard gallery behind the alternating-current board. It is supplied by the British Thomson-Houston Co., is of polished white marble panels bolted on iron frames, and is unusually simple for the switchboard of a Corporation electricity supply works. Instead of the addition of traction connections to a lighting switchboard introducing complications, the impression is rather given that in the lighting part of the board it had been endeavoured to imitate as much as possible the simpler standard practice of traction switchboards. On the traction part of the board, on the extreme right, are four feeder-panels, to each of which two positive feeders are brought. There is a single-pole switch and an ammeter for each feeder, but one automatic circuit-breaker for the two feeders on the same panel. Next to these are the panels for the positive and negative boosters, the former being connected at a point about three miles from the station. Then simple connections on the next three panels for the pump and stoker motors and the lamps in the station, and finally the Board of Trade panel with Elliott recording voltmeters completes the purely traction part of the board. Next to this are three generator panels, the switches being of the throw-over type, with three contacts in the lower portion, in which the series coils are cut in when the machines are employed for traction. There is the usual rheostat in the shunt field circuit, and the main cut-out is an automatic circuit-breaker of the traction pattern, no minimum current cut-outs being employed. Next come two panels for the balancer connections, and at the extreme left hand are the panels for the lighting feeders, fitted with cut-outs, not fuses. An arrangement for signalling to the engine room (which is not in sight of the attendant at the continuous-current board) is to be added, but it had not yet been erected at the time of our visit to the works. There is a miniature telephone exchange on the switchboard gallery, to which connection can be obtained from any one of the section boxes on the track, and also from the chief sub-stations. For the traction earth-connections two independent earth plates have been sunk, in accordance with the Board of Trade regulations,

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but the middle wire of the three-wire lighting network is earthed directly to the water main without an intermediate ammeter.

At present there are four continuous-current lighting feeders, these being five 0·8 sq. in. triple concentric B.I.W. cables running from the station to the four principal sub-stations, where now all the transformers in the central part of the town have been concentrated. When the consumers' circuits are ready for the change-over, all that will be necessary will be to take the distributor circuits one at a time and change them over from the transformer terminals to the ends of these heavy feeders, the sub-stations becoming simply feeding points. These feeders are simply lead-covered and drawn into stoneware pipes. The four high-pressure feeders to the sub-stations are of Siemens vulcanised indiarubber in iron pipes, and have stood well. Newer high-pressure cables are B.I.W. concentric, and Siemens jute and compound three-core cables are employed for the low-pressure distributors.

The tramway lines in Bolton have always been the property of the Corporation, but were leased to a company. The latter were bought out, however, five years before the expiry of the lease. As it now stands, the track is about half the old track, which has been bonded, and half new. Bonding the old track has proved to be no very great success. The track is worn and too light for electric cars, with the consequence that the wheels frequently run on their flanges on the old sections. Rails weighing 104lb. to the yard have been employed for the new track, and both old and new are bonded with a 0000 Chicago bond and also an "Edison-Brown plastic bond" at each joint, in addition to cross-bonding every 80 yards with Chicago bonds of the size above mentioned. The gauge is standard. The total cost of bonding 31 miles of track, of which about 14 miles was old track, was £6,500. It was also necessary to bond the old track, pending the relaying.

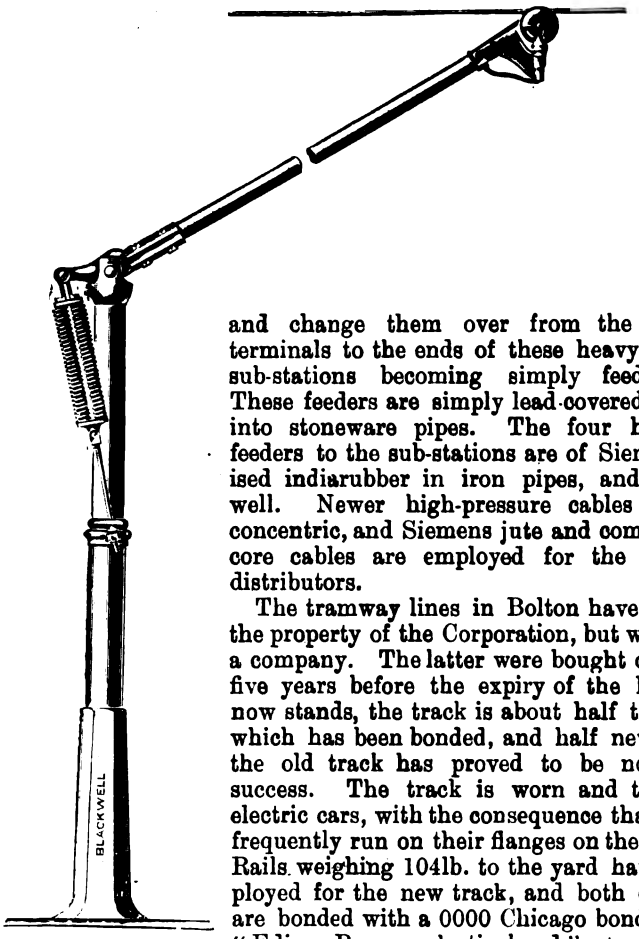

Fig. 14.—Dawson Swivelling Trolley.

The trolley wire is fed from the distributors about every half-mile through section boxes, and divided at these points by section insulators. These distributors are in their turn supplied by feeders running directly from the station to nine feeding points. The majority of the feeders are of 0·25 sq. in. section; some are smaller, and one is of 0·35 sq. in. section. The distributors vary in section from 0·079 to 0·35 sq. in. Bolton should be free from electrolysis, and if any of the return current wanders from the rails, it will be base ingratitude; for, in addition to the generous bonding alluded to, there are four negative feeders of 0·66, 0·66, 0·4 and 0·25 sq. in. section respectively, running to points about three-quarters of a mile from the station, and a fifth of 0·25 in. section connected to a point four miles from the station on the longest route (Chorley New Road) which is about seven miles long.

Fig. 11.—Single Bracket Pole at Bolton.

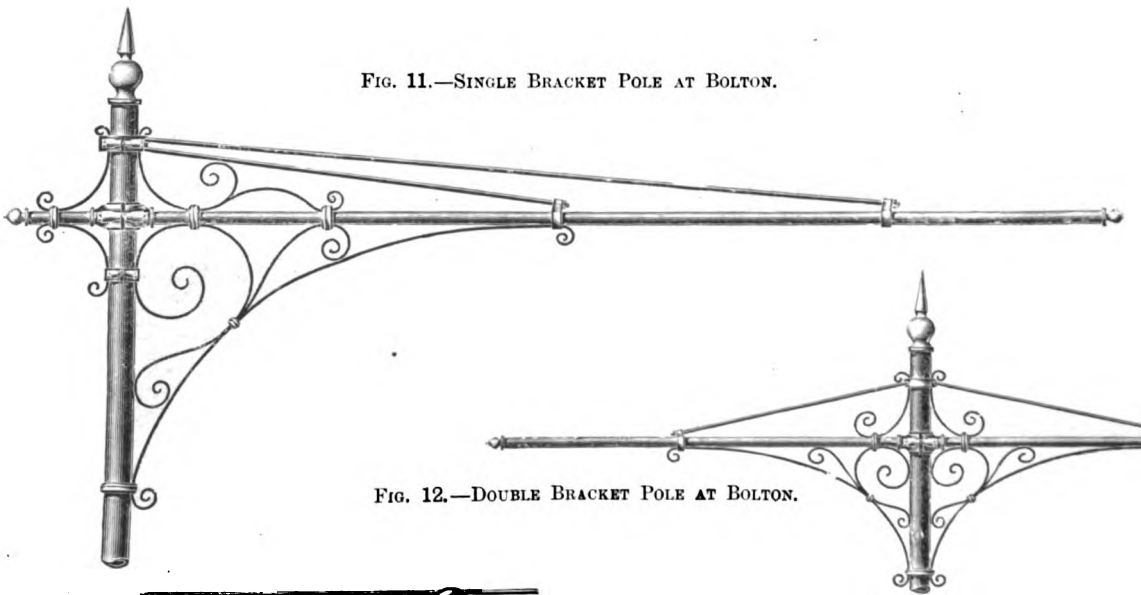

Fig. 12.—Double Bracket Pole at Bolton.

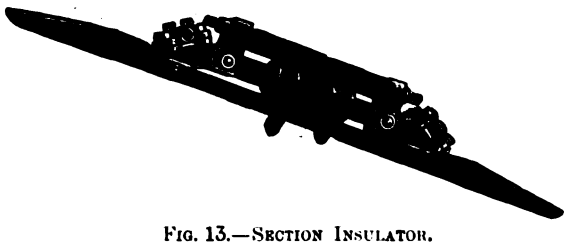

Fig. 13.—Section Insulator.

The total length of feeders and distributors laid is about 30 miles. Three-core pilot cables accompany all the feeders and distributors, and are laid throughout the whole length of the track; two conductors are used as telephone lines, and the third as a Board of Trade wire. The cables are of the British Insulated Wire Co.'s manufacture, plain, lead-covered, the insulation being impregnated paper. They are drawn into 4in. stoneware pipes laid by the same company. The thickness of dielectric on the negative feeders is about three-fifths of that on the positive cables. The pilot cable is drawn in the same duct with the feeder or distributor as far as these are laid, and thence it is placed directly in the ground, the lead covering being heavily armoured to protect it from external injury. The cables were subjected to a pressure test of 2,000 volts, alternating, after they had been laid and jointed up.

All the overhead equipment as well as the track bonds was supplied by Messrs. R. W. Blackwell and Co. as sub-contractors to the British Thomson-Houston Co. The trolley line (No. 0 B & S, weighing 960lbs. per 1,000 yds.) is mostly supported on single bracket poles (Fig. 11), and some of the brackets are of exceptional length, for on all but 5½ miles there are separate trolley lines for cars in opposite directions and, the lines are in most cases well in the centre of the roadway. In one case the arm is as long as the pole itself. Double bracket poles (Fig. 12) are only employed on one route. The poles are of

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steel, and are made in three sections. The three sections are shrunk together hot and under pressure, so as to make a perfect joint. In manufacture 18in. insertion is allowed for each joint, and the joint is hidden by a cast-iron ring. As a jointing when a wire breaks. The device also includes a clamp on each side for the feed wire from the distributor.

Span wire construction is also employed to a large extent: Fig. 15 is from a photograph taken looking down a straight

FIG. 15.—SPAN WIRE CONSTRUCTION AT BOLTON.

test, the poles are dropped, butt foremost, from a distance of 5ft. on to a block of hard wood three times, and must show no signs of telescoping or loosening in the joints. In the section section of track thus equipped. Fig. 16 shows the overhead construction for a sharp corner on a gradient, Fig. 17 is taken at the crossing of two routes, and Fig. 18 is a portion of the

FIG. 16.—A SHARP CORNER ON A GRADIENT.

insulators (Fig. 13) the wooden piece between the terminals is renewable, and there is a device by means of which the wire is clamped without cutting, so that a small coil of wire can be coiled up on the top of the insulator for letting out for track on which some exceptionally long single bracket poles are employed.

The above-mentioned illustrations also show the type of car employed. The bodies are double-decked, and resemble those

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on the Liverpool tramways. They are mounted on Brill single trucks. The cars were supplied by Messrs. Dick, Kerr and Co., and are equipped with four-pole single reduction Short motors of the ventilated type, and series parallel controllers.

Fig. 17.—A Crossing of Two Routes.

Fig. 18.—View on Another Route.

Their trolleys are of the Dawson swivelling pattern, shown in Fig. 14. "Standard" air brakes are employed, the compressor being driven from the axle. A split spur gear keyed to the car axle drives a gear which is mounted free on the pump shaft. The face of this latter gear is provided with the hollow half of a combined cone and positive clutch, the full half of which is mounted on the squared part of the pump shaft. The latter half of the clutch is moved into and out of engagement by a lever, which, with the clutch and gear, is shown inside the open housing in Fig. 19. The compressor proper, on the extension of the shaft carrying the clutch, is bolted to the housing so that it forms an oil-tight continuation of it, and all parts are lubricated by heavy oil placed in the housing. The piston is double-acting, and as it never exceeds a speed of 60ft. per minute, and is idle a very large percentage of the time, the wear of the piston and packing is slight. All four valves are interchangeable, and are provided with removable seats.

The apparatus which automatically throws the clutch in and out consists of two parts. The lower, called the operator, has a spring which, acting on a cross head, always tends to throw the clutch in. Opposed to this spring is a piston of such diameter that when air is admitted to its cylinder the spring pressure is overcome and the clutch thrown out. The upper part, called the governor, admits air to the operator cylinder when the predetermined maximum pressure is attained in the reservoir, which, as explained above, throws the clutch out, and causes the compressor to stop. When, after an application, the air in the brake cylinder is released,

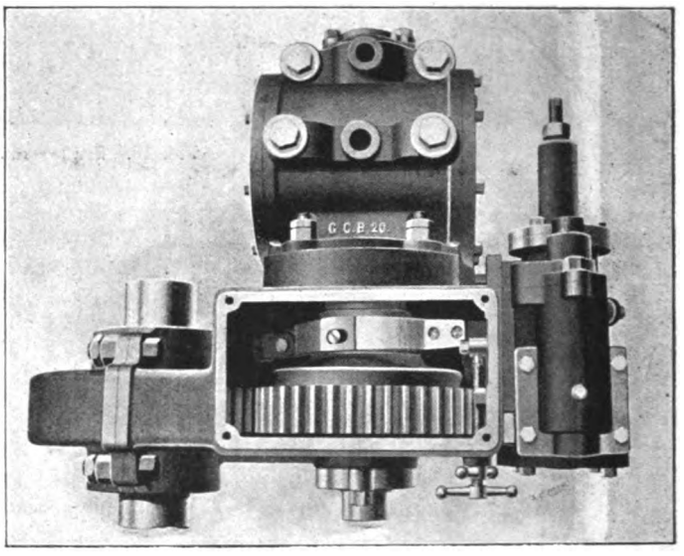

Fig. 19.—Gear Driving the Air Compressor of the "Standard" Brake.

it passes into a chamber of the governor, and this pressure, assisting the spring, causes the release of the air in the operator cylinder; so the spring of the latter throws the clutch in, although the reservoir pressure may have been reduced but a pound or two. Thus there is maximum pressure for all stops when they occur 100ft. or more apart. The exhaust air also lifts the suction valves so there can be no load on the pump piston at the moment when the clutch is thrown in, thereby making the starting of the compressor very easy. The air escapes through the suction screen, and blows off any dust that may have collected on the outside. If the pressure in the reservoir is reduced 10lb. or 15lb., the governor, without the aid of exhaust air, will cause the clutch to be thrown in; but the action is of rare occurrence, and would indicate the presence of serious leakage in the pipe system.

The electric brake is merely intended for employment on emergency.

We wish to express our thanks to Mr. Arthur Ellis, the Corporation electrical engineer, who gave us facilities for inspecting the works and lent us several valuable drawings; to Mr. H. W. Angus, his chief assistant, who took considerable pains in showing us over the works and in answering our innumerable questions; and, lastly, to the various contractors, to whom we are indebted for much of the information as to points of detail.

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RECENT DEVELOPMENTS IN NERNST LAMPS.

Although the fundamental mechanism of the Nernst lamp has now been patented for some years, and largely capitalised companies have been formed for the purpose of exploiting these patents both in this country and abroad, yet the only instance of its commercial employment so far has been in Göttingen, and that quite recently. Engineers, however, have not been idle, and in the meantime we gather that much time and energy, and also money, have been expended in developing and improving this lamp. Judging from the Patent Office files, these attempts have not been directed at merely evading Nernst's fundamental patent, but rather at devising improvements in the lamp itself which would render it more convenient to use.

The first patent to which we desire to draw attention (No. 6,024, 1899) was taken out on behalf of the Allgemeine Electricitäts-Gesellschaft, and describes a form of lamp which can be fitted to an ordinary Edison or Swan lamp-holder. The special features of this type of lamp are clearly indicated in Figs. 1, 2, 3. The illuminating body *e* (Fig. 3) is connected, in a manner which will be described later on, to two metal wires fastened to the pointed metal pieces *g g*. These are forced into the slotted metal tubes *d d* (Fig. 2), and the complete holder is then screwed or otherwise fastened on to the globe, which also contains openings for the introduction of the light which heats the pencil. This lamp very readily admits of the interchanging of the pencils and cleaning the

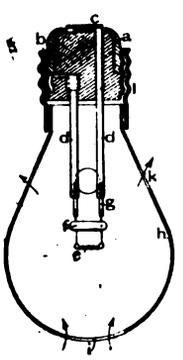

Fig. 1.

Fig. 2.

Fig. 3.

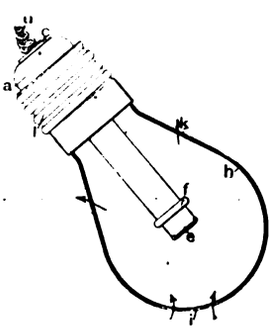

Fig. 4.

globe. Fig. 4 illustrates a similar lamp for obliquely-placed lamp-holders, *u* being a small spring attached to the contact-piece *c* and ensuring constant connection with the centre of it. Slight modifications of the above holder are described for adaptation to a Swan lamp. The simple form of the type of lamp just described has the advantage of cheapness, but on the other hand, the necessity for holding a light to it for some little time renders its employment somewhat inconvenient, and must react against its exclusive or even extensive use. This difficulty has been ingeniously met and, we suppose, overcome in the lamps described in patents Nos. 6,025, 6,026 (1899), also taken out by the Allgemeine Co. The principle made use of is in every case to pass the current simultaneously through an auxiliary heating coil in close proximity to the illuminating pencil and the parallel circuit containing the pencil itself. At first, when the pencil is cold and its resistance is extremely high, nearly all the current will pass through the auxiliary coil. This becomes heated, and in turn raises the temperature of the pencil, which rapidly increases in conducting power, taking an increasing portion of the current. The auxiliary circuit is completed through a steel contact key situated near to the iron core of an electromagnet placed in series with the illuminating circuit; and when finally the current passing through this circuit is sufficiently strong, the core will attract the steel hammer of the contact key and break the auxiliary circuit.

Figs. 5 and 6 illustrate the lamp and holder respectively of a lamp of this kind. The two circuits are here plainly discernible. The first passes from *r* through the iron piece *b*, making contact with the screw *c*, and through *e* and *h* to the auxiliary heater *p*, and back through the parts marked *n*, *i*, *f*, *u* to the other leading wire *s*. The second circuit starts also from *r* and passes round the coil *t* of the electromagnet, and thence through *l* to the illuminating pencil *o*, and back as before. When the temperature of the pencil has been raised sufficiently to make it a good conductor, the current passing through the electromagnet will cause the core to attract the iron piece *b* and break the auxiliary circuit. Fig. 7 illustrates another lamp of the same kind. In this case the auxiliary heating circuit may be traced from *g* through the metal bobbin of the electromagnet, which at its lower extremity rests on the contact tube *d*, and from this through the heating coil *o* and back along the dotted line to *n*. The pencil *p*, in

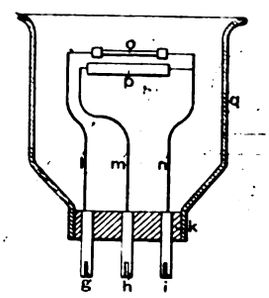

Fig. 5.

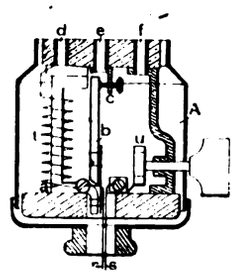

Fig. 6.

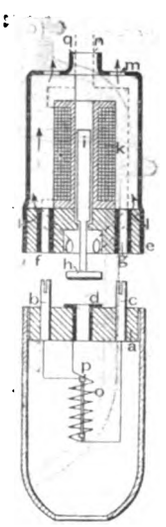

Fig. 7.

this case inside the heating coil, is electrically connected to the coil of the electromagnet *k*, to which *g* is also connected. When this circuit takes a sufficient amount of current, the iron core *i* will be drawn up into the coil, and the auxiliary circuit will thus be broken. A slight modification of the construction of this lamp readily adapts it for the case of bayonet contacts instead of the sliding contacts illustrated in the figure.

The same object is attained in a slightly different manner in the case of a lamp patented by the British Thomson-

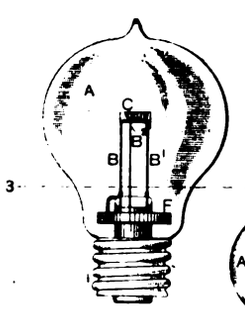

Fig. 8.

Fig. 9.

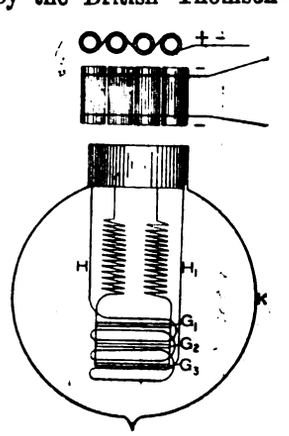

Fig. 10.

Houston Co. (patent No. 5,941, 1899) and illustrated in Figs. 8 and 9. In this case the pencil is surrounded by a heating coil, *c*, of high resistance, and an arrangement is provided whereby the current in this circuit is automatically broken when the pencil *d* takes a sufficient amount of current. Porcelain, clay, or magnesia are some of the substances mentioned in the specification for the illuminating pencils. It is particularly claimed for this type of lamp that it is specially suited for high-voltage circuits and also for alternating currents of low frequency. Fig. 9 is a section taken through 3, 3 (Fig. 8). An entirely different kind of lamp has been

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designed by Prof. Fessenden, and is described in the February number of the *American Electrician*. In this the mechanism permits of coating the pencil with a thin layer of carbon or graphite sufficient to conduct the current in the first instance, and finally to be burned away when the pencil is working properly. This coating of graphite must be re-applied on every occasion on which the lamp is to be lighted.

The lamp shown in Fig. 10 is specially designed to hold a reserve of several pencils, each of which comes automatically into use when the lower one has burned out. The method of arranging these pencils is shown in the side view.

A lamp of somewhat different type was patented by the British Thomson-Houston Co. (No. 13,404, 1899) and is

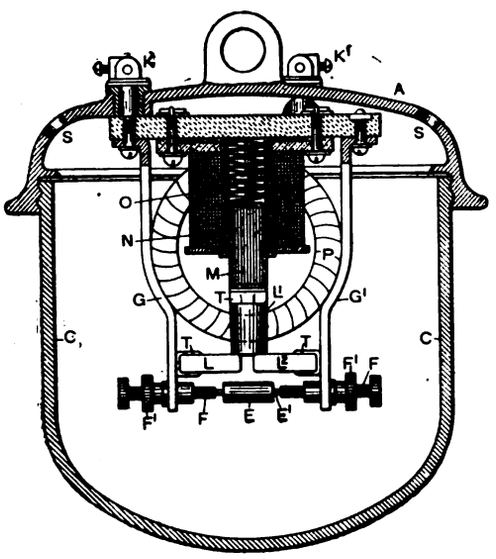

FIG. 11.

represented in Fig. 11. Here the auxiliary heating is performed by striking an arc in close proximity to the pencil, the flame of which heats it. When this conducts sufficiently well, a solenoid in series with it draws the carbon pencil up and the auxiliary circuit is thus broken.

Mr. Hirst, of the General Electric Co., has patented (No. 24,264, 1898) also a switching device for use with Nernst lamps of the independent heating circuit type. This is illustrated in Fig. 12, which is self-explanatory. The first figure represents both circuits open; the second the heating circuit

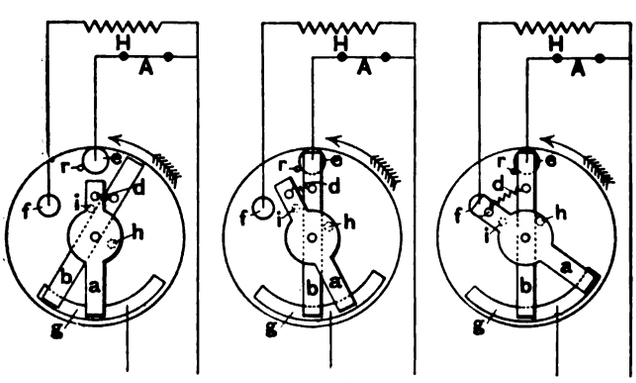

FIG. 12.

open and the filament circuit closed; the third shows both circuits closed. In use, the heating circuit switch is "held" for an instant, during which time the filament will have become sufficiently heated to conduct, and is then allowed to fly back by means of the spring arrangement shown.

The great difficulty in connection with all types of Nernst lamps, and which must in the first instance be satisfactorily overcome, is that the materials of which the pencils are made conduct like electrolytes, in so far as their resistance diminishes with increasing temperature. There exists therefore considerable danger that the illuminating pencil will be burned out. Much ingenuity has been expended in discovering a material which would properly compensate for this effect by a corresponding increase in its resistance under the same circumstances. In the Allgemeine patent specification (No. 6,027, 1899) no materials are specifically referred to as being employed, but it is intended to apply broadly to all materials having a high temperature coefficient. This compensating-resistance is to be placed near to the pencil, and to be subjected to a slight preliminary heating in order to bring it more nearly in correspondence to its resistance when the final current passes through it.

Another important difficulty lies in the method of connecting the non-conducting pencil to the metal wires connecting it to the external circuit. Patents have been taken out by the Allgemeine Co. for the following soldering mixtures, which are said to be suited for this purpose:—

—	Thorium %.	Zirconium %.	Yttrium %.	Cerium %.
1	93·7	3	3	0·3
2	80·0	...	20	...
3	95·0	...	5	...
4	70·0	10	20	...
5	70·0	...	30	...
6	80·0	...	19·5	0·5

In addition to these, Messrs. Siemens and Halske have patented a method (18,489, 1899), in which by the repeated heating of the pencil to incandescence, and dipping into certain powders or pastes of the following metalloids—boron, silicon, and their oxygen-free compounds—the ends become soft and admits of the conducting wire being pushed into it. The metals manganese, molybdenum, chromium, titanium, nickel, the platinum group of metals, and the oxygen-freed compounds of these metals, such as the sulphides, phosphides, nitrides, and carbides, are referred to as being suited for the same purpose.

PHYSICAL SOCIETY.

At an ordinary meeting held March 23, 1900, Prof. W. E. Ayrton, F.R.S., vice-president, in the chair, a Paper on

"Some Experiments Illustrating Syntony"

was read by Mr. P. E. SHAW. The experiments described in this Paper have been devised for the purpose of showing in a lecture room the principles of magnetic space telegraphy, the distance between the sending and receiving circuits being about 15 yards. A current flowing in a main circuit was interrupted by a tuning fork of 100 vibrations per second, and a fraction of the current was passed through the sending coil. The sending coil was placed in series with a coil of adjustable self-induction, and the two coils were shunted with a condenser of variable capacity. By suitable adjustments an oscillation of frequency 400 could be maintained in the sending circuit. The receiving coil was in series with a variable self-induction and a variable capacity, and was tuned to respond to the waves given out by the primary. The current induced in the secondary coil was passed round a light drum fastened to a wire tuned to 400 vibrations per second. The drum was placed in a strong magnetic field, and the electrical oscillations caused mechanical vibrations of the drum. On to the drum was attached one carbon of a microphone, and the induced oscillations were thereby considerably magnified in the microphone circuit. This circuit was also arranged in the same way as the former, and by means of another microphone the vibrations were transferred to another circuit where their intensity was sufficient to actuate the diaphragm of an ordinary telephone receiver to such an extent as to render the sound perfectly audible.

Mr. WATSON described some experiments which he had shown to illustrate syntony, both by obtaining galvanometer deflections and sparks in the secondary circuit.

Dr. LEHFELDT asked how the circuit was tuned when it contained both a variable capacity and a variable self-induction.

Mr. SHAW said that the values of the capacity and self-induction were connected with the vibration frequency by a formula given by Dr. Lodge. Starting with a known capacity, the necessary self-induction was calculated and small alterations produced by means of an iron core.

Mr. SHAW then read a Paper on

"An Electrical Micrometer."

In this Paper the motion of the centre of a telephone diaphragm was measured by means of a system of levers and a spherometer screw. The screw, which had a pitch of 0·5mm. and a head divided into 500 parts, pressed against the long arm of an aluminium lever. The short arm of this lever pressed against the long arm of another, and so on

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through three levers. In this way any motion of the spherometer screw was transmitted to a fine platino-iridium point close to a small platino-iridium disc fastened to the centre of the telephone diaphragm. Since the head of the spherometer could be accurately read to 0·1 of a division by means of a telescope, and since the system of levers minified any motion a hundredfold, it follows that an accurately observable twist of the spherometer head corresponds to a movement of a millionth of a millimetre or 1$\mu\mu$ of the fine point. To test the action of the levers the point was removed and a convex lens was substituted. This lens formed one of a system by means of which Newton's rings were produced and observed. By means of an optical experiment the author has found that 0·1 of a division on the graduated head equals 1·033$\mu\mu$ at the platino-iridium point. The point and the diaphragm then formed part of a circuit containing an ordinary telephone, and the levers were so adjusted that the point just touched the diaphragm. A sharp click was then heard in the telephone. A small current was then sent through the electromagnets of the original telephone, and the displacement of the diaphragm was measured by turning the spherometer screw until the point just touched it and a second click was heard. By carrying out a series of experiments of this description a curve has been drawn showing the relation between current strength and diaphragm displacement. It is then interesting by extrapolation from the curve to find the movement which corresponds to the least audible sound. The author has done this, and finds that he cannot hear sounds if the amplitude is less than 0·37$\mu\mu$. A motion of 50$\mu\mu$ gives comfortable sounds, 1,000$\mu\mu$ uncomfortable sounds, and 5,000$\mu\mu$ sounds unbearably loud. Throughout the experiments it was necessary to get rid of extraneous vibration by means of indiarubber balls and door-spring suspensions, and by working at night.

Prof. EVERETT expressed his interest in the delicacy of the system of measurement, and asked if the micrometer had been used to determine the form of the plate when vibrating.

Mr. PHILLIPS asked if experiments on the smallest sound audible had been made on different people, as it would be physiologically interesting to known if this minimum value were constant.

Mr. CAMPBELL asked if the sound was expected when heard.

Mr. SHAW said he had not conducted experiments on the form of the plate when vibrating, although he had investigated its law of damping. He said the small sounds were expected and the limit varied.

The CHAIRMAN said he found it easy to rid galvanometers and electrometers from extraneous disturbance by placing them on a block of stone resting on a thickness of 3 or 4 feet of slag wool contained in a hollow brick pillar.

The Society then adjourned until April 27th, when the meeting will be held at 8 o'clock, in the Solar Physics Laboratory of the Royal College of Science.

THE ELECTRICAL DRIVING OF FACTORIES.

In a Paper on "Electrical Driving of Factories from the Public Point of View," read by Mr. A. H. Gibbings before the Northern Society of Electrical Engineers, on March 13, there are several lengthy tables showing the extent to which electric motors have been used in this country by consumers on public electric supply mains; also data giving the comparative cost of working such motors as compared with the cost of steam and hydraulic power. The following table, showing the extent to which the electric motor has been adopted in 97 towns of the United Kingdom, is compiled from one of the tables accompanying Mr. Gibbings' paper. We refer to this matter more fully in our leading article this week.

Local authority or company.	No. of motors on mains.	Aggregate H.P.	Units sold for power in 1899.	Price per unit.	REMARKS. (W = Demand indicator system. D = Discounts.)
Aberdeen	7*	15¾	...	3d. & 1d.	W.
Ayr	2	12	...	3d.	Connected recently.
Barking Town	2	17	...	Not settl'd	.....
Barnsley	10	50 B.H.P.	...	7d. & 1½d	Probably large demand. W.
Barrow-in-Furness	10	46	3,726	6d. & 1½d.	Nine months—March to December.
Bath	5	6	1,303	3d.	.....
Bedford	10	65½	95,000	3d.	.....
Belfast	55*	263	74,000	4d. & 1½d.	Other 88 H.P. applied for. W.
Birkenhead	5	16 B.H.P.	4,489	6d. & 3d.	W. After 1½ hours.
Blackpool	7	14	1,100	2d.	Motors supplied from tramway mains
Blackburn	52*	145	39,209	2½d. & 1½d.	All motors not running complete year
Brighouse	6	15	...	5d.	Motors not connected 12 months.
Brighton	150	...	...	...	Current not separately registered.
Bristol	32*	100	58,905	1½d. with D	Supply of cont. curr. 250 or 500 v. just
Bury	12	33	5,510	3d. & 1d.	..... [commenced.
Canterbury	4	3½	...	3d. disc'nt.	Running nine months.
Cardiff	11	128	4,550	2½d. & 2d	4½ H.P. fixed December last.
Carlisle	46	159½	374	2d.	Three consumers only.
Cheltenham	3	4½	1,836	3d.	Also three or four motor fans.
Chester	38	94	15,666	2½d. to 1½d.	Sliding scale, according to quantity.
Coventry	6	12	1,569	4d 3d. & 2d	Sliding scale.
Croydon	7	8½	...	7d. & 2d.	W.
Darwen	9	8	...	3d.	Hardly working last year.
Derby	31	146	39,939	3d. & 1d.	W.
Drwsbury	9	25	2,437	3d. & 1½d.	W.
Dublin	3	6	...	5d.	Practically no motor after first 3 hours
Eastbourne	12	10	...	4d.	550 units sold at 4d. [work done.
Ealing	4	8½	3,000	3d.	.....
Edinburgh	335	...	413,920	1½d.	.....
Exeter	3	4	371	3d.	Special rate for motors just in force.
Glasgow	76	282	81,924	6d. to 1½d.	100v. 6d. & 2½d., 200v. 6d. & 2d., 250v.
Halifax	12*	68	9,450	2½d. with D	..... [6d. & 1½d.†
Hanley	11*	25	2,518	½d. & 1d	W.
Hampstead Vestry	5	11	...	3d. & 2½d.	W.
Harrogate	14	50	60,355	3d. & 2½d.	W.
Hastings	3	1½	500	6d. & 1½d.	Demand only for lifts. W. After 2
Huddersfield	39*	88	48,935	2½d. & 1d.	W. After 2 hours. [hours.
Islington (London)	3	...	1,000	3½d.	Same after dark as for day supply.
Kingston-on-Thames	3	6	...	3d.	Installed only a few weeks.
King's Lynn	2	1½	19	2d.	Motors only just connected.
Lancaster	35	150	27,562	3d.	.....
Leeds	30	86	19,485	2d. with D.	.....
Leith	15	151	42,936	1½d.	First year of supply.
Lincoln	3	7	4,744	3d. & 2½d.	Motors used for driving blowing an-
Liverpool	237	770	226,880	2d. & 1d.	W. [paratus at cathedral. W.
Manchester	464	1,691	...	2½d. & 1½d.	W.
Morley	5	22	816	3d.	.....
Newington	3	18	1,975	2½d.	..... [After 3,000 1½d.
Newport (Mon.)	5	9½	630	2d.	Single-phase alternating motors.
Nottingham	125	450	113,000	2d. & 1d.	W. Since March, 1899, 1d.
Paisley	1	6	...	7d. & 3d.	7d. first hour daily.
Portsmouth	53*	72	19,309	2½d.	Two large consumers at 2d.
Plymouth	2	3	...	4½d.	.....
Salford	30	200	23,000	3½d. & 1d.	About 1,000 H.P. applied for. W.
Sheffield	23	30	8,862	2d. & 1d.	25 p.c. of motors on circuit only few
Shrewsbury	8	29	...	4d. & 3d.	..... [months. W.
Southport	7	9	200	6d. & 2d.	.....
South Shields	1	2	...	2d.	Just started.
St. Helens	8*	23	2,080	2d.	Supplying current since June last.
Sunderland	39	355	101,190	2½d.	.....
Taunton	12	24	850	2d.	.....
Tunbridge Wells	1	2	...	3d.	Alternating current.
Wallasey	5*	10	1,246	3½d.	4 motors on free-wiring system.
Walsall	19	52	12,921	2½d. with D	.....
Watford	1	1	...	8d. & 1½d.	W.
Whitehaven	4	17	1,610	3d.	.....
Wolverhampton	16	26	5,504	1½d.	.....
Worcester	10*	66	118,527	3d. & 1½d.	W.
Great Yarmouth	7	21	1,312	2½d.	.....
Allerton, Wooler-ton & Childwall	1	1½	Nor'c'rd	4d.	Residential neighbourhood.
G. Crosby & Waterloo	1	¼	Nor'c'rd	3 l.	Residential neighbourhood.
Birmingham	186	475	...	4d. & 2d.	.....
Bournemouth	7	5	...	3½d.	Not an industrial centre.
Burton-upon-Trent.	1	1	...	2½d.	.....
Cambridge	4	7½	...	7d. & 3½d.	.....
Chelsea	25	102	10,318	2d.	.....
Crystal Palace Dist.	3	100	404	5d.	.....
Folkestone	6*	18	...	7d. & 1d.	W.
Galway	4	5	2,617	3d. per hr.	Others supplied by contract.
Guildford	2	5	69	3d.	Only one motor in 1899.
Hove	23	49	19,403	2d.	.....
Kensington & Knights-bridge (London)	20	75	...	4d.	Electric lift motors.
Lambeth (London)	13	30½	1,415	4d. with D.	.....
Mardy	2	¾	...	...	Fixed price per quarter.
Newcastle & Dist. Co	11	85	...	2½d. to 1½d.	.....
Northampton	14*	505	5,755	3d. & 1½d.	W. After 3 hours.
Norwich	97*	358	240,138	3d, 2d, 1½d	Revenue for 1899, £3,011.
Notting Hill	7	21	3,091	4d.	.....
Oswestry	1	3	...	...	.....
Pontypool	2	½	...	6d.	.....
Reading	17	88	9,074	3d, 2d, 1½d	Three months' trial only.
Richmond (Surrey)	2	1	180	4d.	Current for launches and motor cars.
Salisbury	6*	5¾	...	4d. & 1½d.	£15. 3s. (revenue).
Scarborough	4	9	258	2½d.	.....
Windsor	9*	31·5	9,124	4d.	.....
Woolwich	4	7	...	3d.	Motors on for few weeks only.
Wycombe	35*	66½	8,917	4d. & 1½d.	.....

* Some of these motors hired. † Average 5 hours per day at full load charged 2d., 2d. and 1½d. for all units.

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Editorial Publishing and Printing Offices,

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Telephone: 949 Holborn. *Telegrams:* "ELECTRICIAN NEWSPAPER LONDON."

All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher "THE ELECTRICIAN," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN" *Printing and Publishing Company, Limited, and be crossed "Coutts and Co."*

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Alterations to existing Advertisements and Copy for new Advertisements must reach the Publisher on Tuesday.

MOTIVE POWER FROM PUBLIC SUPPLY MAINS.

In most modern cities public supply mains laid beneath the principal streets afford a varied selection of forms of motive power, the choice of which in any particular instance it is not always easy for the intending power consumer to settle. The main streets of the larger cities are provided with electric, hydraulic, and gas mains; and in some few cases with compressed air and, over limited areas, even live steam. In smaller cities and towns, or throughout less important streets, it is usual for both gas and electric power at least to be available. Apart, therefore, from the question as to the advisability of erecting isolated power-generating plant, as compared with tapping one of the systems of public supply, there is the problem of striking a balance between the relative merits of rival systems. This problem is sometimes difficult: it is never simple. Many considerations have to be taken into account beyond the mere question of relative costs—*i.e.*, the relative magnitudes of the bills that would have to be paid for the several forms of power. What someone has aptly termed the "worth-whileness" of adopting, say, electric motive power, in preference to gas or hydraulic power, is never wholly a question of relative power costs; in the majority of cases it is only in a minor degree such a question, and in some few instances the cost of power is altogether outweighed by other and more important considerations.

A Paper was recently read by Mr. A. H. GIBBINGS, before the Northern Society of Electrical Engineers, on the subject of the employment of electric motors supplied with power from public mains. One of the tables in Mr. GIBBINGS' Paper is so instructive as to the extent to which electric motors have been thus used, that we have reprinted it, except for a few unimportant excisions, in our issue this week. Another table is designed to show the "cost of working electric motors as compared with gas, steam, and water power." This table gives particulars of nearly 30 installations of electric motors in Bradford, and the testimony in all these cases is uniformly as to the cheapness of electric power in regard to power cost. Owing, however, to the figures given for the costs being merely estimates, we have omitted this table. Mr. GIBBINGS has based his costs for electric power upon an assumed 1d. per unit, and for gas upon a rate of 2s. 8d. per 1,000 cubic ft.

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In numerous instances the cost of electric power appears to be less than half that of gas. As a matter of fact, however, there is not a uniform charge of 1d. per unit for motor power at Bradford, but a sliding scale from 2½d. to 1d.; and it seems to us that in few, if any, of the instances cited could the full advantage of the penny-per-unit rate be derived. It is regrettable that Mr. GIBBINGS has elected to present the case for relative costs in this form. Nothing is to be gained by supposititious cases out of accord with actual practice, and a really much stronger case would have been presented on behalf of electric power had the actual gas and electric bills been compared; and this would still have been true, even had the actual cost appeared to show unfavourably. Mr. GIBBINGS has pinned his faith too much to actual costs; he has not considered sufficiently the claims of "worth-whileness." Take, for instance, one of the examples he has cited of the use of electric power for driving printing machinery. A 3 H.P. electric motor is stated to have cost £1. 16s. 2d., estimated at 1d. per unit, as compared with £5. 1s. 3d. for gas at 2s. 8d. per 1,000 cubic ft. Surely Mr. GIBBINGS does not pretend that a printer, whose bill for gas power during six months amounted to over £5, would find his bill for an equivalent service of electric power actually fall below £2? He would have considerable difficulty in convincing any experienced printer that such would be the case. Then why damage his case by this exhibition of absurd figures? A far better way of approaching the printer, as a prospective consumer, would be to direct his attention to the advantages as a whole—to the superiority of electric power from a score of points of view, every one of which means an indirect saving to the consumer. Even if the printer must face a bill for electric power no less than twice his previous bills for gas, he can well afford to make the change; and every printer who has gone into the matter knows this quite well. Mr. GIBBINGS should know it, too; and it would have added strength to his Paper had he given it prominence. We mention the printing business only by way of example; our contention equally applies to every other trade where motive power derived from public mains is employed. Not that we wish it to be assumed that the bare cost of power would necessarily show to the disadvantage of the electric motor; in quite a numerous variety of cases the electric power itself would be cheaper. Our point is that, even where there is that single disadvantage, there are counteracting advantages which generally make the electric motor enormously superior to any other motor. We may mention some of the more obvious of these merits—viz., the compactness of the motor and consequent saving of costly space; the readiness with which it is started and stopped, and consequent saving of valuable time; and the cleanliness of the motor and all the arrangements for its use, and consequent saving of costly labour for keeping the machinery clean. Besides these, there are to be taken into account the superior adaptability of the electric motor to its work, both in regard to speed and the amount of power required; and the facilities cables afford for distributing power over extensive workshops, efficiently, silently, conveniently, and without moving parts. We strongly commend to all users of motive power the consideration of the "worth-whileness" of the electric motor.

Among the interesting facts brought out by the table we have reprinted on another page, are several instructive data as to the extent to which motors have been employed, either on hire or after purchase. The 97 electric supply undertakings represented in the table are only a portion of the total number of such works in operation in the United Kingdom. At the commencement of this year, indeed, this number aggregated over 150 works, none of which, it may be presumed, would turn a deaf ear to the appeal of any consumer for motive power. These 97 undertakings supply a total of some 2,800 motors, aggregating 7,912 H.P. In only 63 cases is there any return of the amount of energy consumed during the year 1899, the items under this head varying between 19 units at Galway to no less than 240,138 units at Norwich. The aggregate consumption in these 63 cases was 2,025,979 units, which represents a considerable revenue return to the supply undertakers. It is noteworthy that in only 17 places have motors been hired, and that these are usually but a small proportion of the total number of motors in each place. But whether this is due to the disinclination of consumers to hire motors, or to lack of facilities for doing so, is not evident. At any rate, there is little encouragement to the Local Government Board to sanction borrowing powers for this class of business in the case of local authorities, or for directors to risk shareholders' money in the case of company undertakings. In other respects Mr. GIBBINGS' table is an indication of very healthy progress in the commercial use of electric motors fed with energy from public mains.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

Conductivity of Nerves.—Human nerves show a difference in conductivity in accordance with the direction in which a current travels along them. S. Leduc has placed this in evidence by a simple experiment. At one point of a nerve a fixed cathode is brought into contact with it. At other points anodes are placed, and their surfaces of contact are so graduated that the resistance of nerve interposed between any one of them and the cathode is the same. It is found that the muscle contracts when the current is centripetal—*i.e.* when it passes away from the nerve centres. It contracts little or not at all when the current is in the reverse direction. In this respect, therefore, the nerve acts like an "aluminium valve." But the explanation is a good deal more complicated.

[S. LEDUC, *Comptes Rendus*, March 12, 1900.]

Manufacture of Potassium Chlorate.—When a solution of potassium chloride is electrolysed in presence of potassium chromate, the process which takes place depends largely upon the degree of alkalinity of the solution, a higher degree of alkalinity favouring the formation of potassium chlorate at the expense of the hypochlorite. What takes place in a sensibly neutral cold solution is, according to A. Brochet, probably this: Hypochlorite is formed, and its formation uses up the whole quantity of electricity supplied. The hypochlorite, as soon as it reaches a certain density, is spontaneously reduced, giving off oxygen and yielding potassium chlorate. Since oxygen is not required, there is evidently here a waste of energy, and if any process could be discovered for preventing its generation, the whole of the electric energy supplied might be utilised for the manufacture of the chlorate. The author attempts at least to shed some light on the process of formation of the oxygen. He finds that the liquid turns orange at first, and then yellow; when the solution is then left standing, its acidity diminishes, and in about a day it resumes its original orange colour. The yellow colour is probably due to the formation of hypochlorous acid, which oxidises itself into chloric acid and produces the transformation of hypochlorite into chlorate.

[A. BROCHET, *Comptes Rendus*, March 12, 1900.]

Vacuum Electroscope.—That electrostatic attraction and repulsion takes place in an absolute vacuum can hardly be said to be experimentally proved, for the simple reason that no such vacuum has yet been produced, let alone experimented with.

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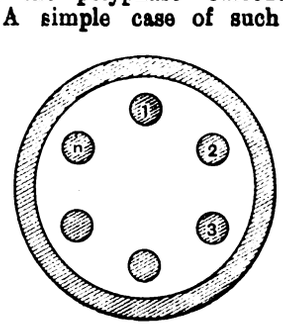
H. Pflaum has therefore taken up the question, with the intention of proving that at the highest vacuum attainable with modern means electrostatic forces play undisturbed, though discharges through the vacuum may have apparently ceased. The construction of the electroscope fulfilling those conditions seems to have been attended with many unexpected difficulties. It had the form of a pear shaped bulb containing two pieces of aluminium foil attached to an aluminium plate. It was found that electrostatic effects took place with great energy. All the reactions were very prompt, but not the slightest luminous effect was observed in connection with them. All the same, the walls of the bulb often assumed positive or negative charges, and the aluminium foil was capable of acquiring or losing charges by some kind of dark radiation. Even under the alternating discharge of a Tesla coil the leaves, while vibrating under its influence, acquired a permanent charge, whose sign depended upon the distance of the coil.

[H. Pflaum, *Ann. d. Physik*, No. 2, 1900.]

Electric Radiation from Points.—The radiation from a point to a disc depends, as we know, upon the potential and the sign of the charge, as well as upon the nature and the pressure of the gas. As regards the sign, which from the point of view of radiant discharge offers the greatest theoretical interest, it is now pretty generally agreed that radiation from a point commences at a smaller difference of potential when the point is charged negatively than when it is charged positively. Also, the quantity discharged is greater in the former than in the latter case. Much work has been done to determine the influence of the pressure and the distance between the electrodes, and these researches include a large number of experiments on vacuum phenomena. H. Sieveking has devoted special attention to the behaviour of different gases at ordinary pressures, a matter of considerable interest to the chemist. He finds that the four gases studied by him have all a preference for the radiation of negative electricity from a point, the ratio of the quantity of negative to that of positive electricity radiated being 1·4 for oxygen, 1·7 for nitrogen, 2·5 for air, and 4·7 for carbonic acid. The behaviour of air in comparison with oxygen and nitrogen is mysterious, and presses for an explanation.

[H. Sieveking, *Ann. d. Physik*, No. 2, 1900.]

Capacity for Polyphase Charges.—The capacity of a conductor is defined as the charge which will raise it to unit potential when surrounded by conductors whose potential is zero. This capacity is in general a constant quantity, but not necessarily so, as for instance in the case of conductors subjected to polyphase voltages. But even here we may have constant capacities, provided the conductors under the influence of the polyphase current are symmetrically disposed. A simple case of such a kind is illus-



trated in the diagram, where the circles may be taken to represent sections of conductors surrounded by a metallic sheath and insulated from each other. C. E. Guye proves mathematically that the ratio of the charge to the potential of each conductor remains constant at any instant, and thus the capacity of a polyphase conductor becomes a precisely definable quantity, from which the current necessary to charge the system to a certain potential may be calculated. It is not at all necessary that there should be six conductors, as long as they are equidistant and arranged on a circle concentric with the sheath. They could also run above an infinite conducting plane at zero potential.

[C. E. Guye, *Comptes Rendus*, March 12, 1900.]

STORAGE BATTERY PROBLEMS.*

BY E. J. WADE.

(*Concluded from page 826*).

With regard to the assumption I have made earlier in the Paper, that the proportional composition of the active materials at the stage where their resistance rises so rapidly as to terminate the discharge and bring about the reversal is Pb, $PbSO_4$ and PbO_2, $PbSO_4$ respectively, my chief corroboration, so far as direct analysis is concerned, comes from Mr. Robertson's analysis of positive active material given in Prof. Ayrton's Paper of 1890. He found that the sediment from the positives and the discharged positive active material itself both approximated in composition to the second of the two formulæ just mentioned. Unfortunately, neither there nor anywhere else that I know of are quantitative data given as to the composition of discharged negative active material; but I have repeatedly found that Planté type electrodes, properly reversed, afford just the same output whether positives or negatives, so that if the one formula is accepted the other should hold good also. Of course the percentage of sulphate present in the discharged active material tells nothing, and is only misleading unless account is also taken of the sulphate there at the commencement of the discharge. In the case quoted above the fully charged active material was found to be quite free from sulphate; but this is unusual, even for new electrodes, and most exceptional for those which have been in use for any length of time; consequently in many instances the percentage of sulphate in the active materials when discharged considerably exceeds that required by the formula.

A more practical confirmation, based on the general experience of a large number of people, is supplied by the specific capacity of the active materials. Although only with difficulty, outputs very nearly as high as 50 and 60 ampere-hours per pound of active material have been and can be obtained, corresponding to close upon 50 per cent. sulphation; but never, I believe, under any conditions whatever, have these figures been exceeded. It is well known that towards the end of a discharge the curve of the potential difference of a cell varies considerably in character, according as the negative or positive electrodes have the smaller capacity and are the first to give out; dropping off with extreme suddenness in the former case, and more gradually, although still with considerable rapidity, in the latter case. Now if, as I maintain, the potential difference at this stage is chiefly controlled by changes going on in the conductivity of the active materials, then the lack of conformity between the two curves must connote a corresponding variation in the way the resistance of the two active materials rises. At the negative the increase is sudden and large, putting a very definite limit beyond which further sulphation is impossible and reversal commences; and analogy with the sub-oxides of lead suggests that this is most likely to occur when a composition Pb_2SO_4, corresponding to Pb_2O, is attained. At the positive the rise in resistance takes place more slowly, and although soon sufficient to bring the potential difference down to the point at which the discharge is usually stopped, yet if it is allowed to continue the sulphation is able to proceed some stages further with a steadily falling voltage. Here again analogy with the oxides of lead points to the change commencing at the composition PbO_2, $PbSO_4$, corresponding to the sesquioxide PbO_2, PbO, and augmenting gradually as the composition of the active material approaches to PbO_2, $2PbSO_4$, corresponding to red lead PbO_2, 2PbO.

We have now examined the *normal* constitution of the active materials under all conditions of use, and I have endeavoured to show by the aid of the hypothesis of polymerisation how at every stage, except when fully charged, it consists of true compounds of lead sulphate with lead or lead peroxide; or, during the period of reversal, with both at the same time. Yet no direct chemical evidence can be adduced as to the existence of any one of these compounds, with the possible exception of Dr. Frankland's "brown salt," PbO_2, $2PbSO_4$, which he believes he isolated in 1889; and even in this instance Messrs. Gladstone and Tribe were unable to confirm his results. To all chemical tests the active materials behave merely as mixtures containing normal lead sulphate in various proportions; but the lack of corroboration in this direction was only to be expected by analogy with red lead, white lead, and similar compounds, and it only serves to show the degree of their instability. Unfortunately there is other most troublesome evidence as to the extreme feebleness of the compounds now in question: not only do they break up under all chemical tests outside the cell, but even in the cell itself they act similarly under many conditions that cannot in practice always be avoided, and herein we have the origin of "sulphating" and the source of most of the infirmities which so largely limit the life and commercial usefulness of lead cells. On the slightest provocation the molecules of active material forsake their allotropic or polymeric structure and are resolved into what, from a general chemical standpoint, would be called a more normal state, but one which in its special relationship to storage cells I shall here term abnormal. Each complex molecule splits up into a

* Paper read before the Institution of Electrical Engineers, March 22.

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number of simpler ones, some of normal sulphate and others of lead or lead peroxide. Taking for example the composition of the fully-discharged active materials as represented by the two terms previously given, these would break up as follows :—

$$Pb_{12}(SO_4)_6 = 6Pb + 6PbSO_4$$
$$Pb_{12}(O_2)_6(SO_4)_6 = 6PbO_2 + 6PbSO_4.$$

Such a change easily accounts for all the effects characteristic of "sulphating." The rearrangement of structure can hardly be accomplished without producing some alteration in the bulk of the active materials; and it is most probable that the independent molecules of sulphate will require more room than when in a combined state. A strain is thus put on the active materials which tends to reduce their porosity generally, while at the points where the sulphation actually occurs the pores will be almost blocked up. If it is more than can be relieved by mere compression of the active materials, their disintegration will commence; and if the sulphation is excessive, the effect extends to the support, which either expands, buckles, or bursts asunder, according to its construction and the amount of the strain experienced. It is difficult to suppose that the free molecules of Pb and PbO_2 can themselves long escape sulphation, and so visible patches of white non-conductive irreducible sulphate soon make their appearance. Other known results such as reduction of capacity follow obviously, and need not be dwelt upon. Prolonged contact with the acid electrolyte appears to be quite sufficient in itself to cause the active materials to pass over to this abnormal state: but in all probability the result is largely dependent on the percentage of sulphate they contain, and only becomes acute after a certain stage is reached, for in practice cells left on open circuit are found to sulphate more or less according to the extent to which they have previously been discharged. Fully-charged active materials maintain their normal condition with considerable tenacity, but it is quite possible that the very gradual loss of capacity so often experienced by negative electrodes, and for which no satisfactory explanation has yet been offered, may be due to a change of molecular structure. The effect is generally accompanied by shrinkage of the active material, and in this connection it is somewhat significant to note that Schutzenberger's allotropic form of copper was found to revert to its more usual state after prolonged immersion in dilute sulphuric acid, this change also being accompanied by shrinkage. Although the instability of the active materials is inherent in their very nature and its results cannot be always or entirely avoided under any practical working conditions, yet much of the trouble is usually brought about by minor causes, some of which at any rate are preventable. Local action due to impurities in the electrodes or electrolyte, or to the presence of active oxygen in the form of persulphuric acid or hydrogen peroxide, or to excessive strength of acid, is one of the most frequent. The active materials, especially if fully charged or nearly so, are probably first partially sulphated just as when discharging, and so disposed to break up in the usual way; but the local action may also have a directly disruptive effect upon their molecular constitution as the proportion of sulphate increases. The most marked effects of local action, however, are experienced during the period of reversal, for not only do the molecules of active material then contain their maximum of sulphate, but both lead and lead peroxide at the same time, and a condition of far greater instability results even than on complete discharge. If the current is stopped during this stage, local action and sulphating proceed with great rapidity, and they are not entirely checked when the current is flowing unless it is of very considerable strength. On this account it is impossible properly to reverse many types of electrodes, for, owing to the very high resistance of the active materials throughout the process, the current is most unequally distributed and only a small fraction penetrates the portions not quite close to the support. Excessive local action ensues, and even if the electrodes are not rendered useless, the active materials will be choked with large percentages of sulphate, which it is impossible to reduce afterwards.

Another cause which no doubt plays a considerable part in breaking down the normal constitution of the active materials is undue weakness of the electrolyte. This condition seldom exists in the bulk of the solution; but owing to imperfect diffusion, as is fully explained in the first part of this Paper, is frequently realised during discharge by the portion contained in the pores of the active materials. Most probably, as soon as the percentage of acid present falls below a certain limit, incomplete sulphation occurs, and compounds containing lead monoxide or hydrated monoxide, $Pb(HO)_2$, are then produced; and the variations in the specific gravity of the electrolyte during discharge sometimes agree best with a reaction of this nature. Distinct evidence indeed has frequently been obtained of the presence of monoxide in discharged positive active material, and upon this has been based an oxidation theory of the cell reactions, which assumes that, at the positive at any rate, the formation of sulphate is only an incidental result, contributing nothing to the E.M.F., and being in amount no function of the output. I prefer, however, to adopt the explanation I have suggested above, and consider that whenever indications of imperfect sulphation are observed, they do not show the double sulphation theory to be at fault, but rather point to defective working conditions which prevent the proper and normal reaction from taking place.

DISCUSSION.

Prof. H. E. ARMSTRONG congratulated the Institution on having received so valuable a Paper on such an important subject. The author had stated his case with a clearness altogether unusual when dealing with matters of this kind: his arguments throughout were logical and reasonable, and although one might not share all Mr. Wade's opinions, his case was argued in a way that could not be objected to. Mr. Wade had first discussed the question as to the nature of the changes which go on in the accumulator. He himself had thought a good deal about the accumulator; he had worked at it in the chemical department of the Central Technical College for 10 years past. The analyses which Prof. Ayrton and his colleagues had communicated to the Institution in 1890 had been carried out by Mr. G. H. Robertson in his (the speaker's) laboratory, and ever since then he had taken the deepest interest in the subject, and felt that it afforded very many features of interest both to the chemist and the electrician. They could congratulate themselves now on having made some slight advance in the treatment of the problems which the cell offered. The author had put forward the conventional idea that they dealt on one hand with lead and on the other hand with lead peroxide, that this was converted into sulphate on both sides, and that on charging again they got a reconversion. He agreed with Mr. Wade that the simple equation itself expressed that result, but probably a very great deal happened in between, but we were not in a position to say what that was. The problem of the electrolysis of lead salts and lead solutions was undoubtedly a complicated one. Faraday worked much with sulphuric acid—and it was a good many years since Faraday electrolysed sulphuric acid—yet we practically knew no more now, and it was astonishing how little progress had been made. What was certain, however, was that the electrolysis of sulphuric acid did not take place in the simple way which was ordinarily assumed. There were a variety of explanations, but probably there were many products produced which played an important part in the accumulator to which very little attention was given. Perhaps one fault in the Paper was that it had not sufficiently noted the possibility of changes in the electrolyte taking place which would affect the life of the cell, and, in fact, did affect sulphation. On the other hand, the problem of the electrolysis of lead salts was very difficult; it was not yet understood how the lead peroxide was formed from the sulphate. Many lead salts could not be electrolysed without lead peroxide being formed. They got peroxide on the anode and lead on the cathode, and they could not get the whole of the lead on the cathode. On the other hand, there were solutions in which it was possible to get the whole of the lead *as lead* without any trace of lead peroxide. He wished to impress upon the meeting the fact that there was very much yet to be learned with regard to what happened to both sulphuric acid and its lead compounds on electrolysis. Mr. Wade had attached considerable importance, however, to the kind of lead compound formed, and had put forward a theory which was a rational one—viz., that they were never dealing with lead peroxide alone or lead sulphate alone, but a more complex substance which contained both these constituents. The author thought this was the explanation of the conductivity of the material in the cell as compared with the want of conductivity shown by lead sulphate. That theory was a perfectly rational one, and no doubt much might be said for it; but he would like to call attention to the statement of the author that "Unfortunately there is other most troublesome evidence as to the extreme feebleness of the compounds now in question." He was inclined to think that Mr. Wade did not help himself very much by assuming the existence of these compounds, for if they did exist they were very unstable substances. Mr. Wade had distinctly put forward the theory which enabled them to understand why it was that only about one-half of the peroxide at present in the material was available. This had been established by Prof. Ayrton and his colleagues, and whether it was good as a theory or not, it was certainly good as a fact, and they could not get much beyond that point. As Mr. Wade had stated the problem, he had emphasised a point which was undoubtedly of great importance in discussing the probable efficiency of a cell. He thought the most important part of the Paper was the latter part, in which was discussed the character and strength of acid necessary to give the maximum rate of discharge and charge. Great emphasis was laid on porosity and on the absolute need for free diffusion of the acid into the material. This latter condition was, he thought, the critical feature in connection with secondary batteries. What Mr. Wade had said with regard to the necessity of increasing the porosity of the medium was the practical key to the position. Any improvement in the discharge and charge of a cell must be by operating in that direction. If they would only picture to themselves what happened in a cell, they would see that it was absolutely necessary that the material should have a high degree of porosity. They knew that there was a very large requirement of acid at both plates, and they were dealing with an acid that diffused at a comparatively slow rate, while during discharge the electrolyte was being depleted of acid, thus varying the rate of chemical action and chemical change. They were, on the other hand, when charging the cell, filling the pores with strong acid. One could see, therefore, it was most essential that there should be a free passage of acid into the pores of the material on the one hand and a free discharge from them on the other. In this respect he thought that Mr. Wade had put the case before them very clearly and had given a clear indication of the lines on which to proceed in calculating the value of the cell, and had further led the way to practical improvements in the cell by insisting very strongly on the need for great porosity.

(To be continued.)

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A PROPOSED SYSTEM OF UNITS.*

BY PROF. REGINALD A. FESSENDEN.

In a recent number of *The Electrician* (Dec. 29, 1899) there appeared a reprint of a note of mine on a proposed system of units. As, however, the original, which was printed in these columns, contained some misprints, and, as I now see, was not explicit enough in regard to some points, I would like to deal with the matter more fully.

First, I would emphasise the fact that this proposed system is suggested as an *alternative* in case the system proposed by Heaviside cannot be carried out. His system is undoubtedly the best, and it will ever be a matter of regret that it was not adopted originally. If it should appear that there is any probability of carrying out Heaviside's original method, I am too ardent an admirer of his work and have too much confidence in his judgment to do otherwise than withdraw my suggestion. It is only in case the opposition on the part of the Governments and of the manufacturing firms proves too strong that this alternative is put forward.

At present we have two units of quantity of magnetism—*i.e.*, the unit pole and the line. We have one unit of magnetic intensity—*i.e.*, the gilbert (adopting for the present the name suggested by the American Institute of Electrical Engineers). The ratio "magnetic lines per sq. cm. ÷ magnetic intensity" is called the "permeability." The ratio "quantity of magnetism per sq. cm. ÷ magnetic intensity" has no name at present (though the ratio "intrinsic magnetism per sq. cm. ÷ magnetic intensity" is called the susceptibility). In the present paper I will call this ratio the "permity." Since it takes 4π lines to make unit quantity of magnetism, when a substance has its permity 1 its permeability will be 4π.

Having two units of magnetic quantity, the ratios between these units and the other electric and magnetic quantities give us a double set of terms, one set of terms being 4π times as large as the other. Evidently, if we make the magnetic line and the unit pole of the same size, we will do away with one set of these terms. Similarly, we have two units of electric quantity—*i.e.*, the line of electrostatic flux and the unit charge. The ratio "electric flux lines per sq. cm. ÷ electric intensity" is called the "specific inductive capacity." The ratio "quantity of electricity per sq. cm. ÷ electric intensity" has no name, and in this Paper I will call it the "capity." Since there are 4π electrostatic lines to unit charge, when a substance has unit specific inductive capacity its capity is $\frac{1}{4}\pi$. Here also we have a double set of units, one set of which can be done away with. Consider now the equation

$$Q\ P\ (curl)\ /T = ML^2\ /T^2.$$

Since the 4π gets in through the curl, we can get rid of the 4π in three ways: (1) Splitting it up between the Q and the P (Q being quantity of electricity and P quantity of magnetism)—*i.e.*, making Q and P both $1/\sqrt{4\pi}$ times as large as at present. (2) Keeping both Q and P the same size as at present, but making the unit of work 4π times as large as the present erg. (3) Making Q $\frac{1}{4}\pi$ times as large as at present, keeping the other terms the same size. (4) Making P $\frac{1}{4}\pi$ times as large as at present, keeping the other terms as at present.

The first method is Heaviside's original proposal. It is the ideal method. It, however, necessitates changing the ampere, ohm, volt, farad, henry, coulomb, and other units. The second and fourth methods are impracticable. The third method is the one I propose. It necessitates the following changes: (1) Making the unit quantity of magnetism $\frac{1}{4}\pi$ times as large as at present—*i.e.*, equal in size to the present magnetic line. This would result in no inconvenience; is, in fact, legalised now, for the henry is 10^9 lines and not 10^9 units of magnetic quantity. It is also very generally used in practice. (2) Making the absolute unit of current turn (*i.e.*, 10 ampere turns) the unit of gilbertance (*i.e.*, difference of magnetic potential). We may call it the amma-turn. (3) Making the permity of air 4π instead of $\frac{1}{4}\pi$ as at present. This would cause no inconvenience, as no one designs magnetic mechanism from printed tables. Every piece of iron must have its magnetic constants determined as it comes into the shop, as no two heats are the same magnetically. (4) Doing away with the term specific inductive capacity, and using the capity instead, the capity of air being $\frac{1}{4}\pi$. This also would cause no inconvenience, for no one would think of using capacity tables to determine the capacity of a cable or condenser, and in every cable manufactory these are determined by experiment. In general the values given in tables are higher than those found in practice. For example, Fleeming Jenkin gives for pure rubber $k = 2{\cdot}80$, and Salford and Halman give it as 3·7, while cable makers will, by treating it so as to remove all mechanically entrained moisture, furnish it as low as 2. And in any case, in calculating the capacity one has to first multiply by 4π in using the present tables, so that this is equivalent to using the capity.

* From the *Electrical World and Engineer* of New York, with corrections and additions by the author.

The following table shows the relation between the present and proposed systems:—

Ampere, coulomb, volt, ohm, farad, henry, erg, joule, watt: No change.

Present.	*Proposed.*
Unit of magnetism	$\frac{1}{4}\pi$ of present, *i.e.* = mag. line.
Permeability	Use Permity instead, which for air has the value 4π.
Spec. ind. cap.....	Use Capity instead, which for air has the value $\frac{1}{4}\pi$.
Magnetic potential	4π times present, *i.e.* = absolute unit turn, *i.e.*, amma-turn.

Present Formulæ.	*Proposed Formulæ.*
$QQ'/kL = PP'/mL = $ Force ...	$QQ/4\pi\kappa L = PP/4\pi\mu L = $ Force.
$D_1^2/8\pi k = $ W per c.c.....	$D^2/2\kappa = $ W per c.c.
$B_1^2/8\pi m = $ W per c.c.	$B^2/2\mu = $ W per c.c.
$G = 4\pi nI$	$G = nI$.
$E = d(4\pi P)/dt$	$E = dP/dt$.
$K = ks/4\pi t$	$K = \kappa s/t$.

Where Q represents quantity of electricity, D_1 electrostatic flux per sq. cm., D quantity of electricity per sq. cm, P quantity of magnetism, B_1 magnetic flux per sq. cm., B quantity of magnetism per sq. cm., W energy, k specific inductive capacity, κ capity, m permeability, μ permity, K capacity (*i.e.*, capance), G magnetomotive force (*i.e.*, gilbertance), E electromotive force (*i.e.*, voltance).

In the present system we have $1/\sqrt{km}$ = velocity of light.

In the new system, since the permity for air (or vacuum) is 4π and the capity is $\frac{1}{4}\pi$, we have $1/\sqrt{\kappa\mu}$ = velocity of light in air (or vacuum).

We have now got a system of units which is perfectly rational so far as the absolute units are concerned. Dr. Fleming, in an extremely able article,* has extended this system by forming a new system of practical units. By making the practical unit of current ten times as large as the present ampere, the ohm one-tenth the size, the unit of energy ten times as large, &c, he obtains a very convenient and simple system of practical units, and one which is much superior to the present system.

I have not myself considered the subject of practical units, for the reason that, as stated in my previous note, I do not believe in practical units. If any system of practical units is to be chosen, then Dr. Fleming's system has many advantages over the others. But I fail to see the use of the so-called practical units. In dealing with lengths, for instance, we have the metre as our standard. Physicists use the centimetre more frequently, but we have not found it necessary to make it a practical unit and call it the "Michaelson," nor have our engineers found it necessary to make a "practical unit" out of the kilometre and call it a "Euclid." I should be glad to know what advantage has accrued to the electric profession from the action of our unit makers in taking one-tenth of absolute magnetic unit of current as the practical unit of current and calling it the ampere. Has it not rather been a source of nuisance without any corresponding benefit? Why not, then, go back to our absolute units of current, voltage, &c., and by making suitable prefixes or suffixes obtain what sizes we desire, just as we do in the case of the metre? I subjoin such a scheme, not that I think it cannot be improved upon, but merely to show the general idea.

Denote absolute electrostatic units by the suffix -sta. Thus Volsta = absolute E. S. unit of voltage, Coulsta = absolute E. S. unit of quantity, &c. Denote absolute magnetic units by the suffix -ma. Thus Volma = absolute electromagnetic unit of voltage, Coulma = absolute electromagnetic unit of quantity, Amma = absolute electromagnetic unit of current, &c. Denote space differentials by the suffix -l. Thus Volstal = volstas per cm. Denote area differentials by the suffix -r. Thus Coulstar = coulstas per sq. cm. Denote volume differentials by the suffix -v. Thus Ergav = ergs per cubic cm. Denote time differentials by the suffix -t. Thus Coulmat = coulmas per second.

Let the prefix l- or le- denote the 1/1000, the prefix m- or me- the 1/1000·000, and the prefix n- or ne- denote the 1/1·000·000·000 of the absolute unit. Let the prefix r- or re- denote 1·000, the prefix s- or se- 1·000·000, and the prefix t- or te- denote 1·000·000·000 times the absolute unit. Thus, 1 tolma represents the present ohm. 11 tevolmas represent 110 volts (or tolmas).

I have no doubt but that some of the gentlemen who have paid attention to questions of nomenclature could improve upon these terminations and prefixes. Our French collegues especially are rather fortunate in dealing with such questions, and so, as I mentioned previously, the above is merely given as showing the general methods.

It will be noted that I speak throughout of the permity, not the permeability, as being 4π for ether. This is because the strict definition of permeability is that it is the constant m in the expression $PP'/L^2m = $ Force, and hence with our new unit of magnetic quantity the new permeability is by strict definition equal to $(4\pi)^2$,

* See *The Electrician*, Dec. 29, Jan. 5, 12 and 19. Also *Electrical World* Digest, Feb. 3 and 10, and following abstract.

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while the permity or the coefficient in the expression $PP'/4\pi L^2\mu$ is 4π for ether. Dr. Fleming uses the term permeability as the ratio B/H, which is identical with the permeability in our present system and is the permity in my proposed system. Hence the supposed discrepancy. For another reason I prefer the term permity, and that is, that I believe the retention of the old term will cause confusion. Moreover, it is inconveniently long.

In the discussions of the proposed system which have appeared previous to Dr. Fleming's admirable Paper I have been struck by two things: First, the uncertainty as to whether the air or the ether is the substance of permeability unity. There is reason for this confusion, and the following list will be instructive :—

Author	*Substance permeability 1.*	*Substance spec. in. cap. 1.*
Maxwell	Ether	Ether.
Faraday	... .	Air
J. J. Thomson	Air	Air.
Everett	Ether	Air.
Webster	Ether	Ether.
Lodge	Air	Air.

The actual facts of the case are, I believe (though I stand subject to correction), that *air* is the substance of specific inductive capacity unity, and that there has been no authoritative statement as to what substance should be considered as having unit permeability.

Another point which has somewhat surprised me is the very general idea that there is something incorrect in making the permity of air 4π. To quote one of my critics, "The objection would be that the permeability of any substance would no longer be its specific magnetic inductivity with respect to the inductivity of the standard dielectric, namely, ether, but with reference to an imaginary body whose inductivity was $(4\pi)^2$." This idea, as has been pointed out by Prof. Fleming, is entirely incorrect.

As Lodge has shown, whatever the permeability of ether is, it most certainly is not unity, and so we have just as much right to take its permeability as $(4\pi)^2$ as to take it as unity. In fact, there are some advantages in doing so, for it is evident, from the criticism referred to, that the fact that both the permeability and spec. ind. cap. are now taken as unity for the ether has led some to overlook a point to which Lodge has called attention—*i.e.*, that *both* are arbitrary assumptions, and *both* cannot be true. If we say, "Let the permity of the ether be 4π and its capity be $\frac{1}{4}\pi$," they *are* 4π and $\frac{1}{4}\pi$ respectively, just as much as the permeability and spec. ind. cap. are now unity. We are not in the least taking any liberties, and in fact, since, if I am not mistaken, the substance of unit permeability has never been authoritatively settled, the subject is still wide open, and we are not revoking the decisions of any scientific congress. From the conflict of authorities pointed out above, it is high time we decided to fix upon the value of the permeability for air.

In the Paper referred to in my previous note ("A Determination of the Nature of the Electric and Magnetic Quantities, and of the Density and Elasticity of the Ether," *Physical Review*, January, 1900), in an appendix which will appear in March I have given some details of this system, and suggested symbols and a nomenclature. The symbols, I think, will be found very convenient, but the nomenclature is meant merely as an illustration of the method.

To sum up, we have our choice of four methods :—

1. Heaviside's. The advantage of this system is that it gives a perfect and rational system of units, and simplifies calculations very much. Its disadvantages are that it necessitates the changing of the legal units of current, voltage, capacity, resistance, &c. It also necessitates the changing or the throwing away of all our present resistance boxes and standards of current, and the recalibration of many other electrical instruments, such as ammeters and voltmeters Moreover, all the vast mass of electrical literature which we have accumulated during the past 20 years will be rendered somewhat inconvenient of reference, for when in the course of our reading we find say 10 amperes mentioned, we will have to divide the 10 by 1·7724 in order to get the value in terms of the new units. This will make considerable arithmetical work. And lastly, since it has been but recently that the present units were legalised, we can hardly expect our Governments to change them again, after being in use for so short a time, at once. It may be doubted if they can be induced to take action within 10 or 20 years.

2. To go ahead with our use of the present absolute and practical units. This means a loss of time of about three-quarters of a year (according to my experience) for every electrical engineering graduate, and the perpetual annoyance of a complicated, irrational, and vexatious system of reckoning.

3. The writer's method. The advantages of this system are that it gives a simple and rational system of units, the equations and formulæ being identical with those of Heaviside's system, the only difference being that a different medium is chosen as having unit permeability. It disturbs none of the legal units, it necessitates no changes of calibration and no loss of apparatus, and renders useless no printed tables which are used in practical work. The whole change is merely one of definition, and if the proposed changes were made by the Paris congress to-morrow, there would be absolutely no disturbance, the only difference being that we would write our equations in a simpler form. It is curious to note that, as if by instinct, designers have been tending towards this system, for in most works the ampere-turns are used instead of the gilberts, and the henry has been chosen as being a certain number of magnetic lines instead of a certain amount of magnetism. Moreover, in electrostatic problems we have for years been using the capacity, which is analogous, not to the permeance, but to 4π times the permeance. As regards the present legal practical units, there is absolutely no need of touching them; we simply use absolute units instead. The yard and the metre are the absolute units of length, but as a matter of fact we use the yard and metre less than any other units of length, yet it does no harm. It is not necessary to sell current by amperes any more than it is necessary to sell land by the yard. Still we can do so if we choose. The disadvantage of the system is that in place of the time-honoured fiction that the ether has unit permeability and specific inductive capacity we substitute another fiction—*i.e.*, that the permeability is $(4\pi)^2$ or the permity is 4π. We have just as much right to make the one supposition as the other (both being incorrect as a matter of fact). The injury done is hence of a purely sentimental character.

4. We may use the above system, and make in addition a new system of practical units. This is the plan proposed by Prof. Fleming. The advantage of this system is that we get a good system of practical units, and all our present electrical instruments and standards are still available. The disadvantage, if there is any, is that it is not evident that practical units are anything but a nuisance and a source of confusion. As regards this point, there will be diversity of opinion.

It may safely be said that here in America, where a great deal of polyphase and long-distance work is done, requiring equations consisting of mixtures of absolute electrostatic, absolute electromagnetic, and practical units, the prejudice against the practical units is very strong. It is only necessary to read the editorials in and communications to our electrical papers to realise how strong the feeling is that we should give names to the absolute units and abandon the practical ones.

So far as can be judged, the same feeling obtains in France, and may possibly have antedated the movement here in America. In any case, for some time MM. Hospitalier, Blondel, and others have been advocating the same thing in a series of admirable articles, and the arguments they have presented appear very convincing and in entire accord with our experience on this side. As Prof. Hospitalier eloquently puts it: "War is declared on all sides upon the C.G.S. practical units, and in a more general manner upon all units, whose use entails parasitical factors in their relation with other units, even though said factors are decimals;" and, whilst there may be differences of detail, as for instance in the proposed nomenclatures, there seems to be none in regard to the end to be sought for.

If we adopt the third method proposed, there is no reason why we should not do so at the present Paris congress. All that will be necessary will be to pass the following resolutions: (1) That the unit quantity of magnetism be $\frac{1}{4}\pi$ times the present unit. (2) That the unit of difference of magnetic potential be the absolute unit of current turn. (3) That a name be given to the ratio quantity of magnetism ÷ difference of magnetic potential, which is in this Paper called the permity. If the congress should then give names, as suggested by Messrs. Hospitalier, Blondel, Kennelly, and others, to the absolute units, and give us a system of simple prefixes, the whole system of units would be in an extremely satisfactory state, and both theoretical and practical electricians be relieved of a great and irritating burden.

METHODS OF CHARGING FOR PUBLIC SUPPLY OF ELECTRICITY.*

BY W. W. LACKIE.

In order to get at the basis upon which the various methods at present in use are founded, it is necessary to consider (1) the cost of the different parts that go to make up an electric power station, and (2) the cost of generating the energy. No two cities will give the same cost for all the different items that go to make up either of these, but in order that we may have figures that will not only be of interest, but with which I will be able to deal with some ease and freedom, I will take the costs of the Glasgow Corporation electricity department. The approximate costs per kilowatt capacity are :—

(1) Land and buildings	£14	0	0	
(2) Machinery	25	0	0	
(3) Accumulators	2	0	0	
(4) Mains and cables	44	0	0	
(5) Meters	4	0	0	
(6) Instruments	0	18	0	
(7) Counting house furniture, &c.	0	2	0	
Total	£90	0	0	per kw.

* Abstract of a Paper read before the Glasgow section of the Institution of Electrical Engineers.

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The first item, land and buildings, is of course particularly subject to variation, according to the local price of land, labour, and building, but the above is the approximate average cost of the three generating stations in Glasgow. The next item, machinery and plant, includes boilers, steam piping, engines, dynamos, travelling cranes, switchboards, and all accessories to complete the station proper. The outside work consists of feeders and distributing mains. The fourth item is the largest at present, although no doubt this will be very much less in due course. We next come to consider the annual cost of each of these items—*i.e.*, the depreciation to be allowed on each of them. It has been the custom in Glasgow to rate and allocate this depreciation as follows :—

(1) Land and buildings	1	per cent. on	£14	0	0	=	£0	2	9
(2) Machinery	7½	do.	25	0	0	=	1	17	6
(3) Accumulators	10	do.	2	0	0	=	0	4	0
(4) Mains	2½	do.	44	0	0	=	1	2	0
(5) Meters	6	do.	4	0	0	=	0	4	9
(6) Instruments...	5	do.	0	18	0	=	0	0	11
(7) Counting house furniture..	5	do.	0	2	0	=	0	0	1
			£90	0	0		£3	12	0

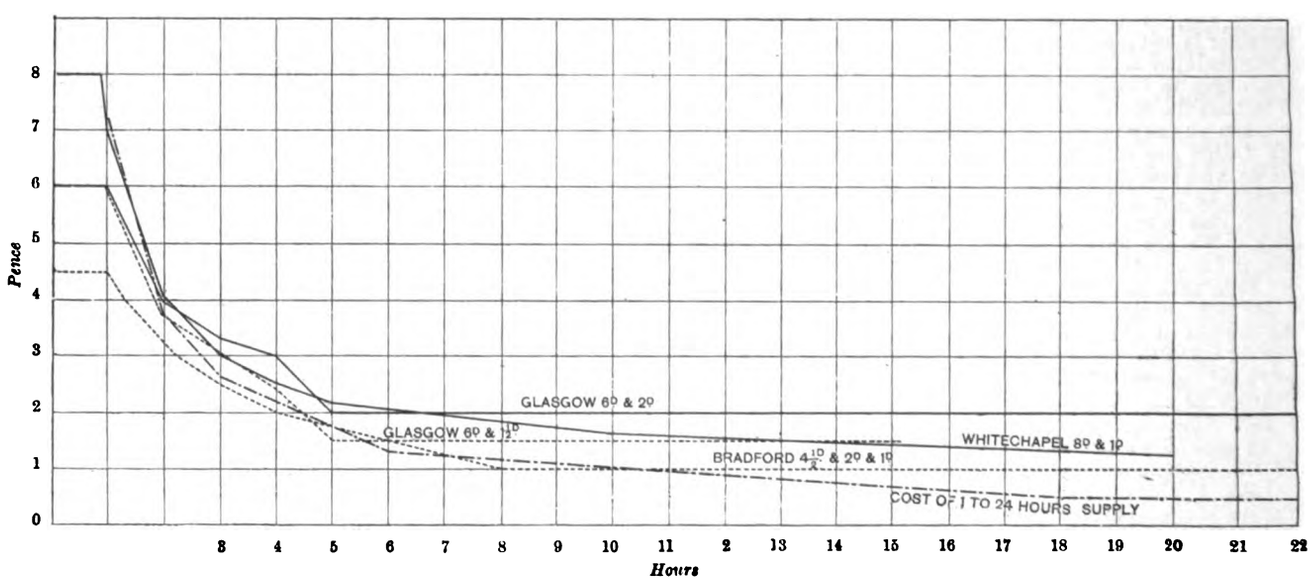
This gives an annual cost per kw. of £3. 12s., or an average of just 4 per cent. on the capital. There is further interest on the capital at the rate of 3·1 per cent., and a sinking fund to be allowed for at the rate of 1 per cent., which together make a total of 8·1 per cent. on the capital, or a cost of £7. 5s. 9d. per kw. of plant, no matter whether the plant is used for supplying 1 unit or 10,000 units. It is therefore clear that any consumer who applies to the supply company, and causes one kw. of plant to be put down, and whose bill is under £7. 5s. 9d. per annum, does not pay the bare cost of the upkeep of the plant, not to mention the actual cost of generation—*i.e.*, the cost of coal, oil, &c. These are the chief items which go to make up what are called the standing or stand-by charges. Other items which might fairly be added to the stand-by charges are the rent, rates, and taxes, and part of the management expenses. If these items are added the above figure is increased by £1. 10s. 3d., and the standing charges are brought up to £8. 16s. If the items last mentioned are omitted, it simply means that the actual cost of the unit will be increased.

The items included in the actual generation of the current practically vary in proportion to the units generated, and were in Glasgow for the past year :—

Coal	0·54d.
Oil, &c.	0·06d.
Wages	0·26d.
Repairs.....	0·42d.
Per unit.....	1·28d.

I understand that Mr. Wright, of Brighton, not only puts under the head of standing charges the items I have mentioned—viz., depreciation, interest, sinking fund, and management—but he also includes stand-by coal charges used for banking fires, &c., and all wages of workmen. In this I think Mr. Wright is taking an extreme view, and I submit that a portion of the wages of firemen, enginemen, and engineers should go to the running expenses.

The maximum demand of all the consumers added together is equal to about 70 per cent. of their aggregate application, and the maximum demand made on the station is about 50 per cent. of the total power applied for. If the standing charge of £8. 16s. per kw. of plant in the station is to be proportional to the consumer's application, the charge should be £4. 8s. per kw. of application; if according to the maximum demand of the consumers, the charge will be £6. 4s.—*plus* in both cases a charge to cover the cost of generation per unit. Take it that it is to be proportional to maximum demand—*i.e.*, each consumer is to pay £6. 4s. per kw., *plus* in both cases a charge to cover the cost of generation per unit of maximum demand as his share of standing charges, *plus* a sum of say for the present 2d. per unit to cover the cost of generating the current. The system of charging adopted in Glasgow allows of this £6 4s. being paid practically in three ways, certainly in two. It may either be paid in 12 equal monthly instalments of 10s. 4d. per kw., or it can be paid in 365 equal payments of 4d.—*i.e.*, on the first 365 units per kw., *plus* in each case 2d. per unit. This last case we are all familiar with. It corresponds to the first system of charging for 200 volt supply offered by the Corporation, which is that for a quantity not exceeding the maximum demand for 365 hours per annum the charge is 6d. per unit, and all above this quantity 2d. per unit. The first method of paying off the standing charges is also offered, but the Corporation having introduced the maximum demand system and maximum demand indicators, and wishing to do without the latter, have no alternative but to charge on the consumer's application. The charge is also slightly higher, being £6. 15s. 5d. per kw. of application. If all the consumers would agree to pay on their application, I have no doubt this charge would be nearer the figure I have stated—viz., £4. 8s. per kw. This system of charging is by no means new. Dr. Hopkinson drew attention to the matter in his classical Paper read before the Junior Engineers,* and Arthur Wright was the first, I believe, to make use of this idea. In a return made by the town clerk of Gloucester last year it appears that, out of 60 local authorities owning electricity supplies, 40 of them use Wright's indicator and system of charging.



In some cases motive power is quoted at a lower uniform rate, but the sole reason for doing so is that the chances are that motive power will be used for some four or five hours per day throughout the whole year; but it seems unfair that a similar benefit should not be extended to long-hour consumers using current for lighting purposes, seeing that the cost of generation is the same whether the energy be used for power or lighting.

The third method offered by the Glasgow Corporation is a uniform rate, and is as follows for a 200 volt supply. Current is supplied at a uniform rate of 2d. per unit, provided the consumer agrees to pay for a quantity corresponding to his maximum demand for the equivalent of five hours per day for 365 days in the year—*i.e.*, for 1,825 hours per annum. Under this method the applicant's standing charges are spread over at least 1,825 hours, and on a charge of £6. 4s. therefore only amount to 0·8d.—that is, supposing his consumption exactly equals 1,825 hours of maximum demand. The actual average works costs per unit are 1·28d. for an average of 2½ hours per day consumption on the whole station, so that it is not underselling the current if a five hour per day per annum consumer gets it at 2d.

It may be asked why it is necessary to adopt this method of charging for a supply of electricity when gas is supplied at a uniform rate. I think we only need to apply the maximum demand system to a gas supply to see the reason and the necessity for this, especially at the commencement of an electrical installation; for later on it may be possible to level things down a little and to make the system of charging more like a uniform one. I take the gas accounts of the Glasgow Corporation gas department for last year from the *Gas*

[* See *The Electrician*, Vol. XXX., p. 29.—ED. *E.*]

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World Year Book. The capital in works and plant is £1,315,680. These works and plant I roughly calculate supply what it would take 112,000 kw. of electric plant to supply. The cost per equivalent of a kw. is therefore only £11. 15s., as against the electricity plant £90. The amount written off for depreciation was £35,716, or 2·7 per cent. Interest and sinking fund account for £69,933, or 3·1 per cent. This makes a total of 5·8 per cent., or an annual cost of 13s. 7d. for gas plant as against the annual cost of £7. 5s. 9d. per kw. for electrical plant. If the management expenses are added to this, the sum of 13s. 7d. is raised approximately to 14s. 6d , which, if divided into 365 equal payments, is less than ½d. The actual costs of making gas are given as :

Coal, &c.	1s.	8d.	per 1,000 cubic ft.	
Distribution, &c.....	0s.	2½d.	ditto.	
Sundry charges	0s.	1½d.	ditto.	
and the gross cost of gas is	1s.	11¾d.	ditto.	say 2s.

The charge for gas on the maximum demand system would therefore be something like this : 2s. 0½d. for the first 365 hours of maximum demand, and 2s. for all used above that. You can therefore understand why a uniform charge of 2s. 2d. is adopted.

I would like to give you one other set of figures in this connection. The capital of the gas department is £1,315,680, and the revenue is £631,644, or nearly 50 per cent. of the capital. The capital of the electricity department was at May 31 last, £322,000, and the revenue £44,141, or only 13·7 per cent. of the capital. This also shows the difference between the two supplies. No doubt the capital of the gas department is very low, for the department has been in existence for 39 years, and has regularly written off large sums for depreciation, which go to reduce the capital. The electricity department will have a similar benefit. These figures must be taken as only approximately correct, as there are other items which enter into the gas accounts such as the sale of residuals.

I now wish to consider briefly the question : In what direction are we to look for a reduction in our present price and a nearer approach to a uniform rate ? The first item on the capital cost sheet is land and buildings. This for several reasons should be at least halved, making it £7. The cost per kw. for plant would come down to something like £16. Accumulators will at least be quartered. Mains and cables should approach £33. (The result of an increased pressure of supply would have materially lowered this item, had not the price of copper nearly doubled itself just as the 200 and 250 volt lamps were coming.) Meters will be increased, and may be doubled. The other two items will at least be halved, and we hope in the course of time to have a capital cost per kw. of—

	Capital cost per kw.				Depreciation.					
1. Land and buildings	£7	0	0	.....	1	per cent.	.....	£0	1	4
2. Machinery and plant	16	0	0	.....	7½	do.	.....	1	4	0
3. Accumulators	0	10	0	.....	10	do.	.....	0	1	0
4. Mains and cables	33	0	0	.....	2½	do.	.....	0	16	6
5. Meters	8	0	0	.....	6	do.	.....	0	9	6
6. Instruments	0	9	0	.....	5	do.	.....	0	0	5
7. Counting-house furniture.	0	1	0	.....	5	do.	.....	0	0	0½
	£65	0	0					£2	12	9½

Allowing the same rate of depreciation, the sum of £3. 12s. is reduced to £2. 12s. 9½d. Adding on as before 3·1 per cent. and 1 per cent. on a smaller capital, we have the standing charge of £7. 5s. 9d. reduced to £5. 6s. 1d., and adding on management expenses, the sum will not be more than £5. 10s. This will have the effect of reducing the sum of £6. 4s. per kw. of maximum demand in my first figures to £3. 17s. per kw. The selling price per unit will no doubt be reduced, too, but it will only be by decimals of a penny. Let us assume it will be reduced to 1½d. per unit. On the Glasgow prices and methods of charging the figures then would be 3¾d. per unit for a quantity equal to 365 times the maximum demand, and 1½d. per unit thereafter ; or, if every consumer would agree to it under the fixed-charge method, £2. 15s. per annum or 4s. 7d. per month per kw. (*i.e.*, 1. 8d. per 8 c.p. lamp fixed) of application, *plus* 1¼d. per unit, or 1½d. all round for a five hour per day consumer. Further, the depreciation written off from year to year and the sinking fund will go to reducing the capital, so that even these figures may be further reduced.

A uniform charge may be adopted before these prices are realised, but it will undoubtedly require to be one in which consumers are classified according to their probable hours of lighting. Even then there will be cases where consumers should be charged higher or lower rates than those used for the bulk of the consumers. From a table made out by the Reason Manufacturing Co., classifying consumers of electric energy in Brighton, it is shown that in the case of shops, for instance, 6 per cent. of them use the light for under one hour and 6 per cent. use the light over four hours. The great majority use it between two and three hours. Such a method as this averaging would mean that in Glasgow—

Shops would be charged	5d.	Offices	6d.
Private houses	4d.	Theatres	3½d.
Hotels and clubs	3d.	Hospitals	3d.
Public houses	1½d.	Schools and churches	5d.

I will here call your attention to some curves I have had drawn, showing the cost of a 1 to 24 hour consumer in various cities, and a curve showing the actual cost of such a supply. The dotted curve shows the actual cost of a supply in Glasgow. The other curves are for Glasgow charges of 6d. and 2d., and 6d and 1½d ; Whitechapel, 8d. and 1d. ; Bradford, 4½d., 2½d., and 1d. In Aberdeen the charges for lighting are 6d. per unit for the first 365 hours of maximum demand, and 3d. per unit thereafter, and for motive purposes 4½d. and 1½d. Other municipalities under this system are :—

Brighton	7d. for the first 365 hours, and 1½d. thereafter.
Bradford	4½d. for 3 hours, 2½d. for 4 hours, 1d. for 8 hours.
Manchester.....	5d., or £7 per annum per kw., *plus* 1½d. per unit.
Shoreditch	5d. for 730 hours, and 2d. thereafter.
Stafford	7d. for the 1½ hours in winter, and ½ hour in summer, and 3d. thereafter.

Edinburgh is a notable exception to all other cities. A uniform rate is charged there of 3½d. per unit for lighting and 1½d. per unit for power, with discounts, I believe. The success that has attended electric lighting in Edinburgh is no doubt partly due to the high price of gas—viz., 3s., as against Glasgow gas at 2s. 2d.—and to the liberal use of electricity in street lighting. Not only has this raised the load factor of the station (*i.e.*, the ratio of the number of units generated to the number that could be generated if the greatest load remained on for 24 hours per day throughout the whole year) 50 per cent. higher than we have in Glasgow, but it has been the means of their selling a greater number of the low rate units, which are the units on which there is by far the greatest profit. Still, it is probable that in Edinburgh there are consumers who should only be charged 1½d. per unit, and others 5d. per unit. In two supply stations meters registering at different rates have been used, the object being to charge the low rate all day long and then sixpenny or standing charge units between the hours of sunset and sunrise. This of course tells hard on the long-hour consumers who use the power late in the night, and I cannot see why they should not be treated equal with the consumer who uses it for long hours during the day. One other point. You must all remember that a supply in Glasgow, London, and Manchester is different from that in any other city, in so far as it has to meet a day and night demand and foggy days, and nothing tends more to give the supply a bad reputation than failing on such a day just when it is most required.

DISCUSSION.

Mr. HENRY MAVOR said that he must take credit to his own firm for instituting the two-rate charge when they had their pioneer station at Glasgow.

Prof. WATKINSON thought that the one thing wanted in connection with supply of electric light was an improved system of storage, so that the advantages due to gas storage could be taken advantage of. He thought that if a simple battery could be designed, and one placed in each house, that the ideal would be more nearly reached.

Mr. McWHIRTER was inclined to think the depreciation put down to mains and accumulators was too low.

Mr. E. GEORGE TIDD said that when the Cadogan Electric Supply Co. was first started a system such as had been described by Prof. Watkinson was in use—namely, a battery of E.P.S. cells in each house, certain cells being cut out from each set automatically and charged in series. The results were more or less unsatisfactory, and the system had been discarded. He considered 2½ per cent. depreciation *plus* 1 per cent. to the sinking fund for cables and accumulators on the high side. He thought that faults in the cable should be considered as upkeep, and that a cable once properly laid and undamaged had practically no depreciation. He also applied similar remarks to the case of accumulators, and said that he believed makers were prepared to maintain the battery at a very much lower cost than Mr. Lackie put down.

Mr. McCALL and Mr. COATES also spoke.

AN EXPERIMENTAL RESEARCH ON SOME STANDARDS OF LIGHT.*

BY J. E. PETAVEL.

(*Concluded from page 828.*)

The Furnace (F, Fig. 6).—The outer shell consists of an ordinary Fletcher furnace, 23cm. in external diameter. The interior is filled up to within 7cm. of the top with sand, on which rests one of the ordinary magnesia bricks used for smelting platinum. Their chemical composition is—

Magnesia	92·0	per cent.
Lime	4·3	do.
Silica	2·4	do.
Iron and alumina	1·3	do.

These bricks are eminently suitable to resist high temperatures. Owing to the presence of silica they could not be used alone for the purpose we have in view, but they are very valuable as an outer crucible in which to place the pure lime on which the platinum rests.

* Paper read before the Royal Society.

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In a brick 11 × 11 × 7cm. a cylinder of 7cm. in diameter and 3cm. in depth is drilled out; the hollow is filled up with chemically pure lime in the form of powder, which is pressed tightly in. The platinum, roughly hammered into shape, is forced into the bed thus prepared until the lime is flush with the upper surface of the metal. Before the temperature has reached the melting point of platinum the lime has formed itself into a sufficiently coherent mass to support the weight of the metal. Another brick 11 × 11 × 4cm. forms the cover; it is held in a cast-iron frame by six ¼in. screws equally spaced along two adjacent sides of the square. A hole 1·6cm. in diameter is drilled through the centre of this cover. It is through this hole that the blow-pipe plays vertically on the surface of the metal. The lower surface of the cover should be not more than 1cm. above the platinum. Both blow-pipe and diaphragm are attached to the same vertical axis **A**; the electromagnet M, which controls the motion of this axis, is placed in series with the magnet N, which cuts off the supply of gas to the blow-pipe. The instant the gas is stopped the axis swings round, bringing the 1 sq. cm. diaphragm D above the hole in the cover of the furnace. A number of screens are provided, so as to prevent any light from the furnace itself reaching the photometer. The screens have been removed in Fig. 6, so as to give a better view of the furnace.

The light from the platinum is reflected on to the photometer by a mirror. The secondary standard is not placed in the axis of the photometer, but at right angles to it, its light being also reflected by a mirror. Each mirror is supported by a bar, which is held in a socket provided with a **V**-shaped check, so that when one of the mirrors is taken out of its supporting socket it can always be replaced in the same position: the fittings are made interchangeable. Thus by interchanging the two mirrors any error due to their coefficient of absorption can be eliminated. A metronome ringing every ten seconds gives the intervals at which the photometric observations are to be made. To save time the readings are not taken, but the position of the index on the photometer bar is marked off. The distances are read at leisure later on.

The method by which the observations are obtained is as follows: Let us suppose that the platinum is in position, the standard of reference adjusted, the metronome started, the "rate" and "ratio" gauges calibrated, and that we are ready to start the blow-pipe. We turn on the gas and increase the supply until the gauge shows that the hydrogen is burning at the rate of 0·8 cubic foot per minute; we then regulate the supply of gas so as to keep the ratio gauge in balance. At the end of 15 minutes we press the key which stops the gas and swings the diaphragm into position. No photometric readings are taken at the end of this first fusion for two reasons: 1. The walls of the furnace have not yet had time to heat up, and the platinum, though fused on the surface, is probably still solid underneath. 2. Some particles of lime dust are pretty sure to be floating on the surface if the ingot of metal has only just been put into a newly-made crucible. We therefore merely use this fusion to adjust the position of the furnace and cover, so that the centre of the platinum surface and the centre of the aperture in the cover should be on a vertical line passing through the centre of the diaphragm. This done, we re-start the blow-pipe, and 15 minutes later, as the metronome rings, we press the electric key, keeping an eye on the photometer. The photometer is kept in balance, and every 10 seconds, as the metronome rings, the position of the photometer head is marked off. By the time some 10 or 15 readings have been recorded the platinum has cooled below its melting point. The distances are then read off at leisure, the blow-pipe is swung back into position, the chopper re-set, the mirrors are interchanged, and everything is ready for a fresh start. Fifteen minutes later another series of readings can be taken.

A Lummer and Brodhun photometer* and photometer bench were used during these experiments, the distance between the lights being 331·4cm. The position of both the sources of light was fixed, the photometer head alone being movable. To ensure the maximum sensitiveness it is well to keep one eye exclusively for the photometric observations, covering it when the readings are not being taken with a black screen. In all the experiments incandescent lamps were used as standards of reference. When the necessary precautions are taken these form very reliable standards, remaining absolutely constant for many hours.† The pressure on the terminals of these lamps must be adjusted with the greatest care, as the light varies with the sixth power of the electromotive force. In the present case 50 volt lamps were used, a specially constructed divided resistance being placed across the terminals of the lamp. By means of a potentiometer the electromotive force on 1/20th of this resistance was compared with the electromotive force of a Clark's cell. To avoid any rapid changes of temperature the cell was placed in the inner chamber of a calorimeter. Under these circumstances the pressure on the terminals of the lamp could be kept constant during many hours to within one-hundredth of a per cent.

Table V. *(See Fig. 8.)—Normal conditions.*

Intensity of the light from 1 sq. cm. of platinum at the temperature of solidification as deduced from the observations given below is 1·002 (the error of this determination is therefore 0·002).

Time.	Photometer reading.	Light.	Time.	Photometer reading.	Light.
10	118·3	2·236	90	150·3	1·001
20	133·8	1·503	100	150·6	0·993
30	143·0	1·196	110	150·7	0·991
40	154·3	0·908	120	150·8	0·988
50	164·5	0·693	130	150·9	0·986
60	171·8	0·623	140	151·0	0·984
70	174·4	0·559	150	154·8	0·897
80	150·0	1·008	160	163·8	0·722

Having in the manner indicated above obtained a set of photometric readings at intervals of ten seconds from the time the blow-pipe was stopped, let us consider what is the best manner of reducing these observations. The typical shape of the curve obtained is shown in Fig. 8 (see Table V.); the abscissæ represent time, the ordinates light. The curve consists of three parts, the first falling rapidly represents the decrease of light sent out from the liquid metal as its temperature falls. There is a sudden break in the curve when the platinum begins to solidify, followed by a practically straight line. This second period (40secs. to 50secs. in the conditions under which these experiments were made) marks the time during which the platinum ingot is freezing. For the sake of brevity we shall in future refer to this part of the curve as the "constant" period, though

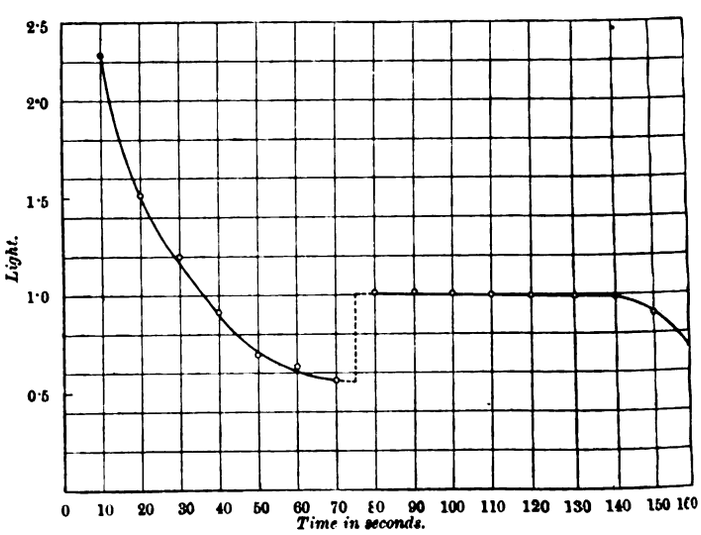

FIG. 8.—"Normal" conditions: total mass of platinum, 345 grammes; superficial area, 17 sq. cm.; diameter of aperture in the cover of the furnace, 1·6 c.m.; intensity of the light at the temperature of solidification, 1·002 (the error of this determination is therefore 0·002).

strictly speaking, owing to the imperfect conduction of the metal, the intensity of the light decreases slightly as the time increases. The third part of the curve represents the cooling of the surface after the entire mass is solid. The want of sharpness in the transition between the second and third parts is due to the fact that the heat loss at the surface is at first supplied by conduction from the lower layers still substantially at the temperature of solidification, and it is not until the corresponding temperature gradient is established throughout the entire mass that the normal rate of cooling is shown by the light given off from the surface. Curves similar to the above, but referring to the case of molten silver, were shown by Violle in 1884.*

A second form of curve is possible (see Figs. 9 and 11). This shape is obtained when the metal has been heated very slightly above its melting point. In this case there is no flash up of the light, the three parts of the curve being continuous. The photometric readings, reduced as shown below, vary but little from those obtained when the curves are discontinuous, but for several reasons the results are likely to be less consistent than when the conditions are so regulated as to obtain the "flash" in Fig. 8.

* The photometer head and part of the photometer bench are shown in Fig. 4. To avoid any stray light, the photometer was hung with black velvet curtains. These have been drawn aside in Fig. 4. For a full description of this instrument see *Zeitschrift für Instrumentenkunde*, p. 41, 1892, and *J. für Gasbeleuchtung und Wasserversorgung*, Vol. XXXVII., p. 61, 1894.

† *Zeitschrift für Instrumentenkunde*, Vol. X., p. 119, 1880.

* *Annales de Chimie et de Physique*, sér. 6, Vol. III., p. 373, 1884; also Conférence Internationale pour la Détermination des Unités Electriques, séance de la Troisième Commission, 3 Avril, 1884. There is, however, one essential difference between the present results and those obtained by Violle. In the case both of silver and platinum Violle indicates the "flash" as occurring not before but after the constant period.

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Table VI. (*see Fig. 9.*)—*Superficial Area of Platinum Ingot 30 sq. cm.* Intensity of the light from 1 sq. cm. of platinum at the temperature of solidification = 1·012.

Time.*	Photometer reading.†	Light.‡	Time.*	Photometer reading.†	Light.‡
10	145·7	1·119	60	150·3	1·001
20	148·2	1·054	70	151·5	0·972
30	150·1	1·005	80	151·7	0·967
40	149·8	1·013	90	163·3	0·730
50	150·1	1·005	100	178·8	0·502

The definition of the standard quantity of light is that emitted in a normal direction by 1 sq. cm. of surface of platinum at its temperature of solidification. It has already been pointed out: 1. That it is practically impossible to obtain an instantaneous photometric observation. 2. That each part of the surface is, strictly

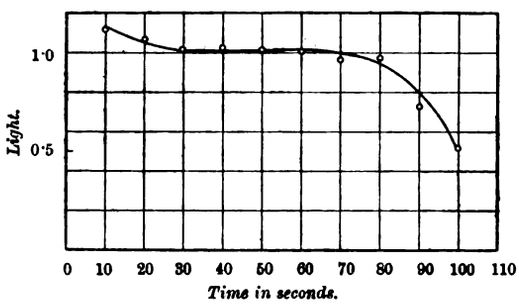

FIG. 9.—Superficial area of platinum ingot, 30 sq. cm. (or 76 per cent. above the normal); intensity of the light at the temperature of solidification, 1·012 (or 0·012 above the normal).

speaking, only at the standard temperature for the small time-interval during which the solid film is actually forming. 3. That, owing to the difficulties inherent to all photometric observations, each determination should rest on a number of separate readings. The most obvious method would be to take the mean of the readings obtained during the "constant period," but in doing so we should certainly be wrong, as these readings form a decreasing series, the first one only being theoretically correct. The rate of decrease of the readings varies with the mass of metal used and the circumstances under which it is allowed to cool; and were we

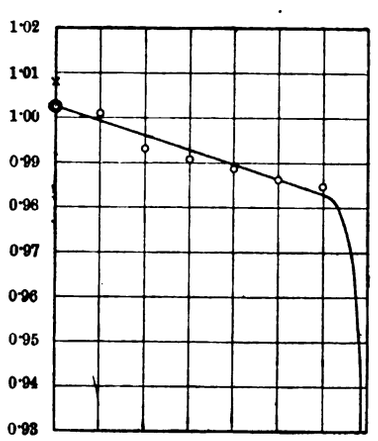

FIG. 10 (*see* Table V., Fig. 8).—Illustrating the graphical method used in reducing the observations.

to take the mean of the readings, the final determination would necessarily be dependent on these experimental conditions. The first reading, though theoretically the most correct, is practically the least reliable of the series. This reading immediately follows a sudden and considerable change in the illumination of the photometer, and the eye has not yet had time to become accustomed to the change. It is therefore out of the question to base our determinations on this first reading. All things considered, it is best to establish the value of the intensity of the light emitted by the platinum at the instant of solidification by a graphical exterpolation. The shape of the curve during the period of solidification is practically a straight line. The various observations during this period differ but little in absolute value, and can easily be plotted to a very large scale. If we draw a straight line through these points, the height of this line above the axis at the time at which the "flash" occurred will give us the quantity of light emitted at the temperature of solidification. The values of the observations themselves determine within 10 seconds the time at which the "flash" occurred, and for a first approximation this is sufficient.

The above method of reducing the results is illustrated in Fig. 10. After a set of observations has been taken, and while the platinum is still white hot, the surface visible through the diaphragm should be inspected. Should any specks of lime dust or other impurity be apparent, the observations should be rejected. It is advisable to make it a rule to discard any set of readings where: (1) The "constant period" extends over less than 30 seconds; (2) the mean rate of change of the intensity of the light during the so-called "constant period" exceeds 0·03 per cent. per second.

In the course of the present investigation observations were taken for some 300 curves, but for obvious reasons only a few of the most typical are recorded here. It must be clearly understood that the

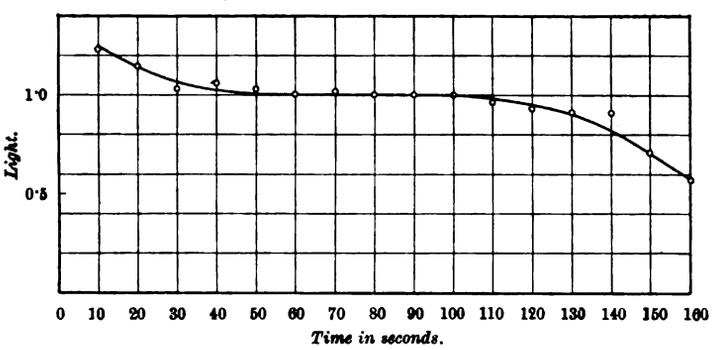

FIG. 11.—Superficial area of the platinum ingot, 10 sq. cm. (or 41 per cent. below the normal); intensity of the light at the temperature of solidification, 1·004 (or 0·004 above the normal).

present experiments were not undertaken with a view of obtaining any absolute determinations, but purely as a preliminary investigation. The objects in view were: (1) To ascertain the most favourable experimental conditions; (2) to determine the degree of accuracy to be obtained under these conditions. The results are expressed in terms of the quantity of light emitted by 1 sq. cm. of platinum at its temperature of solidification and under the following conditions: The total mass used was 345 grammes in the shape of a disc. The area of the upper surface of the disc was 17 sq. cm. The diameter of the hole in the cover of the furnace was 1·6cm. The observations were taken after the blow-pipe had been alight for 15 minutes, burning 0·8 cubic ft. of hydrogen per minute, the two gases being mixed in the ratio of four volumes of hydrogen to three of oxygen. The above conditions will, for the purpose of this

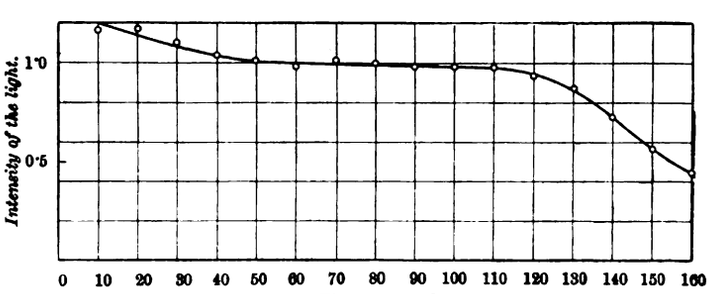

FIG. 12.—Mass of the platinum ingot, 510 grammes (or 45 per cent. above the normal); intensity of the light at the temperature of solidification, 1·004 (or 0·004 above the normal).

investigation, be taken as the "normal conditions" (*see* Table V. and Fig. 8). It must, however, be borne in mind that for the final experiments it would be advisable to increase the mass of metal to 1,000 or 2,000 grammes, and this would entail a change in the quantity of gas burnt.*

This said, let us proceed to determine to what extent the intensity of the light is dependent on the experimental conditions.

Change in the Shape of the Platinum Ingot.—By changing the shape of the ingot we shall modify not only its rate of cooling, but also the maximum temperature it will reach under the "normal" supply of gas. If we flatten out the disc beyond a certain limit, only the central

* The time is counted from the instant at which the blow-pipe was stopped.

† The photometer reading is the distance in centimetres between the photometer head and the incandescent lamp which served as a standard of reference.

‡ The unit of light is the mean of a number of determinations made under the "normal" conditions.

* It would also be advisable in future experiments to shape the platinum ingot into a half-sphere, as this shape would be preferable with regard to the constancy of the observations during the time the metal is freezing.

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Table VII. (*see Fig. 11*).—*Superficial Area of Platinum Ingot 10 sq. cm.*

Intensity of light from 1 sq. cm. of platinum at the temperature of solidification = 1·004.

Time.*	Photometer reading.†	Light.‡	Time.*	Photometer reading.†	Light.‡
10	141·8	1·232	90	150·2	1·003
20	144·8	1·144	100	150·2	1·003
30	148·8	1·038	110	151·5	0·972
40	148·3	1·050	120	152·8	0·942
50	149·6	1·018	130	154·0	0·915
60	150·3	1·001	140	154·2	0·910
70	150·0	1·008	150	164·8	0·704
80	150·1	1·005	160	173·3	0·573

portion of the platinum will actually fuse. On the other hand, if we make the superficial area too small, forming the metal into a long cylinder, a limit will be reached when the fusion will cease to extend to the lower layers. In the present case 35 sq. cm. and 8 sq. cm. are

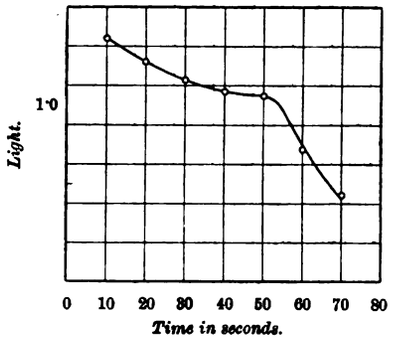

FIG. 15.—Showing that when a small mass of platinum (90 grammes) is used, the light does not remain constant for any appreciable time.

the limiting values. A number of determinations were made with a superficial area of 30 sq. cm. and 10 sq. cm. The details of two of the determinations are given in Tables VI. and VII.; the form of the curves is shown in Figs. 9 and 11. The maximum temperature reached by the metal was not sufficient to cause the sharp break in the curve of light, but notwithstanding this fact the values obtained differ less than 1½ per cent. from the "normal" value. We are therefore justified in concluding that the intensity of the light is independent of the shape of the mass, so long as the entire mass is raised above its melting point.

Variation of the Mass of Metal Used.—The effect of increasing the quantity of platinum from 345 to 510 grammes is shown in Table VIII. and Fig. 12. In this case the change produced in the light works out at 0·4 per cent. It is not possible to decrease the mass of

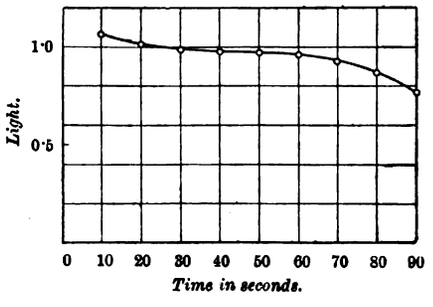

FIG. 14.—Area of the aperture in the cover, 4·9 sq. cm. (or 145 per cent. above the normal); intensity of the light at the temperature of solidification, 1·005 (or 0·005 above the normal).

metal much below 345 grammes, as the "constant period" becomes too short for reliable readings to be obtained. For 90 grammes, for instance (*see* Fig. 13), the "constant period" has altogether disappeared, or, strictly speaking, it is only represented by a slight

* The time is counted from the instant at which the blow-pipe was stopped.

† The photometer reading is the distance in centimetres between the photometer head and the incandescent lamp which served as a standard of reference.

‡ The unit of light is the mean of a number of determinations made under the "normal" conditions.

Table VIII. (*see Fig. 12*).—*Mass of Platinum Ingot 510 grammes.*

Intensity of the light from 1 sq. cm. of platinum at the temperature of solidification = 1·004.

Time.*	Photometer reading.†	Light.‡	Time.*	Photometer reading.†	Light.‡
10	143·8	1·173	90	150·9	0·986
20	144·6	1·150	100	151·0	0·984
30	146·5	1·098	110	151·2	0·979
40	148·8	1·038	120	152·8	0·942
50	150·1	1·005	130	155·8	0·875
60	150·8	0·988	140	163·8	0·722
70	150·3	1·001	150	173·8	0·567
80	150·4	0·998	160	183·8	0·444

Table IX. (*see Fig.* 14).—*With the Diameter of the Opening in the Cover of the Furnace increased to 2·5cm.*

Intensity of the light from 1 sq. cm. of the platinum at the temperature of solidification = 1·005.

Time.*	Photometer reading.†	Light.‡	Time.*	Photometer reading.†	Light.‡
10	147·8	1·064	60	152·0	0·960
20	150·0	1·008	70	153·6	0·924
30	150·7	0·991	80	155·8	0·875
40	150·9	0·986	90	160·8	0·776
50	151·3	0·976			

inflection in the curve. The experiments are, however, sufficient to show that though the mass of the ingot has a considerable effect on the degree of accuracy obtainable, it does not affect the quantity of light emitted at the temperature of solidification.

Variation in the Shape of the Enclosure.—From the laws of thermal radiation we are led to expect that the shape and temperature of the enclosure will have a considerable influence on the quantity of light emitted by such a body as platinum. Any change in size of the aperture in the cover of the furnace will greatly modify the rate of cooling of the metal, and from this cause also might affect the photo-

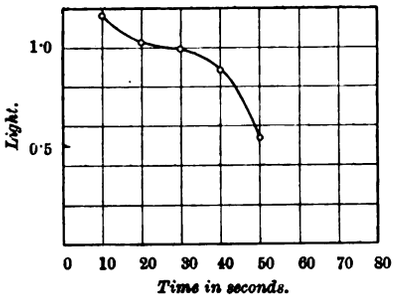

FIG. 15.—Showing the effect of removing the cover from the furnace.

metric observations. The "normal" conditions are chosen in order to make the rate of cooling as slow as possible, and any variation in the circumstances must necessarily cause the platinum to cool more rapidly. One of the determinations made with the aperature in the cover 2cm. in diameter, or nearly three times the area of the "normal" opening, is illustrated in Fig. 14 (see Table IX.). The quantity of light differs from the "normal" by less than 1 per cent. If the aperature in the cover is increased much beyond this limit, or if the cover is removed altogether from the furnace, the constant part of the curve vanishes and determinations become impossible. This case is shown in Fig. 15.

The recommendations made with regard to the rate at which the gases are to be burnt, and to the time during which the blow-pipe is to be alight, are only intended as an indication of the conditions under which the observations will be most easily obtained. A variation of 10 or even 20 per cent. in these factors would leave the final results practically unaffected, but a number of the observations would probably have to be discarded according to one or other of the three rules given.

The effect of contaminating the platinum with either silica or carbon is very marked.—Carbon forms the best illustration, as there is no difficulty in subsequently getting rid of this impurity. On March 26th, after a certain number of normal determinations had been made, it was decided to try the affect of using coal gas instead of hydrogen. After the blow-pipe had been supplied for 20 minutes with coal gas, the curve shown in Fig. 16, curve I. was obtained; 15 minutes later a similar set of readings were recorded. The entire

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surface of the metal was covered with a white film. The intensity of the light was 36 per cent. above the normal. The coal gas was then stopped and the hydrogen turned on, the surface gradually clearing as the carbon oxidised out. In an hour and a half the curve (Fig. 16, curve II.) was obtained, the error having already been reduced to less than 2 per cent.

From the above results I believe I am justified in stating *that the probable variation in the light emitted by molten platinum under the standard conditions is not above 1 per cent.* With more perfect apparatus, and with the experimental conditions altered in the direction that has been suggested, the accuracy of this standard would certainly be increased. Physiological considerations fix a limit to the accuracy of photometric observations. It is not impossible that the accuracy of the platinum standard may attain to or even surpass this limit.

The present work has occupied nearly three years, and it was thought advisable before devoting more time to the subject to publish such results as had already been obtained. It is hoped that those who are interested in photometric work will, by their advice and criticism, help to bring the research to a satisfactory close. In

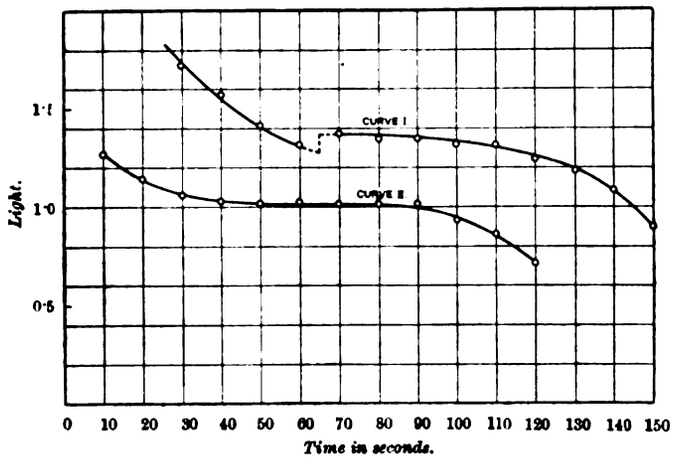


FIG. 16.—Curve I. shows the effect of using coal gas to heat the platinum; the light is 36 per cent. above the normal. Curve II. was taken an hour and a half later, the coal gas having been replaced by pure hydrogen. The error is already reduced to 2 per cent.

concluding, may I be allowed to express my gratitude to the managers of the Royal Institution for placing the splendid resources of the Davy-Faraday Laboratory at my disposal, as well as for generously defraying the necessarily heavy expenses incurred by the present work. My thanks are also due to Messrs. Johnson, Matthey and Co., who most kindly lent the platinum employed.

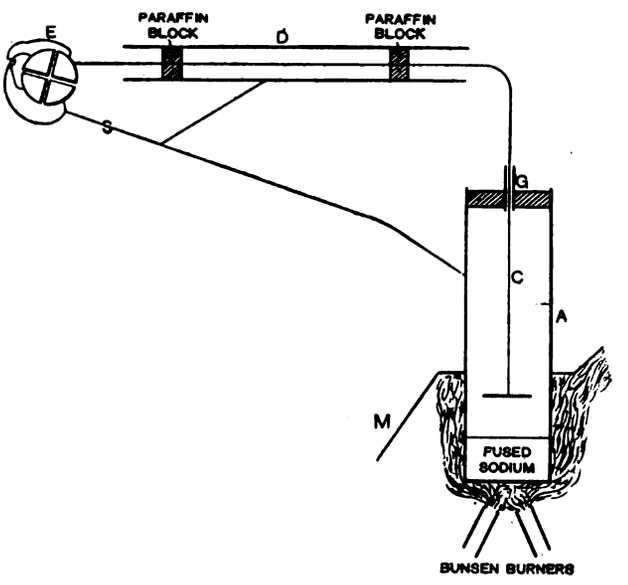
A Novel Application of Electrical Heating.—All those towns which obtain their water from Lake Superior have experienced considerable trouble and hardship during the cold weather by the stoppage of the water flow along the intake pipe, in consequence of the accumulation of an immense number of needle-crystals of ice there. The intake is 2ft. in diameter; the accumulation of these crystals is sufficient, however, to block it up entirely. Formerly, in each case of a "choke-up," it was necessary to thaw out the mouth of the intake with salt, but this has remedied the evil only temporarily. According to an American contemporary an experiment is about to be tried at Marquette, in the upper peninsula of Michigan, of a method which it is hoped will remove the evil entirely. An electrical heater of cylindrical form has been hung concentrically within the opening of the intake, and its efficacy will be tested on the first occasion of difficulty. The heater is of the iron resistance-coil pattern. It consists of an inner and outer drum of galvanised iron, respectively of 19in. and 21in. diameter and 5ft. in length. The inner cylinder was wrapped with asbestos sheeting to a depth of nearly ½in., and around this were wrapped convolutions of No. 18 iron wire in one continuous spiral. It is expected that the heat generated by this stove will be sufficient to melt all the needle-crystals formed before they pass through the cylinder. If successful it will be much cheaper than the only other alternative which suggests itself, of altering the position of the intakes.

ON ELECTRICAL EFFECTS DUE TO EVAPORATION OF SODIUM IN AIR AND OTHER GASES.*

BY W. CRAIG HENDERSON, M.A., B.SC.

The experiments described below form part of a research which I began in the summer of 1897 in the Cavendish Laboratory, Cambridge, but was unable to complete before leaving Cambridge that same year. The object of this part of the research, which was suggested by Prof. J. J. Thomson, was to determine whether evaporation of an unelectrified liquid produces any electrification or not. The liquid used was fused sodium, and the arrangement of apparatus is shown in the accompanying drawing.

The sodium to be fused was held in a vertical iron cylinder, A, closed at the bottom and having a tightly-fitting asbestos plug at the mouth. Through a small hole in the asbestos plug there passed a tightly-fitting glass tube, G, only a little longer than the thickness of the plug. A stout bare copper wire, C, passed through this tube G without touching the sides, and had a copper disc at the end inside the iron cylinder. Outside the cylinder this wire passed direct to the insulated quadrants of an electrometer, E, and was surrounded throughout this portion of its length by a metal guard-tube D, which screened it from outside electrostatic influences. Besides the fastening to the electrometer, the sole supports of the wire C were two paraffin plugs fixed into the ends of this tube D. The iron cylinder A, the tube D, and the uninsulated quadrants of the electrometer E were connected by a wire with one another and with the



sheath of the electrometer, denoted by S in the diagram. The heat to fuse the sodium was supplied by two Bunsen burners placed below the cylinder A; and in order to protect the insulated wire from the hot gases rising from the burners, a metal screen M was fixed on the cylinder and bent up on the side remote from the electrometer to serve as a funnel.

With these arrangements it was found that very soon after heat was applied to the sodium a negative electrification of 2 to 3 volts was indicated by the electrometer. The electrification persisted for a considerable time, but eventually the insulation broke down, owing to the sodium vapour condensing in the glass tube G at the mouth of the cylinder sufficiently to cause a solid connection between the tube and wire. When the same experiment was repeated *without* the sodium, no electrification was indicated by the electrometer.

These results were confirmed by repeated experiments, and the question then arose whether this negative electrification is due to the evaporation of the sodium, or to oxidation of the sodium going on in the iron cylinder. The latter seemed probable, as the electrometer showed electrification almost from the moment when heat was applied to the sodium, whereas sodium does not fuse till at a temperature of 96°C. and boils at about 400°C.

To determine this point the same experiment was repeated, with this difference—that the air in the cylinder was replaced by an atmosphere in which the sodium could not oxidise. Carbonic acid gas was first tried, being kept flowing into the cylinder after passing through a drying apparatus; but in this gas the sodium became coated with a white incrustation, and showed no signs of evaporation or of boiling even at a red heat.

Coal gas was next tried, and no difficulty was found in boiling the sodium in this gas. To prevent accident by explosion, the apparatus was set up in the fireplace, so that the escaping coal gas might pass

* Paper communicated to the Royal Society.

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up the chimney and not mix with the air of the room. Great care was taken to ensure the complete removal of air from the iron cylinder before heat was applied. With this atmosphere of coal gas no electrification was obtained while heat was applied to the tube for over an hour. The insulation was tested from time to time during this period by giving a charge to the wire from an electrified vulcanite rod, watching the rate of leak indicated on the electrometer scale, and then discharging. It was found to be excellent; but eventually, as before, it broke down when some of the sodium vapour condensed in the mouth of the cylinder between the wire and the glass tube. Repetition of this experiment confirmed this result.

This problem of the possible generation of electricity by evaporation of a liquid has been recently investigated for the case of water by Pellat,* who found no trace of electrification. A similar result was found in the earlier experiments of Blake,† who used water and solutions of copper sulphate and of sodium chloride, but found no electrification. The present experiments lead to the conclusion that evaporation of fused sodium does not give electrification, such as could be detected by the method used, unless oxidation is going on.

CORRESPONDENCE.

ELECTRIC TRAMWAYS AND SUBMARINE CABLES.

TO THE EDITOR OF THE ELECTRICIAN.

It is evident that Mr. Hay does not fully understand the conditions under which the tests were carried out, and no doubt the figures drawn by Prof. Jamieson are in some degree misleading, although to those who were present and saw the experiments everything was quite clear. Take Fig. 10, which I maintain represents the actual arrangement of cable at Capetown under discussion. However, as arranged here in the works, the length of sheathed cable, 70ft. long, was bent at the middle, so that the connections from the storage cell or alternator, although 50ft. apart on the sheathing, were actually only 18in. distant from each other. The connections to the sheathing were of twisted twin cable, and further, the ends were joined together and tests made while disconnected from the sheathing, and there was absolutely no effect upon the telephone or galvanometer. Mr. Sayers was present, and made no objection to the arrangement of connections, although he refers afterwards to the possible effect of the battery circuit in his contribution to the discussion. We have always been taught that electromagnetic induction cannot exist within a tube carrying currents, and no doubt theoretically this is correct, provided the tube is a perfect conducting tube, and that there is nothing but space within the tube. Certainly in all our experiments induction did take place in the enclosed conductor. I for one would be glad to see the whole matter fully explained, and as Mr. Hay could so easily make the experiment, it would be worth his while doing so.

He must, however, keep to the actual conditions found in the submarine cable at Capetown, and for myself I see no resemblance between that condition and his suggested explanation, Figs. 1 and 2.—Yours, &c., W. McWHIRTER.

Glasgow, April 3.

BOOKS RECEIVED.

(Copies of any of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price.)

"Pratique Industrielle des Courants Alternatif (Courants Monophasés)." By G. Chevrier. (Paris: G. Carré et C. Naud.) 9fr.

"Wood Turning for Beginners." By the Rev. F. C. Lambert. No. 20 of the Useful Arts Series. Edited by H. Snowden Ward. (London: Dawbard and Ward.) 6d. net.

"The Official Gazette of the United States Patent Office." No. 12. Vol. XC. Published by authority of Congress. (Washington: Government Printing Office.)

"Electric Bells." How to Make and Fit Them. Edited by Paul N. Hasluck. (London: Cassell and Co.) 1s.

"Les Bandages Pneumatiques et la Résistance au Roulement," by B. de Mauni. (Paris: V. C. Dunod.) 2fr.

"Science Abstracts." No. 3, Vol. III. (London: E. and F. N. Spon.) 2s.

* Pellat, "Séances de la Société Française de Physique, 1899," 1er Fascicule, p. 21.

† Blake, *Wiedemann's Annalen*, Vol. XIX., 1883, p. 518.

LEGAL INTELLIGENCE.

Eastern and South African Telegraph Co. v. The Cape Town Tramway Companies.

The evidence in this action (heard in the Supreme Court at Cape Town, before Chief Justice the Right Hon. Sir J. H. de Villiers, the Hon. Mr. Justice Buchanan, and the Hon. Mr. Justice Lawrence) was given in our issue for March 16th, as well as a brief reference to the judgment of the Court in favour of the defendants, and the announcement that the plaintiff company had decided to appeal. Following are the arguments of counsel.

The ATTORNEY-GENERAL, for plaintiff, said it was common cause that the plaintiff company had been damaged through the use by the defendants of electricity as a power to work their tramway system. One most important question for their lordships to decide was the construction of the clause in the enabling Acts of the tramway company, under which they undertook to reimburse and make good any loss or damage caused to any public body or person "in the event of any electric leak taking place," and injury thereby resulting, "electrolysis or otherwise."

The CHIEF JUSTICE: But you have put in "electric leak."

The ATTORNEY-GENERAL: Yes, and I shall give my authority for this. I do not see anything in principle in the case of "Fletcher v. Rylands" which is antagonistic to the principle of the old Roman-Dutch law. In the High Court of Griqualand West the principle was put directly with regard to an escape of water from one mine to another mine. This principle is a sound one. We say we are lawfully there. We have laid our cable at the bottom of the sea under powers given us by Government, and we say that the defendants have brought electricity on to their property—a most dangerous force—and if that force escapes, even although there be no negligence on the part of defendants, and, escaping, does does damage to us, they are liable for it on the principle stated in "Fletcher v. Rylands." Your lordship said just now that I wished to add to that judgment the words electric fluid as one of the escaping things that might do harm. Fortunately for me these words have been added to the judgment in that case, and even more recently. The action to which I refer is that of the "National Telephone Co. v. Baker," and on several points this is analogous to the present action. The defendants represented the tramways in the town of Leeds (England), which had been laid under statutory authority. The rails were used for the return current. The Telephone Co. used the earth for their return instead of bringing the current back by a metallic conductor. Their telephones were injuriously affected by the current which escaped from the tram rails and an action was brought for damages. Mr. Justice Kekewich, in this action, laid down a principle which seems to have been accepted as sound, and there has been no appeal from it. Subsequent to that decision a parliamentary joint committee was appointed to inquire into the question of the advisability of allowing tramway companies to use uninsulated rails for their return currents. In Mr. Justice Kekewich's judgment it is laid down perfectly clearly that a case of this kind is brought within the principle laid down in "Fletcher v. Rylands." It is therefore clear that if any person brings on to his property electric power, which is known to be mischievous, and if this electric power escapes, even if there be no negligence, if it does damage to any person, that person has cause of action.

Mr. Justice LAURENCE: What was held was that the tramway company were protected from liability.

The ATTOREY-GENERAL: Under the statute, yes. What I say is that Mr. Justice Kekewich's argument seems to me a very strong one—that he could make no distinction between electric power and any other escaping force.

Mr. Justice BUCHANAN: And you adopt his argument to-day?

The ATTORNEY-GENERAL: To the fullest extent, where he says that there is liability for the escape of anything which is known to be dangerous and mischievous if it escapes after he has brought it on to his land for his own purpose. That was accepted as a prinicple at common law, and it was very relevant in the present case, because as to one section of their tramways (that between the Toll Bar and Mowbray Hill) the defendant companies had constructed and were working that length without statutory authority, and they were therefore responsible under common law, whilst as to the other sections of their system they were, he held, liable by the section to which he had referred.

The CHIEF JUSTICE: As you refer to that portion of the line which is on your statement worked without statutory powers, I should like to say that there is no evidence that if worked by itself and leakage had ensued, any damage would have been caused.

The ATTORNEY-GENERAL (continuing his argument): Oh, yes, one of the chief witnesses for the defendant companies had admitted that if only the one section of line (that between the Toll Bar and Mowbray Hill) were being used, it would affect the cable, and a twin-core cable of at least a mile in length would be necessary to be laid in order to obviate the electric disturbances of which the plaintiff company complained, and which had so seriously interfered with the working of their business. A good deal would depend on the way in which the Court construed those words "by electrolysis or otherwise"; but his contention was that they should be taken in their widest sense, as was the rule in practice nowadays, and construed as if the Legislature had meant them to cover every possible injury that could arise from the escape of electricity from the rails employed to return the current to the generating station. It was clear that the Legislature intended the words to have as general an application as possible; otherwise they intended that the company should only be liable for damage caused by electrolysis, which was a thing *sui generis*. In

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several cases in England, especially in "Anderson *v.* Anderson," it was laid down positively that general words following specific words in a clause should be read in the most general sense. The liability clause in the statutes made the class of person to be protected as wide as possible, and he held there was absolutely no reason to believe that the Legislature intended the words "or otherwise" to have any limited meaning such as was claimed by the other side. Another question of great importance was whether this escape of electric current through the rails was an electric leak for which the companies would be liable, and he contended that, no matter how scientific men would speak of it, to the ordinary man and to the Legislature this escape of current from the rails into the earth was a leak. Mr. Jacob in his evidence condemned the use of the word, but it was commonly employed by Lord Kelvin, the late Dr. John Hopkinson, Major Cardew (the late electrical adviser to the Board of Trade), and many other eminent men. It was known that a certain amount of current was likely to escape, and all the Legislature said was: "We do not know what damage you may do, we do not know how much current may escape, but you must give an undertaking, in consideration of the large powers we give you, that you will be liable for any damage caused by the electric current escaping from the rails." That is the construction we place on the sections of the tramway companies' enabling Acts, and that construction merely places upon these companies exactly the same liability for damage as would be placed upon them under common law. After all, they are private Acts; they are merely in the nature of contracts between the promoters and the public, and the only compensation the public could get under these Acts from the promoters is, as we construe the Act, that, in the event of any damage being done by an escape of electricity from their system, the companies will be responsible for that damage. His learned friend (Mr. Innes) said they were going to put a very limited construction on two or three words of these sections. These were the words "electrolysis or otherwise," and they were also going to put a limited construction on the word "leak." If this construction was correct, he failed to see what was the use of getting the special undertaking from the tramway company, because he would ask them then to be liable only for the damage which takes place in a certain way—that is, damage caused by a process called electrolysis. It was common cause that electrolysis was *sui generis*, and if they give the words "or otherwise" the narrowest construction, they might as well strike out the section altogether, because there was nothing else to cause damage.

The CHIEF JUSTICE: Fusion is a possibility.

The ATTORNEY-GENERAL: But no one contemplates that for one moment.

Mr. Justice LAURENCE: With such a subject as electricity something might occur which you could not call electrolysis, and yet which might be analogous.

The ATTORNEY-GENERAL: I think it is far more reasonable that the words "or otherwise" were put in to give them the most general application, because the Legislature did not know what particular damage was going to be done.

The CHIEF JUSTICE: Then why insert electrolysis? Why not say any damage which shall be done?

The ATTORNEY-GENERAL: We have several Acts of Parliament where the Court has given the widest possible application to these general words, and where the same argument has been applied as to why the Legislature did not insert specific words. If defendants' construction was correct, then the Legislature intended that this company should only be liable for the damage caused by electrolysis, and the only persons who would benefit by that at all would be the Town Councils and the water companies, because they would be the owners of the only kind of thing that could be injured by electrolysis—that was, gas and water pipes. But the unfortunate owners of telephone or telegraph wires, who would be injured in a different way to electrolysis, they would have no remedy whatever under this section, because their damage could not classed as electrolysis. If it was possible for the Court to put a wider construction on that section, the Court would put the wider construction on it, so as to make the companies liable for damage not confined to electrolysis. This was the only section of the Act which gave any compensation whatever to any persons who are likely to be injured by this dangerous power which is brought upon the tramways, and therefore the Court ought to put a liberal construction on any section of the Act whereby compensation is intended to be given. As a matter of fact, the preamble of the Act said that this was a contract entered into between the promoters and the Town Council, and he dared say the Town Council put in that word electrolysis because that would be the only mode in which their gas pipes and water mains could be injured.

The CHIEF JUSTICE: The impression on the ordinary reader would be that this damage must consist of something physical, something having a physical effect, and not a disturbance at a distance caused by a current which does not damage the wire proper. There is no physical injury by these currents.

The ATTORNEY-GENERAL: That I admit. I admit the injury done to us is not a physical injury at all.

The CHIEF JUSTICE: It is a very remote effect, this influence on the signalling.

The ATTORNEY-GENERAL: At the time the Act was passed it was pretty well known that there would be an escape of electricity, but I do not know that the Legislature knew very much about that. There had been the Joint Committee of the Lords and Commons sitting on the matter, and it was generally known, in the scientific world at all events, that damage was done to telephones and telegraphs and other things by the escape of electricity from the tram rails. The decision in an action, "The Richmond Hill Steamship Co. *v.* the Corporation of the Trinity House," in which the words "other goods" were held to be general goods, was confirmed on appeal; and he contended that those cases, taken in conjunction with what must have been the intention of the Legislature, show that the words "or otherwise" should receive a general construction, and in that case would include any damage caused in any way whatever through the escape of electricity from the tramway rails. As to the meaning of the words "electric leak," the question was, Did the escape of this electric current in the way in which it had been described to the Court come within the meaning of "electric leak"? That was rather a question for electrical engineers, but while it was perfectly true they might have an escape of electricity from an overhead wire, that was not likely to cause electrolysis—to the same extent, at all events, as an escape of electricity from the tram rails. The escape of electricity from overhead wires was a thing that rarely occurred, and if it happened they did not get electrolysis. There was therefore no necessity for the Legislature to merely provide against a leak from an overhead wire. It would be far more likely that the Legislature would protect people against the escape of electric currents from the rails than from an overhead wire. The ordinary man, speaking of this escape of electricity from the rails, would call it a leak. He would say: "Here is a metal conductor which is intended to convey the return current back to the generating station. It is intended to convey as much as possible of the return current, and whatever portion of that current gets away from this conductor, which is intended to convey it back, will be spoken of as a leak!" Mr. Jacob said he would not be surprised at an ordinary individual speaking of an escape of electricity from the rails as a leak, but he would be surprised to hear electrical engineers speaking of it in such a way. But Major Cardew, a gentleman who has had large experience in these matters, who advises the Board of Trade and drafts the Board of Trade regulations with regard to tramways worked by electricity, speaks of this escape as a leak. Lord Kelvin, the late Dr. Hopkinson, Sir William Preece, Mr. Crompton, and others, in the discussion before the Joint Committee of the Houses of Lords and Commons, commonly referred to this escaping electric current as leakage. Mr. Wilkinson, also of large experience in these matters, and who has spent a considerable time in America in the study of electric tramways, says that, as an electrical engineer, he would have no hesitation in speaking of these currents as leakages. Then we have the Paper of Mr. A. P. Trotter before the Institution of Electrical Engineers. One would have supposed that Mr. Trotter, who was for years the Government electrician to the Cape, would be most exact in his language. In a report to the Postmaster-General he uses this very term leakage. It was not necessary for him, as an expert, to strain language at all so as to bring it within the comprehension of those whom he was addressing, or to brin it within this section. He was reporting to the Government on what had occurred here, and, as an electrical engineer, he uses language that he knows is familiar to electrical engineers. He there uses the term leakage in reference to these currents. In the discussion on Mr. Trotter's Paper by scientific men there was not a single scientific man who joined in that discussion who found fault with the language used by Mr. Trotter, and not one pointed out that this was not leakage, or found some other name for the escape of current. In fact, some scientific men concurred with him in calling it leakage. You have on the other side witnesses who gave evidence in the case, and who wished the Court to come to the conclusion that an escape of electricity through the rails cannot possibly be called a leakage within the meaning of the section. The Attorney-General then dealt with the question of damages. He said Defendants contend that we ought to have sustained no damage at all, because we ought to have had the shore end of our cable twin-core. If that be so, when this system was invented in 1886 we ought to have changed our system here and put a twin-core cable on our shore end. At all events, they say this: that as soon as the tramway company started operations we ought to have provided a twin-core cable for our shore end, and that if we had done so we should have sustained no damage. I wish to point out that the system which we now use—the single-core cable—is a system which is used generally. The only people who do not use that system are people who have cables laid by Messrs. Siemens Bros. and Co. It is not clear for what object Messrs. Siemens Bros. and Co. provide a twin-core cable: Mr. Jacob says it is to obviate disturbance, but he could not quote a single case in which their cables had been disturbed by currents escaping from an electric tram. He could only refer to the case of Coney Island, and as far as Coney Island is concerned it is clear that one other company whose cable is alongside to that of the company for which Messrs. Siemens provided a twin-core cable had no twin-core.

The CHIEF JUSTICE: It is admitted now that the twin-core cable is the perfect cure: that was known: and was it not your duty to have put it on for a distance of two miles as soon as your instruments were interfered with?

The ATTORNEY-GENERAL: As soon as the tramway company started operations Mr. Jacob says we ought to have known at once what length of twin-core cable was required. We were obliged to perform certain experiments, and to find out exactly what the area of disturbance was, before we could provide a twin-core cable. I am taking up the position that they cannot say that we have no claim for damages because when they started operations we did not provide a twin-core cable. And we say that we are entitled to a twin-core cable to the length of 10 miles. We have come to that conclusion, my lord, after experience. They say that by means of a wonderful mathematical formula of Mr. Jacob's we are only entitled to a two-mile length. We have come to this conclusion in regard to a 10 mile cable on facts, and we are satisfied that the disturbances necessitate our having a 10 mile cable. In January, 1897, a five-mile cable was laid out to sea, and after putting down that five-mile cable the disturbances were almost eliminated. But as the tramway system extended and as the traffic increased we felt the disturbances more, even with the five-mile cable. Now if Mr. Jacob is right in his theory, never mind how far the system extended after January, 1897, we were with this five-mile cable as secure after the extension of the system and after the traffic increased as we were before. And yet defendants say a two-mile twin-core cable would be sufficient. If

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so why was it that in January, 1897, we found that the five-mile cable was not sufficient to eliminate the disturbances. Mr. Jacob gets over that by saying that the five-mile cable was shifted, but before the date when it was repaired in June, 1897, the disturbances had increased, and according to Mr. Jacob's rule we ought to have been as safe from disturbances with the five-mile cable as we were with the ten-mile cable. Then, the five-mile cable not working satisfactorily, we put in a ten-mile cable. The ten-mile cable gave us almost absolute relief. What is the reason of that unless the disturbances extended beyond five miles? Here we have the plain fact that after we found the five-mile cable did not assist us we put in a ten-mile cable and that ten-mile cable made the disturbance less.

The CHIEF JUSTICE: But, as I understand Mr. Jacob's evidence, he admits that the disturbances go beyond two miles, but he says the disturbances will not have any effect on the signals if you have a twin-core cable.

The ATTORNEY-GENERAL: I say our experience is entirely different. I say you have the same conditions exactly with the ten-mile cable as you have when the five and the ten-mile cable improved matters vastly, which showed at all events that the protection beyond the ten-mile cable was a protection beyond five-mile cable. Putting down the ten-mile cable was extending the five-mile cable to another five miles. Now it is clear that if we had extended the five-mile cable for another five miles it would have given us a far better protection. Surely that shows that the disturbances came from a distance beyond the five miles. According to Mr. Jacob it really does not matter what the conditions are when the disturbance takes place. Here is this infallible rule of three which tells you exactly what distance you must take out the twin core cable. Mr. Jacob has never made any experiments to test whether this mathematical equation which he puts before the Court is accurate or not. He has been out here for a long time, and has had ample opportunity for testing its accuracy. Mr. Jacob himself points out a way by which it might be ascertained with certainty by experiments. He has been here for two or three weeks doing nothing, and one would have supposed that the first thing he would have done would have been to test by experiment whether this mathematical equation of his was correct or not. He says that he does not require to go to a place, a plan is quite sufficient. On no occasion has he ever experimented to find whether this rule which he lays down to find the length of a twin-core cable is correct, or not. He says he went out to the plaintiff company's station and saw the disturbances on the signals on a Saturday afternoon, and he takes a hundredth part as a fixed quantity and says that not one-hundredth part of the disturbance would have been felt at the receiving station. But what I find is this: he takes a sectional area of the wire but does not take a sectional area of the sea water at all. He finds out the superficial area of a hollow cylinder of water around the cable for a length of two miles, and he says because the superficial area of this hollow cylinder of water is so much, therefore the current of electricity will prefer that to the sheathing of the cable. But he does not take the sectional area of the sea water. He treats the sea water as merely a hollow cylinder of water surrounding this conductor. According to his calculation depth of sea water has nothing to do with it at all. It would be the same thing if you simply had right through the bay a depth of water of 2ft., ignoring the great depth of ocean and merely having a shallow pool of water which is to cover this conductor. He starts by saying that the resistance varies inversely to the sectional area, and he takes the sectional area of the conductor, but he does not take the sectional area of the sea water at all. It is clear that Mr. Jacob does not take into account the depth of sea water.

The CHIEF JUSTICE: I suggest that you should come to an arrangement as to what the damages should be, because we are in doubt as to what distance the twin-core cable would be required. It is impossible for the Court to say definitely what is required. Could not the parties agree upon a distance, say four or five miles, in case the Court holds that damages are payable?

Mr. SOLOMON said that Mr. H. D. Wilkinson (on behalf of the plaintiffs) was quite prepared to demonstrate to Mr. Jacob that disturbances were felt at a distance of 10 miles.

The CHIEF JUSTICE suggested that the sum of £10,000 should be accepted by both sides.

Mr. INNES said he had no instructions, and could therefore not agree to the suggestion. He took up this position on the definite statement of Mr. Jacobs that a twin-core cable could be laid for £2,000.

The CHIEF JUSTICE: There is no sum, then, that you are prepared to suggest?

Mr. INNES: Not without consultation.

Mr. SOLOMON said that in regard to damages for loss of business by the plaintiffs he would suggest £5,000 as a very moderate figure.

The CHIEF JUSTICE: The Court would accept £6,000 for the laying of the cable.

The ATTORNEY GENERAL: Then with regard to the loss of business?

The CHIEF JUSTICE: I thought perhaps a compromise might be effected with regard to the final decision. It could not affect the question of liability.

Mr. Justice LAURENCE: What do you suggest as the loss of business?

The ATTORNEY GENERAL: I suggest a moderate figure, £5,000. That is a very moderate estimate of the loss we have sustained. I do not wish to go further into the question of damages.

As no agreement was come to,

Mr. INNES addressed the Court for defendants, and dealt with the sections of the Acts under which the tramway companies worked, and particularly with sec. 4 of the Act 22 of 1895 and sec. 4 of the Act 26 of 1896—the Metropolitan and Southern Suburbs Tramways Acts. The plaintiffs, he said, were alleging what was not seriously denied at all, that the effect of the electricity used on defendants' lines interfered with the use of their cable, and they claimed damages on two grounds. He took it the claim for interdict was not pressed, and it was therefore merely a question of damages, which were claimed on two grounds. The first was the most important—that defendants were liable under their own statutes. As to the second, relying on the statute with regard to the main portion of the companies' lines, plaintiffs would rely on the common law in regard to the bit between the Toll Bar and Mowbray. It was quite clear that there was no question of negligence in the case. He held that to make defendants liable for damages, as was now sought, there must be an electric leakage, and that, concurrently, damage must be caused by that leakage. The mere escape of electricity from the rails was a thing normal, unavoidable, and contemplated by the Legislature. That was not leakage, because a leak, from the expert evidence given both at Capetown and in London, was such a thing as could be remedied: it was something abnormal, not inseparable from the transmission of electricity. The drawing of a wet string of a kite across a trolley wire and connecting it with a telephone wire would be such a leak, but not the natural escape of current by way of the earth. A leak was something you could stop and which was not contemplated when you made the conductor. But when it escaped in an inevitable way, and in a manner provided for by the people who made it, that was not a leak. If his learned friend's construction were correct the word leak would include an escape from the trolley wire and the rails, for he (Mr. Innes) knew of none other for practical purposes, and if the company were liable for every escape there was no need for the proviso as to electrolysis or otherwise. But his learned friend also said that if the escape from the rails was not a leak then the section was almost meaningless, because there was so little else—electrolysis could hardly take place in any other way. He thought that was a fair way to put his learned friend's statement. Theoretically it could take place from the trolley wire, but practically the escape from the rails was the way in which damage would be chiefly done by electrolysis, and there would be no remedy for damage done by electrolysis from the tramway rails. It was impossible to place on the words of the sections of the Acts to which he had referred the wide interpretation urged by the learned Attorney-General, as the Legislature clearly foresaw that damage might arise to gas and water pipes through electrolysis, and granted protection to road and local authorities accordingly; but in subsequent sections it also made the companies liable for any loss, damage, or expenses to which any public body or company or person might be put by reason of electrolysis, no matter how caused, or any neglect or default on the part of the company or its servants. What was the object of inserting that section if the Legislature meant to deal with the whole subject of damage by electrolysis in sec. 4? That section was obviously so constructed as to guard against damage caused by leakage from the trolley wire in an accidental and unavoidable manner, and had no reference to the escape of current from the rails.

The CHIEF JUSTICE: I have been looking at several dictionaries. I find that the original meaning of the word "leak" in Johnson is a crack, crevice, or aperture. The first meaning of the word is given as a "crack, crevice, or fissure that permits water or other fluid to escape." A second meaning is "the oozing or passing of water through a crack, fissure, or aperture."

Mr. INNES: Which is exactly my contention. There must be a crack, fissure, or aperture; there must be a defect in the conducting channel. I would put it in another way, speaking, one may say, electrically. You can only talk of a leak in regard to an insulated conductor; and it is dangerous and impracticable to use the rails as insulated conductors. That is what Mr. Jacob said. And Mr. Wilkinson also admits it would be impossible. Therefore, I contend, it was the intention of the Legislature that these rails should be uninsulated, because it would be impracticable and dangerous to make them insulated. There is one thing to which I should like to refer the Court, as I submit it materially strengthens my argument. That is, the terms of the Government regulations I put in, I think, in the cross-examination of Mr. Wilkinson. These are the regulations passed by the Government, doubtless under the advice of the Government electricians, and the act under which they are passed is the Electric Lighting and Power Act of 1895. They are, as I understand, mainly on the lines of the regulations adopted by the Board of Trade. Mr. Wilkinson very accurately gives the respects in which these regulations differ from the Board of Trade regulations in England. Regulation 7 deals with the escape from the rail to the earth.

Mr. Justice BUCHANAN: It does not say that when the rails are used for the return current they may not be insulated; it says they may be, and when they are insulated there is no leakage.

Mr. INNES: But it would be dangerous. As Mr. Jacob pointed out, if a horse stepped on to that insulated rail it would be killed, and if the iron-tyred wheel of a cart touched the rail it would receive the whole potential. Of course the rails might be entirely insulated by the use of glass or some other non-conducting material, but contact with the iron tyre of a cart would send the whole current to earth. It could not be done, and Mr. Wilkinson admits that. Regulation 7 deals, I wish the Court to observe, with the escape of current through the rails to the earth. "Where the return is partly or entirely insulated the inspector shall make a periodical test of the differences of potential," and so on. That is the way in which they deal with the escape of current from the rails. They say it shall in no case exceed a certain amount of units of pressure, and if it does steps shall be taken at once to reduce it. That may be done either by a booster, as these companies have done, and setting back the current along the rails, or by having more generating stations, sub-stations at various points of the line, and dividing the line into sections and applying your power to the trolley wire at various points, because the pressure is always greatest at the furthest end, and therefore you can diminish it by having more stations. That would be very expensive, and therefore we are allowed to attain the same

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end by boosters. But the important point is contained in Regulation 10, which deals with leakage of the current from the trolley-wire. This deals in two ways with the escape of current—one from the rails, and the other from the trolley wires. The escape must be minimised as far as possible. When it is from the wire, if it exceeds a very small amount, it is to be localised; you must go to some portion of this wire and find out where the abnormal condition of things exists in this wire, and where the extra amount of current is escaping. That is called a leak.

The CHIEF JUSTICE: Supposing there is a leak from the trolley wire, how does it manifest itself?

Mr. INNES: That might happen. I suppose there is some instrument or some means of measuring the whole of the infinitesimal leakages that might be going on. I am informed that they can tell at the station at once.

The CHIEF JUSTICE: How does it show itself? I mean practically. Would it show at the station where the leak is? Could they tell whether it was at one point or another, or whether it is a gradual escape?

Mr. INNES: It is theoretically possible to absolutely insulate the trolley wire, but there may be minute defects which might allow a small but not dangerous leak.

The CHIEF JUSTICE: But is that by contact with a wet string, or anything of that kind? The Legislature has wished to guard against some injury. I want an illustration of a leak from the trolley wire by which injury can be done.

Mr. INNES: I will take the biggest leak of all, which would be localised at once. That is, the breaking of the trolley wire. Supposing it snaps and falls on a telephone wire; it sends the whole force of the current along the telephone wire. If there is no fuse ready fitted to melt at the end of the telephone wire, that current will injure the instrument, and perhaps the person at the instrument.

The CHIEF JUSTICE: Would the Legislature call that a leak?

Mr. INNES: Oh yes; certainly that would be a leak.

The CHIEF JUSTICE: I am in doubt still whether the Legislature would call that leakage. I can understand some other wire getting in contact with the trolley wire.

Mr. INNES: That is the next case I was going to put. If a wire got in contact with the trolley wire, and at the point of contact there was some defect in the insulation, then the trolley wire would impart its current on to the other wire. Or, suppose that the trolley wire, at the place where it is suspended between the posts, had some defect or break in the insulation; a large portion of the current would pass down the post into the earth, and might cause great danger by way of fusion or electrolysis. Or, take another instance. Supposing the trolley wire is passing a gas lamp, and, if the insulation is imperfect, touched that lamp; it would fuse the gas pipe, and might probably cause an explosion. Evidently the trolley wires carry a very strong current, and it is necessary for the public safety that it should be kept absolutely insulated as far as practicable. The Legislature have gone a long way in saying that if there is an escape of only $\frac{1}{10}$th of an ampere the company shall localise and find out where that leak is and put it right.

Mr. Justice BUCHANAN: I understand the trolley wire is insulated throughout its entire length?

Mr. INNES: Yes; it is suspended between poles by a wire fitted with special insulators at each point of suspension.

Mr. Justice BUCHANAN: But that is only an insulation between each pole; it is not an insulation of the whole trolley wire.

Mr. INNES: If anything goes wrong the current comes down the pole.

Mr. Justice LAURENCE: Then does your contention go so far as to say that the word leak cannot refer to an escape from an uninsulated rail?

Mr. INNES: That is my contention, that "any leak" can under no circumstances refer to an escape from an uninsulated rail.

The CHIEF JUSTICE: Supposing a copper wire were attached to a rail, and the current conveyed thereby in no way damaged any metal; would not that be a leakage for which they would be liable in the same way as there might be a wire connected with the trolley wire, and which causes a leak? Might there not be a wire attached to the rail which would cause a leak?

Mr. INNES: In theory, yes; but it would not be very likely to occur perhaps, therefore I ought to modify my answer to Mr. Justice Laurence to that extent; but I still say that in speaking of a leak electricians would really speak of a defect in an insulated return. That is my first condition. If the Court is against me there, at any rate I say it does not mean a continuous escape all along the line, which the Legislature contemplated should take place.

Mr. Justice BUCHANAN: I quite follow your argument. For a wire to touch the return is something so very unlikely as not to be considered.

Mr. INNES: Then we come to consider the next point; that even if there were a leak, has damage been caused thereby "by electrolysis or otherwise"? Shortly, we contend that the doctrine *ejusdem generis* should be applied to the construction of the words "or otherwise," for that is a doctrine which has not entirely disappeared, I think, from the ordinary canons of legal construction.

Mr. Justice BUCHANAN: If your argument is sound, it can only be damage done "otherwise" than by an electric leak?

Mr. INNES: That is the dilemma; in fact, the word "electrolysis" need not have been used at all. So, in the cases of deeds and Acts of Parliament, the great thing is to find out from the document what really the Legislature or the person who subscribed to the document meant. And, applying that rule to these sections, we find the whole of section 4 of the tramway companies' Acts is dealing with material things, with the construction of works, the erection of poles, the placing of underground wires, and so on; and it proceeds to deal, as we contend, with physical injury caused by such works, because it says "damage caused thereby." That is hardly an expression that the Legislature would have used if they had meant some damage other than that in the ordinary sense, some injury done to some material in the neighbourhood, some physical lesion to something material. They never contemplated an interference by induction with something a long way off, say the transmission of signals along a certain electric cable.

Mr. Justice BUCHANAN: There is no damage done, you argue?

Mr. INNES: There is no damage; there is interference with signals, but there is no physical injury to the thing.

Mr. Justice BUCHANAN: They suffered damage by the interference.

Mr. INNES: Probably in a legal sense it may be an *injuria*, but there is no physical lesion of any of their property; there is no material harm done. There is much significance in the use of the word "electrolysis," which is the only species of injury hinted at before you come to the words "or otherwise." What is electrolysis? It is just a physical injury caused to a material substance by certain chemical action. It is an injury caused by conduction, and yet the Court is now asked to extend the words "or otherwise" to the disturbances of signals by induction, not conduction. I submit that is giving much too wide an interpretation to the words "or otherwise." If the Legislature had meant that, what is the use of the word electrolysis at all? Evidently there were two companies, the electric lighting company and the Cape District Waterworks Co., who were not satisfied either with the provisions of section 4 or section 16 of the tramway company's Act, because in section 41 they got special protection. That includes, I submit, the working of the tramways as well as the making of the works before they started. I do not know why the plaintiff company did not oppose the bill, but if they had meant to take up the position which the electric lighting company evidently did take up, they would have put a clause in saying that if the operation of this Act, or the works of the company, rendered it necessary to make any alterations to their cables or any other plant of theirs, it would be done at the expense of the tramway company. But they did not do that, although the electric lighting company did.

The ATTORNEY-GENERAL having replied, the Court adjourned.

[The Judgment will be given in our next issue.—ED. *E.*]

Goldberg and Sons (Ltd.) v. Liverpool Corporation.

This action was heard in the Court of Appeal on Monday, before the Master of the Rolls, Sir Francis Jeune, and Lord Justice Rigby, being an appeal by defendants from an order of the Vice-Chancellor of the County Palatine Court of Lancaster.

Mr. NEVILLE, Q.C., said the appeal was with regard to the right of the Corporation of Liverpool to put a post for electric wires together with a fuse box, in a position which plaintiffs said was inconvenient to them at their Paradise-street premises. The defendants owned and worked the tramways in the city. Recently they had undertaken the introduction of electric trams in place of horse-drawn cars. Under the Liverpool Corporation Tramways Act of 1897 the Corporation had power to adapt the tramways and streets for the purposes of mechanical traction. There was also a provisional order which incorporated parts of the Act of 1897.

The MASTER OF THE ROLLS: Is there anything in the provisional order which cuts down the operative clauses of the Act of 1897?—That was to be argued.

Lord Justice RIGBY: Were these tramlines in Paradise-street before the date of the provisional order?—No; but a line along this street was found a necessary deviation for the purpose of working the electric system with safety and convenience.

Lord Justice RIGBY: Then does the Act apply? There does not seem to have been any tramways there to adapt.—In the interpretation clause of the Act of 1897 the expression the tramways includes the tramway lines existing and any other tramway lines which may hereafter be constructed and worked by the Corporation.

Proceeding, counsel said the wires carrying the current might either be supported by centre poles of T shape, or by span wires carried by side posts planted in the pavement, or by means of rosettes affixed to the buildings on either side of the street. Rosettes could only be fixed by consent of the owners of the buildings, and in consideration a nominal rent of 5s. was paid. The span wire system was decided upon by the Tramways committee for Paradise-street, and a circular was issued to the owners of property in the street asking for their permission to affix rosettes to the buildings.

Lord Justice RIGBY: The posts are only wanted in default of permission to affix rosettes?—Yes. In this particular case the engineers decided that where poles had to be placed in Paradise-street they must be put as near the building line as possible. In reply to the circular he had mentioned Messrs. Goldberg would not give their consent to a rosette, and a post therefore became necessary at that point.

Lord Justice RIGBY: Is Goldberg's a retail business?—No, wholesale. After the pole was finally in position Messrs. Goldberg complained of inconvenience and trouble to their customers as well as to themselves. Messrs. Goldberg seemed to have got the idea into their heads that the erection of the pole at this particular point was a method adopted by the Corporation to punish them for their contumacy in not allowing a rosette to be fixed to their premises, but there was no ground for any such idea. The pole could not be placed in any other position, and there was no alternative. The case was one of very considerable importance to the poration, as, if they were compelled to remove this post, they would have Cornumerous actions brought by people who might consider themselves inconvenienced by having these poles erected in front of their premises. If the Vice-Chancellor was right in thinking that the proper way to deal with the case was to consider expert evidence on the one side and on the other, and finally to decide what in his opinion was the best possible position for the pole, then it opened up a vista of interminable litigation. The Corporation did everything possible to consult the convenience of the frontagers with due regard to the convenience of the public and the proper working of the tramway system. The real question, he submitted, in this case was whether any court could interfere with a discretion possessed by the Corporation and exercised in a bona fide way.

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The MASTER OF THE ROLLS said a difficulty seemed to arise on the last words of the judgment. The learned judge seemed to have come to the conclusion that what the defendants had done was perverse and vexatious. They did not seem to have taken the trouble to ascertain whether there was not a more convenient place for this post.

Sir FRANCIS JEUNE: When the Corporation made up their minds to accept the advice of engineers, had they made any investigation as to the real facts?

Mr. NEVILLE: The question of the method in which the engineers who advised the Corporation arrived at the conclusions which induced them to give the advice they did was, he urged, not a proper subject matter for inquiry before the Court at all.

Lord Justice RIGBY: Unless it can be shown definitely that they were wrong in their methods.

The MASTER OF THE ROLLS: But, apart from that, are they not bound to exercise their powers in a reasonable manner? If they could have found another position for this post equally convenient to them, could the point have been withheld from a jury?

Mr. NEVILLE said he should submit so. There were a variety of cases upon the point. Where it was a question of the exercise of a discretion committed to the undertakers by Act of Parliament, and that discretion had been exercised honestly, there was no appeal.

The MASTER OF THE ROLLS: They are, I suppose, bound to consider everybody in a reasonable way, and if that was done he did not think the courts would interfere. He quite saw if they went too far they might be turning the court into a tribunal to decide where these posts were to be put.

Mr. NEVILLE said that was what it seemed to him to come to.

Mr. MATTINSON, Q.C., for respondents (the plaintiffs) said that the complaint in the present case did not rest upon the mere fact that the pole was placed on the pavement. The plaintiffs' case rested on the fact that the defendants had placed a pole with a fuse box in combination immediately in front of their main business entrance, so near and under such circumstances as constituted, in the opinion of the learned judge who tried the case, a nuisance. If the decision of the Vice-Chancellor was affirmed, there was not the slightest reason to think that the Corporation of Liverpool would be persecuted by other persons who would say that the poles were put in such a position as infringed their rights. A fundamental part of the present case, which he (counsel) thought would distinguish it from a large mass of the authorities on which Mr. Neville relied, was that in the present case it was established that defendants had themselves created the nuisance. That was the first point; and in the next place it would be found that from the nuisance created by defendants plaintiffs had sustained special and particular damage. Was there any statute which *prima facie* justified defendants in doing what they did? The statute relied upon by the defendants was the provisional order of 1898. Although he should not dispute for a moment that the Corporation had full power under various statutes and provisional orders to use the carriageway for the purpose of constructing their tramway, he should contend that they had no power to use the pavement. His contention was that the word "street" used in sec. 36 of the Act of 1897 comprised the carriageway only, but if the word "street" comprised the pavement as well as the carriageway, his argument on this point would not be well founded. Even assuming the defendant Corporation had power to put the poles and fuse boxes on the pavement, he should submit that sec. 36 of the Act only authorised them to erect in any street such poles and fuse boxes as were in fact necessary for the efficient working of the tramway system, the necessity of particular poles and fuse boxes being a question for the Court or experts to determine. In this assumption he must concede that if a nuisance to plaintiffs was a necessary incident to defendants making an efficient tramway, then plaintiffs must submit.

The MASTER OF THE ROLLS: There is no compensation clause, is there?

Mr. MATTINSON: No. Whatever the Corporation was authorised to do was subject to two qualifications, one being that the Corporation should act bona fide, and not from any indirect motive; and the other, that the Corporation should act without negligence; and in this connection negligence had been defined by Lord Blackburn as the "failure to do everything reasonable to prevent damage to the person complaining." He contended that the learned judge had arrived at a correct conclusion, and that the appeal ought to be dismissed.

Mr. NEVILLE, in reply, referred to the suggestion that Mr. Brodie, the engineer, had acted in bad faith in the matter, and that all the transactions complained of followed upon the refusal of Messrs. Goldberg to have a rosette fixed upon their premises. Looking at the facts, he was, he thought, justified in saying that a more unfounded suggestion was never made in a court of justice. If the defendants had got to show that in no other way could they work their tramways except by planting this pole and fuse box in the particular spot they had selected, it was obvious they could have no case at all. He had no doubt there were dozens and dozens of places in which the poles could have been put and yet the tramways be worked with efficiency. They were really beating the wind in arguing this question about the pole being placed in this spot or in that spot. Supposing plaintiffs were right. If the Corporation put the pole in front of a man's house, he could come to them and say that next door would suit their purposes just as well, and that they must put it there. Then the next-door man would come and say that they must not put it there, but they could put it somewhere else. And so things would go on. He submitted that this proposition was entirely wrong in law. The whole point was whether in the opinion of the Corporation this was an expedient place to put it. The judge of that was not the Vice-Chancellor or the experts who were called, but the Corporation themselves; and having exercised their discretion, then the Court would not interfere with them in any way.

The MASTER OF THE ROLLS said he did not think anything could be gained by reserving judgment in this case. The opinion of all of them was that the view taken by the Vice-Chancellor was not correct in point of law. The first thing was to ascertain what powers the defendants had, and the second whether those powers had been bona fide exercised for the purposes for which Parliament had conferred them, and that involved the question which had been very much pressed upon them as to whether the Corporation through their officers had acted bona fide or had acted with the ulterior view of more or less "paying out" the plaintiffs because of their refusal to consent to the affixing of a rosette outside their house. As to the first point, he did not think there was any real difficulty, nor did the Vice-Chancellor think so. There could be no doubt of the defendants' power to make an electric tramway along the street. He could not assent to the argument of Mr Mattinson that the words "any street" in the Act did not apply to the pavement as distinct from the carriageway. There could be no doubt that the powers conferred by sec. 36 were applicable to any street, and that the pavement was part of the street for the purposes of constructing, erecting, laying down, and maintaining in, over, or under its surface such works as might be necessary or expedient for the purpose of adapting the tramway to the use of mechanical power. As to the second point, whether the defendants had acted bona fide in the exercise of their powers, it was obvious that what they had done was for the purpose, and bona fide for the purpose, of adapting this tramway to the use of electric traction. A pole was genuinely wanted for the purpose, and a fuse box was genuinely wanted. It was said that the officers—and especially Mr. Brodie, the engineer of the defendants—had not acted bona fide. He thought Mr. Neville had succeeded in showing that that view could not be sustained. In order to succeed in their contention plaintiffs must make out the essential proposition that there had been an abuse of the power of the Corporation. The Vice-Chancellor had gone into the question of whether a more convenient spot could not have been found for this pole and fuse box, but to his mind that was an inquiry which they ought not to go into. Their duty was to control the Corporation in the exercise of their powers if it could be shown that the Corporation were exercising them in a way which called for interference. He considered that the powers of the Corporation had been bona fide exercised for the purposes of the tramway undertaking, and the Court would not interfere. The appeal would accordingly be allowed and the action dismissed, with costs there and below.

Sir FRANCIS JEUNE and Lord Justice RIGBY concurred.

Gas Companies and Electricity Supply.

In the Chancery Division, last week, before Mr. Justice Stirling, Mr. Freer appeared in support of a petition under the Companies' Memorandum of Association Act, 1890, presented by the Harrington (Cumberland) Gas Light Co. Mr. Freer said the object of the petition was to more clearly define the area within which the company might supply gas, and to acquire fresh powers which would enable it to manufacture and sell residual products and to supply electric current.

Mr. Justice STIRLING said the powers asked for were very wide, and would enable the company to deal with all sorts of illuminants, including electricity. Were the company proposing to carry on an electrical business?

Mr. FREER said the company had been asked to supply electric current.

Mr. Justice STIRLING said he should require further affidavits before granting the petition in so far as it related to electricity and other illuminants. The other powers sought by the petition would be granted.

Strikers and Poor Relief.

In the Chancery Division recently, Mr. Justice Stirling gave judgment in the case of Attorney-General *v.* Guardians of the Poor of Bedwelty Union. The case arose out of the South Wales coal strike in 1898, when defendants gave poor relief to able-bodied colliers who were out on strike, and the point raised was whether the Guardians could legally relieve such persons when they were offered but refused work at a remuneration which was sufficient for the support of themselves and their families. The Guardians alleged they had opened stoneyards with the authority of the Local Government Board first obtained, that they had such authority also for the kinds of task to be imposed and the relief to be given. The relief was afforded after due inquiry in each case, and only to cases of absolute destitution, and defendants contended that in such cases, no matter what the cause, the law compelled them to give relief.

Mr. Justice Stirling gave judgment for the plaintiffs with costs in so far as the plaintiffs asked for a declaration that the relief given was illegal, but without costs on the point that the plaintiffs asked for an injunction to restrain the making of the payments, as that part of the relief asked by the statement of claim was abandoned. The decision of the Court of Appeal in the Merthyr Tydvil case was binding upon him (Mr. Justice Stirling). It was proved before him that defendants applied the poor rates to the relief of able-bodied men sufficiently well able to work, and this continued for seven weeks and more at the commencement of the strike, and afterwards in July, 1898. The owners of certain pits gave public notice of their willingness to give work at not less than 4s. a day. The offers were well known to all concerned, workmen and Guardians alike. On these facts he came to the conclusion that the able-bodied workmen could have obtained work at remunerative wages, and therefore the case came within the decision of the Court of Appeal, and he should make a similar order to that made in the Merthyr Tydvil case.

Attorney-General v. National Telephone Co. (Ltd.).

This case, particulars of which were given in our issue of 23rd ult., was fixed for hearing yesterday (Thursday), but, by arrangement, will be taken to-day (Friday),

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PARLIAMENTARY INTELLIGENCE.

TIME OCCUPIED IN TRANSMISSION OF TELEGRAMS.

In the House of Commons yesterday (Thursday) Mr. CHARLES M'ARTHUR asked the Secretary to the Treasury (representing the Postmaster-General) whether he was aware that although direct cables have been established between Liverpool and Havre and Liverpool and Hamburg, telegrams between those cities still take at least nearly an hour in transmission and delivery; that cablegrams between the Liverpool and New York Cotton Exchanges are sent and replies received within a few minutes, and that messages despatched daily via the United States to Bremen reach that city an hour earlier than messages sent to the same place from the Liverpool post office by British wire; that the arrangement proposed by him for telephoning cablegrams after business hours through the Exchange post office is insufficient for the requirements of the cotton trade, especially during the cotton season, and that nothing short of direct telephonic communication between the cable companies and their clients will meet the exigencies of the case; and, whether, in view of the importance to commerce of quick telegraphic communication between Liverpool, the Continent, and the United States by reason of the limited duration of market hours and of the increasing diversion of business from Liverpool owing to the lack of telegraphic facilities, the best efforts of the Post Office will be exerted to remove insufficiencies in the present system to which their attention has been frequently called.

Mr. HANBURY said: Under normal conditions the time occupied in the transmission of telegrams between Liverpool and Havre and between Liverpool and Hamburg is about 25 minutes in the one case and 35 minutes in the other. The Post Office has no information as to the time occupied in delivery abroad. Any telegram sent between Liverpool and Bremen by way of the United States would not pass through the Post Office, and the Post Office has no knowledge of the time occupied in transmission as compared with the ordinary route. The cable company could not adopt the route via America consistently with its arrangements with the Administrations concerned. It is hoped that the arrangement recently made for the telephoning of telegrams after business hours through the Exchange post office will be found to answer the requirements of the case; at all events, it is thought that the arrangement should have a trial. At present no great use appears to be made of it, as the number of messages does not exceed an average of six per diem. The Postmaster-General is alive to the importance of efficient telegraphic facilities between Liverpool and the Continent, and measures for improving the communication between this country and the Continent are under discussion between the Post Office and the Treasury.

HAMILTON, MOTHERWELL, AND WISHAW TRAMWAYS BILL.

This bill was before the Select Committee of the House of Commons, presided over by Mr. Jeffreys, last week. The object of the measure was to authorise the construction of tramways on the overhead electric trolley system between Blantyre and Wishaw, through the burghs of Hamilton and Motherwell, with a branch to Larkhall, at a cost of £325,000.

In the course of the evidence given for this bill, Mr. J. Stewart, C.E. (Messrs. Warren and Stewart, Glasgow and London), said his firm were engineers to the promotors. The cost of construction in this case was estimated at £150,514, but besides that there was the cost of equipment.

Mr. PHILIP DAWSON, C.E., said there would be no difficulty in establishing electric tramways along the route proposed. The scheme presented no complex engineering problem. The working expenses could not be more than from 4½d. to 5d. per mile. He could not see how the working expenses of an electric tramway could amount to 8d. per mile.

Mr. FORBES LANKESTER, in cross-examining counsel, said he had in his mind a return made to the House of Commons in regard to the Bradford, Dublin, and other tramways where the average cost was 8d. per mile

WITNESS: That is an extremely high sum. I believe this tramway can be worked at from 4d. to 5d. per mile.

Mr. ALBERT R. MONKS, one of the promoters of the bill and managing director of the British Thomson-Houston Co., said the £10 shares of the B.T.H. Co. were worth £18 in the market. Originally it had been proposed to spend £375,000 on the tramway contemplated by this bill, but that amount had now been reduced to £325,000. The promoters would be satisfied with a 6 per cent. yield from this enterprise.

The Committee passed the preamble, with the exception of the part relating to the branch from Hamilton to Larkhall.

DEVONPORT CORPORATION BILL.

This bill was considered by a Select Committee of the House of Commons on Tuesday and Wednesday. The object of the bill is to confer powers in respect to the construction and working of tramways, for extending the powers as to electric lighting and other purposes. The Corporation have exercised the option to purchase the Plymouth, Stonehouse, and Devonport tramways, and they will shortly be the owners of part of the undertaking powers for working which are now sought. It is also desired to obtain authority to use electric or mechanical power on the tramways, and to reconstruct the existing lines. The Corporation also seek power to supply the borough and Stonehouse with electric current for all purposes. The consideration of the bill has been adjourned.

TRADE NOTES AND NOTICES.

[Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.]

NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers, or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London:—

READY.

(Price 12s. 6d., by post, 13s. 3d.; Colonies, 14s.; abroad, 14s. 6d. (United States, 15s.)

"The Electrician" Electrical Trades' Directory and Handbook for 1900 (corrected to January 31st, 1900).—In addition to the well-known features of this Directory and Handbook (all of which have been carefully revised and brought quite up to date) a large addition has been made to the Handbook Division, including a Digest of the Law of the Telegraph and Telephone, for the use of municipalities and companies contemplating applying to the Postmaster-General for a Telephone Licence. This section of the book now includes the new model form of Licence issued by the Postmaster-General in January, the Telegraph Acts and Orders passed by Parliament in 1899, and other information in connection with this the latest development of electrical enterprise. The huge sheet tables of Electric Light and Power and Electric Railway and Tramway undertakings of the United Kingdom have been made complete up to the 31st January. These sheets form a most complete record of electrical engineering progress in connection with electricity supply and power and traction applications. The Directory Division has been carefully extended and corrected up to Feb. 2, and is the most reliable list of firms and persons engaged in the electrical and allied industries ever compiled. A number of additional sketches of the careers of well-known electrical experts have been added to the Biographical Division, together with many new portraits. The new volume is, we claim, the most complete and correct book of its kind ever published in any language. An analytical digest of the contents of this volume can be obtained post free.

"THE ELECTRICIAN" READING CASE.—To hold four numbers of the journal. Strongly bound, 1s. net; post free, 1s. 4d.

"LOCALISATION OF FAULTS IN ELECTRIC LIGHT MAINS."—By F. C. Raphael. Price 5s., post free. The book deals with the important subject of localising faults in electric light and power cables; and the various methods of insulation testing are here collected and discussed.

"WIRELESS TELEGRAPHY: SIGNALLING ACROSS SPACE WITHOUT WIRES BY ELECTRIC WAVES." A Review of the Work of Hertz and his Successors.—By Dr. O. J. Lodge, with a large number of illustrations, bringing this latest application of electrical science quite up to date. New and Enlarged Edition, 5s. nett. *Now ready.*

"PRACTICAL NOTES FOR ELECTRICAL STUDENTS."—By Messrs. A. E. Kennelly and H. D. Wilkinson. Price 6s. 6d., post free. The authors give in a clear and concise manner a good summary of the general principles of electrical science.

"THE INCANDESCENT LAMP AND ITS MANUFACTURE."—By Gilbert S. Ram. Price 7s. 6d., post free. The principles underlying the manufacture of the incandescent lamp are carefully and fully dealt with in this volume.

"THE CENTENARY OF THE ELECTRIC CURRENT, 1799-1899."—By Dr. J. A. Fleming. Price, paper covers, 1s. net, post free 1s. 3d.; strong cloth, 2s. 6d., post free.

"MOTIVE POWER AND GEARING FOR ELECTRICAL MACHINERY."—By E. Tremlett Carter, C.E., M.I.E.E. Price 12s. 6d., post free. In this comprehensive work an account is given of the scientific principles and modern practice in the use of engines for dynamo driving, not only for isolated power plants, but also for public electric lighting and power stations. The various forms of gearing in the power station and for electric motors are also dealt with; and the book contains, in addition, numerous tables giving exact data of the equipment and working of electric power stations.

"THE MANUFACTURE OF CARBONS FOR ALL ELECTRICAL PURPOSES."—by Francis Jehl. 10s. 6d., post free. This is a practical handbook, giving a complete description of the art of making carbons for electric lighting, electrodes, &c., with particulars of the various gas generators and furnaces used in carbonising. The work also contains particulars of the cost, &c. of erecting and working carbon works, and plans of a model factory.

"ELECTRIC MOTIVE POWER," by Albion T. Snell, contains the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. Price 10s. 6d., post free; abroad, 11s.

"ELECTRICAL TESTING FOR TELEGRAPH ENGINEERS."—By J. Elton Young, M.I.E.E. The scope of the book aims at furnishing a fuller treatment of the subject, from the standpoint of the Telegraph Engineer, than it has hitherto received, whilst it endeavours to facilitate a thorough comprehension of the theory of testing as applied to electrical lines in general. Demy 8vo, fully illustrated. 10s. 6d., post free.

"ELECTRIC LAMPS AND ELECTRIC LIGHTING," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is handsomely bound, and full of original illustrations, designs, initials, &c. *New and Cheaper Edition*, 6s., post free.

"SUBMARINE CABLE-LAYING AND REPAIRING. —By H. D. Wilkinson M.I.E.E., &c., fully illustrated; price 12s. 6d. This work gives a detailed technical summary of modern practice in manufacturing, laying, testing, and repairing submarine telegraph cables.

"ELECTROMAGNETIC THEORY."—By Oliver Heaviside. *Vol. I.*, 12s. 6d. *Vol. II.*, 12s. 6d.

"THE ART OF ELECTROLYTIC SEPARATION OF METALS."—A second issue of Dr. Gore's book is now ready, price 10s. 6d., post free. The author treats fully both the theoretical principles of the art of electrolytic separation of metals and the practical rules and details of technical application on a commercial scale. The work is adapted to the use of the manufacturer as well as the student.

"DRUM ARMATURES AND COMMUTATORS," by Mr. F. Marten Weymouth. also ready. Price 7s. 6d., post free. Propsectus on application. This is a complete treatise on the theory and construction of drum winding, and of commutators for closed coil-armatures, together with a *résumé* of the principal points involved in their design, and an exposition of armature reactions and sparking.

"LABORATORY NOTES AND FORMS."—We have ready a set of 40 Elementary and Advanced Exercises for use with Electrical Engineering classes. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators, and Students. The object of the series is the saving of the time of the Teacher and his Assistants, and to serve as a record of the work done by the Student. Each Form is supplied either singly at 4d., or 3s. 6d. per dozen net; in sets of any three, 1s. net; or the set of Twenty (Elementary or Advanced) Exercises can be obtained, price 5s. 6d. net. The complete set of Twenty Elementary and Twenty Advanced Exercises are price 10s. 6d. net; or in handy portfolio, price 12s. net; or bound in strong cloth case, price 12s. 6d. net. Strong portfolios can be had, price 1s. each.

NOW READY.—The cheaper edition of Dr. J. A. Fleming's "Electrical Laboratory Notes and Forms." These cheaper Forms have been prepared for the use of students and teachers at the Polytechnics and other Science classes throughout the country. The demand for the original set of these Notes and Forms has led to a request for a cheaper set for use at the day and evening classes at many of the technical institutes. These new Forms, which differ only from the higher-priced set in being printed on smaller and cheaper paper, and with less space for tabulated records, are issued at half the price of the original set.

"THE ALTERNATE CURRENT TRANSFORMER."—By Prof. J. A. Fleming, M.A., D.Sc., F.R.S. Vol. I.—*New Edition.* Price 12s. 6d., post free, Vol. II., price 12s. 6d., post free, is also ready.

"MAGNETIC INDUCTION IN IRON AND OTHER METALS."—By Prof. J. A. Ewing. Price 10s. 6d. net. *New Edition ready April 15.*

"ELECTRO-CHEMISTRY."—By Dr. G. Gore. Third Edition. Price 2s., post free.

"THE POTENTIOMETER AND ITS ADJUNCTS": A Universal System of Electrical Measurement.—By W. C. Fisher. Fully illustrated. Price 6s., post free.

"THE STUDENTS' GUIDE TO SUBMARINE CABLE TESTING."—A new edition of this book, by Messrs. H. K. C. Fisher and J. C. H. Darby, is now ready, price 6s. net; abroad, 6s. 3d. This work is intended to serve as a guide to operators already in the telegraph service, and to those who desire to enter that service. The great cable companies now insist that their operators and probationers shall pass certain examinations in electrical subjects. The book is very fully illustrated.

"THE STEAM ENGINE INDICATOR AND INDICATOR DIAGRAMS."—Edited and enlarged by W. Worby Beaumont. Price 3s. 6d., post free. This work is a concise guide to the objects, construction, and use of the steam engine indicator and to the interpretation of indicator diagrams.

"BIBLIOGRAPHY OF X-RAY LITERATURE AND RESEARCH."—A valuable compilation. Being an attempt to classify the data relating to X-Ray work. This work contains a quantity of general as well as special information bearing upon the whole subject of electrical discharge research. Edited by C. E. S. Phillips. Price 5s., post free.

"THE ELECTRICIAN" PRIMERS.—In Two Volumes. Vol. I., Theory. Vol. II., Practice. Price, stout paper cover, 2s. 2d. each, post free; cloth, 2s. 9d. Single Primers, 3d. each, post free.

"ELECTRICAL ENGINEERING FORMULÆ," a pocket book, by Messrs. W. Geipel and H. M. Kilgour; price 7s. 6d.; by post, 7s. 9d.; abroad, 8s. *New Edition nearly ready.*

"THE MANUFACTURE OF ELECTRIC LIGHT CARBONS."—A Practical Guide to the establishment of a Carbon Manufactory. Fully illustrated, price 1s 6d.; post free, 1s. 9d. In this work the author gives useful hints as to the manufacture of electric light carbons, including the preparation of material. firing, saturating, and coring, together with a description and estimate of cost of the plant required.

"ARMATURE WINDING OF ELECTRIC MACHINES."—By H. F. Parshall and H. M. Hobart. This work has been compiled from notes made by Mr. Parshall in his capacity as Chief Designing Engineer of the Edison and General Electric Companies of America, and is intended to serve as a working treatise on dynamo design. Large 4to, 370 pages, 140 full-page illustrations and 65 full-page tables, 30s. post free.

"TEMPERATURE COEFFICIENTS OF 'CONDUCTIVITY' COPPER." Compiled by Messrs. Clark, Forde and Taylor, consulting engineers. Strongly bound in cloth, 2s. 6d. net. Also a Sheet Table of Log. Reciprocals of Coefficients for Copper Resistances at different temperatures from 32° F. to 84·9 F. Printed on strong cardboard, 6d. net.

TENDERS INVITED.

The *Dundee* Town Council invite tenders for the supply and erection of a traction switchboard and equipments. Further particulars are set out in an advertisement, and specifications can be obtained from the city electrical engineer (Mr. Walter H. Tittensor), Dudhope-crescent road. Tenders must be lodged with the town clerk (Sir Thomas Thornton, LL D.), City Chambers, Dundee, by 25th inst.

The *Sunderland* Corporation invite tenders for two additional switchboard panels, with instruments, &c. Specifications can be obtained from the borough electrical engineer (Mr. J. F. C. Snell), Dunning-street, and tenders (addressed chairman of Lighting committee, Town Hall, Sunderland) must be delivered at the offices of the town clerk (Mr. Fras. M. Bowey) by noon, 27th inst. An advertisement contains further particulars.

The *Plymouth* Corporation invite tenders for overhead line construction, &c. Further particulars are set out in an advertisement and specifications, &c., can be obtained from the borough electrical engineer (Mr. John H. Rider), Prince Rock, Plymouth. Tenders by May 2.

The *Belfast* Electric committee invite tenders for 12 months' supply of electric motors. Particulars from the city electrical engineer (Mr. Victor A. H. M'Cowen), and tenders to the town clerk (Sir Samuel Black) by 19th inst. See advertisement.

The *Halifax* Electricity committee invite tenders for electricity meters, and the Tramways committee invite tenders for various parts in connection with the overhead equipment of new lines. Particulars from the borough electrical engineer.

The *British Electric Traction Co.* invite tenders for a three-throw deep-well pump for their Maybank power house, Potteries. Particulars from the contract engineer, Donington House, Norfolk-street, London, W.C.

The *Glasgow* Corporation invite tenders for telephone cables (including drawing into conduits and jointing) and telephone instruments (wall and table). Tenders to town clerk (Sir J. D. Marwick) by April 18.

The *Glasgow* Corporation invite tenders for 136 cast-iron columns with brackets and 17 split bases and brackets for arc lighting. Tenders to superintendent of lighting, 52, College-street, Glasgow, by 10th inst.

The *Wimbledon* District Council invite tenders for 5,000 16 c.p. and 1,000 32 c.p. incandescent electric lamps. Tenders to clerk (Mr. R. H. Butterworth) by April 9.

The directors of the *Lancashire and Yorkshire Railway* invite tenders for various stores for twelve months ending April 30, 1901, including signal and telegraph fittings, signal, telegraph, and electric light wires, copper tubing, glass, oil, screws, &c. Tenders to the secretary (Mr. R. C. Irwin), Hunt's Bank, Manchester, by 10 a.m., April 9.

The *Salford* Corporation invite tenders for an ash conveyer and two electrically-driven travelling jib cranes. Tenders to town clerk by 10 a.m., April 9.

The Visiting Committee of the *Northumberland* Lunatic Asylum invite tenders for an electric lighting installation. Tenders to clerk (Mr. H Vassall), Market-place, Morpeth, by April 9.

The *Dunmanway* (Cork) District Council invite tenders for electric lighting, to be in by May 3.

The *Barking* District Council invite tenders for the construction of an electric railway, with bonding, &c. Tenders by May 7.

The *Dublin* Electric Lighting committee invite tenders for electric lighting plant. Tenders to town clerk by 4 p.m. April 26.

The *Newcastle-upon-Tyne* Tramways committee invite tenders for steel and iron work for the car sheds at Byker. Tenders by 21st inst.

The *Birkenhead* Corporation invite tenders for tramway plant. Tenders by 23rd inst.

Tenders are invited by the municipality of *Mariupol* (Russia) until May 16/29 for the construction and exploitation of electric tramways and the supply of electric current for lighting in the town.

The *Prussian* State Railway authorities, Posen, require tenders for 5,500 porcelain insulators and 45 tons of iron wire 4mm. diameter.

TENDERS RECEIVED AND ACCEPTED.

The following tenders have been accepted by the Plymouth Corporation:—

W. J. Corse and Co. (wiring municipal offices)	£198 15 0
C. Hawken (12 months' supply of engine oils)	Schedule rates.
J. Laing, Sons and Co. (12 months' supply of cylinder oils).	do.
General Electric Co. (Aron alternating-current meters) ...	do.
British Elec. Transfr. Mfg. Co. (sub-station transformers)..	do.
Brush Electric Engineering Co. (street box transformers)..	do.
De Grelle, Houdret and Co. (carbons)	do.

As announced in our issue of the 23rd ult., the Poplar (London) District Board of Works have accepted the tender of the National Electric Wiring Co. for wiring premises in the district free of initial cost. The agreed charge is ¾d. per unit for hire of fittings, and easy purchase system payments by instalments are to be spread over a period of from one to five years, the price to be furnished to consumers when the fittings are put in. Messrs. Pearson and Co. also submitted a tender.

The Salford Electric Light committee recommend the acceptance of the tender of Messrs. W. H. Bailey and Co. for supplying eight jet condensers, and pumps with steam exhaust and water pipe work, at the Strawberry-road electricity works, for £16,500; and the

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tender of Mr. Bertram Thomas for erecting at the new electricity works six electrically-driven feed pumps, complete with connections to tanks and boilers, for £3,157.

The Walthamstow District Council have accepted the tender of Messrs. Frank Suter and Co. for the supply and erection of plant for the electric lighting of the isolation hospital at Chingford at £4,579.

The Blackpool Tramways committee have accepted the tender of the Midland Railway Carriage and Waggon Co. for the supply of 15 tramcars.

The Swansea Corporation have accepted the tender of the Callender Co. for the supply of cables and mains at £12,613. 2s. 8d.

The Glasgow Tramways committee have let contracts (in sections) for the erection of electric tramcar sheds at Possilpark at £20,000.

The Whitechapel District Board of Works have accepted the tender of Messrs. Babcock and Wilcox for the supply of two boilers (at £2,300), a feed pump (at £450), and other work for a total of £3,097.

The Cheltenham Town Council have accepted the tender of Messrs. C. A. Parsons and Co. for a 500 kw. steam turbo-alternator at £3,820.

The West Ham Corporation have accepted the tender of Messrs. Senior and Son for lighting and traction posts for High-street at £19. 10s. each.

The Barrow-in-Furness Town Council have accepted the tender of Messrs. Goddard, Massey and Warner for the erection of a refuse destructor at £1,768. 16s.

The Newcastle-on-Tyne Corporation have accepted the tender of Messrs. J. Russell and Co. for the supply of centre poles for the tramways, and that of Messrs. R. W. Blackwell and Co. for side poles.

The Bangor Council have accepted the tender of Messrs. Veritys Ltd. for an electric lighting switchboard at £642. 12s.

The Birkenhead Corporation has accepted the tender of Messrs. R. W. Blackwell and Co. for the overhead line equipment of the Wirral Tramway Co.'s lines.

The East London (South Africa) Town Council have accepted the tender of the South African Electric Lighting Co. for three additional tramcars at £900. The cars are to be made in America, and a bonus of £50 per car will be paid if they are delivered in East London within five months.

APPOINTMENTS VACANT AND FILLED.

The Islington (London) Vestry require a qualified mechanical draughtsman and a skilled mechanician for their electricity department. Further particulars are given in advertisements, and applications must be sent to the Vestry clerk (Mr. Wm. F. Dewey) by noon of April 9.

The Carlisle Corporation require a mains foreman for their electricity works. Applications to the city electrical engineer (Mr. Charles D. Burnet). See advertisement.

The Cardiff Corporation require a mains superintendent. Particulars and forms of application may be obtained at the office of the borough electrical engineer (Mr. N. Appelbee), and applications to the town clerk (Mr. J. L. Wheatley) by 16th inst. See advertisement.

A telephone superintendent is required to take charge abroad. Particulars will be found in an advertisement.

A mains' superintendent is required for the Ayr electricity department. Applications to the chief electrical engineer (Mr. A. J. Fuller), electric works, Ayr. See advertisement.

The Cambridge Electric Supply Co. require a mains superintendent. Applications to secretary (Mr. John H. Barker), Thompson's-lane, Cambridge, before 20th inst. See advertisement.

The professorship of mathematics and physics in the Malta University is vacant. Applications to Director of Education.

A competent foreman for telephone instrument inspection, fitting, and wiring, to go abroad, is advertised for on another page.

Two or three good cable jointers are required by the electrical engineer to the Wigan Corporation (Mr. H. Collings Bishop). See advertisement.

A fitter driver (for Belliss engines) and a cable jointer are required at the Buxton electricity works. Applications by 12th inst. to the chief engineer (Mr. Edward Calvert). See advertisement.

A clerk of works is required to supervise electric lighting installation at Hereford Lunatic Asylum. Applications to clerk by 16th inst.

The Birkenhead Tramways committee require an assistant engineer. Applications by 21st inst.

Mr. V. J. Delebecque, A.M.I.E.E., late manager of the Penistone Electrical Co., has accepted a position on the staff of the British Electric Works Co.

Mr. W. J. W. Bullock, of Leith, has been appointed mains superintendent at West Ham.

Mr. M. B. Field, of London, has been appointed assistant electrical engineer of the Glasgow tramway department, at a salary of £400 per annum. Mr. Field has had considerable experience in three-phase work, and was for some time in the service of Messrs. Brown, Boveri and Co., of Baden, Switzerland.

Mr. Sidney R. Mallinson, of Hull, has been appointed assistant permanent way engineer to the Manchester tramways department.

BUSINESS NOTICES.

The Electrical Co. (Ltd.), of 122 and 124, Charing Cross-road, London, W.C., have, in order to meet a large increase in their business, taken more extensive premises at Brighton, and have opened large showrooms at 134, North-street, where increased stocks will be available to the company's clients on the South Coast.

The general offices of the Central London Railway have been removed to 125, High Holborn, W.C.

Messrs. W. H. Robson and A. S. Robson (trading as William Robson), electricians, &c., 177, Lord-street, Southport, have dissolved partnership. Debts by Mr. A. S. Robson, who continues.

The Brockie-Pell Arc Lamp (Ltd.) give notice that on and after Monday next, April 9, the offices of the company will be removed to 60, Worship-street, London, E.C., to which address all communications should be sent.

The address of the Electrical Engineer Institute of Correspondence Instruction has been changed from 120, Liberty-street, to 240-242, West 23rd-street, New York City.

BANKRUPTCIES, LIQUIDATIONS, &c.

At a meeting of the creditors of W. P. Theerman, electrical engineer and contractor, 22, Devonshire-street, C.-on-M., Manchester, on March 19, a committee was appointed from representatives of the three largest creditors to investigate debtor's affairs, and the committee recommended that the creditors assent to a deed of assignment, and that the trustees be authorised to complete the works and contracts in hand, in order to strengthen the position in the event of a sale of the business. This recommendation was approved at a subsequent meeting. The statement of affairs shows unsecured creditors £2,886. 12s. 2d., partly secured creditors, expected to rank, £775. 13s. 6d. The gross assets (less preferential claims) are shown at £4,551. 2s. 7d., leaving an estimated surplus of £886. 16s. 11d. Creditors who have not yet returned their assents to the proposal that the contracts in hand be proceeded with are asked to do so without further delay.

The Scarborough District Lighting Co. (Ltd.) is to be wound up voluntarily. Mr. S. C. Blades, York-chambers, Scarborough, has been appointed liquidator. This company is in no way associated with the Scarborough Electric Supply Co. (Ltd).

E. Bates (now or lately trading with W. H. Walley at 4, Hopwood-avenue, Manchester, as E. Bates and Co.), electrician, has been adjudicated bankrupt.

Claims against Claud Vautin, electro-metallurgist, &c., lately trading at 66, Old Broad-street, London, E.C., must be in by 20th inst. to J. J. Saffery, 14, Old Jewry-chambers, E.C.

Sale by Auction.—Messrs. Farebrother, Ellis, Egerton, Breach, Galsworthy and Co. will sell by auction on the premises, 110, Westminster Bridge-road, London, on Monday, April 23, and following days, a costly collection of modern engineers' tools, plant, and machinery, by best makers, particulars of which will be found set out in an advertisement elsewhere. Catalogues, price 1s. each, can be obtained of the auctioneers, 29, Fleet-street, and 18, Old Broad-street, London, E.C.

Plant for Sale.—Messrs. Albright and Wilson (Ltd.), Oldbury, near Birmingham, have a Willans-Crompton steam dynamo for sale. See advertisement.

The Works and Finance committee of the St. Olave's (Southwark) Board of Works invite offers for a small dynamo. Particulars from the clerk (Mr. G. L. Hawker), Vine-street, Tooley-street, London, S.E. See advertisement.

Messrs. A. Verey & Co., Dover, advertise some electrical instruments, arc lamps, wire, switches, &c., for sale.

Land for Sale.—Mr. Peter Newton, 4, Albert-street, Derby, has for sale about 20 acres of freehold land, conveniently situated and suitable for the erection of electrical or general engineering works. See advertisement.

"Stellite" Cable Connector and Terminal.—The British Electric Works Co., of Cheston-road, Aston, Birmingham, are placing upon the market a new patent cable connector and terminal made in all necessary shapes to connect to butt cables, terminals, two-way terminals, &c., and to carry 3, 5, 10, or 15 amperes, according to sizes ordered. Through these connectors the cable is inserted, and a clip is closed with a blow from a hammer. The connector may then be soldered if required. The joint is instantaneous, and is claimed to be electrically and mechanically perfect.

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Electric Motor Cars.—We are informed by Mr. Arthur Shippey that the Still Motor Co., of Toronto, Canada, will exhibit (through Messrs. Shippey Bros., the London agents) some new types of electric motor cars at the exhibition at the Agricultural Hall, London, on 14th inst. These cars will be equipped with the new "Ideal" storage batteries for the development, and manufacture of which, it is stated, a company is in course of formation to purchase the British patents.

Conradty Carbons.—It having come to Mr. Conradty's knowledge that carbons are being sold as Conradty carbons which are not his make, the Sloan Electrical Co. (Ltd.) give notice that in future no carbons will leave Mr. Conradty's factory unless stamped with his name.

B.T.H. Plant.—Pamphlets Nos. 58, 59, and 60, just issued, deal respectively with "Punched Clip Switches," "Magnetic Blow-out Automatic Circuit Breakers," and "Quick Break Switches." The lists are fully illustrated.

"Cassier's Magazine."—The April issue of this magazine contains articles on "The Relative Efficiencies of Gas and Electricity for Heating, Lighting, and Power," and on "The Lessons and Results of the British Engineers' Strike of 1897-1898."

"Engineering Magazine."—The contents of the April issue include articles on "Gas Engines and Electricity Supply Stations," "The Jungfrau Three-phase Electric Railway," and "The World's Supply of Copper."

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from March 28 to April 3, with the ports of destination :—

Africa—Alexandria, £92; Cape Town, £3,735 (including £3,693 telegraph material); Chinde, £124 (telegraph wire); Durban, £250; East London, £112. *Australasia*—Lyttelton, £251; Melbourne, £201; Sydney, £1,020; Wellington, £128. *China*—Shanghai, £334, and 67 tons old telegraph wire. *Denmark*—Copenhagen, £115 (telegraph material). *France*—Rouen, £60. *Germany*—Hamburg, £810 (telegraph material). *Gibraltar*, £60. *Holland*—Amsterdam, £370; Rotterdam, £400 (telegraph material). *India*—Calcutta, £668; Madras, £535. *Japan*—Kobe, £146; Yokohama, £116. *Malta*—£18. *Norway*—Christiana, £62 (telegraph wire). *Russia*—Reval, £89; St. Petersburg, £250 (telegraph material). *Spain*—Seville, £270. *Straits Settlements*—Penang, £310 (telegraph apparatus); Singapore, £61. *Sweden*—Gothenburg, £235 (telegraph material). *Uruguay*—Monte Video, £633. *West Indies*—Trinidad, £31. Total £11,486, against £3,452 on March 29 and 30 last year.

MUNICIPAL, FOREIGN, AND GENERAL NOTES.

Aberdeen.—The Council have resolved to acquire the property known as Dee Village, for £8,000, as a site for the new electricity works.

Alfreton.—Mr. J. S. Barnes has been appointed consulting electrical engineer, on the usual terms—viz., 5 per cent. on the estimated outlay (£12,000) on the proposed electricity works.

Alloa.—It was announced at a special meeting of the Burgh Commissioners last week that the agreement with the British Electric Plant Co. to supply the town with electric current for public and private lighting was practically settled, and that the erection of the buildings would be begun in a short time. About 20 acres of land have been acquired from the Earl of Mar and Kellie. It is stated that when the company is in full operation over 1,000 men will be employed.

Asylum Lighting.—The committee recently appointed to report upon the advisability of the electric lighting of the Fife and Kinross Asylum, at Springfield, report that it would be a much cheaper and better light than the present gas supply from Cupar, which costs over £400 per annum.

The managers of the Poplar and Stepney (London) Sick Asylum have decided to adopt electric lighting.

Ayr.—A committee has been appointed to visit towns in England where electric tramways are in operation, for the guidance of the Council in their proposed electric lighting and tramway scheme.

Barrow-in-Furness.—An application by the British Electric Traction Co. for the conversion of the local tramways to the overhead trolley system is before the Council, and the surveyor is to report.

Batley.—The Board of Trade have granted the Council's application for a provisional tramway order, but running powers over the Halifax-road route have been conferred on the British Electric Traction Co., the promoters of the local light railway scheme.

Birkenhead.—Sanction has been obtained to the borrowing of £22,666 for purchasing the undertaking of the Wirral Tramways Co., and the borough engineer has been instructed to proceed with the reconstruction of the lines.

Birmingham.—At Tuesday's meeting of the Corporation the resolution passed about two years ago, prohibiting the Public Works committee from receiving and considering any proposals made by the City of Birmingham Tramways Co, was rescinded, and the recent offer of the company in regard to the conversion of the Bristol-road route to the overhead trolley system will now be considered by the Tramways sub-committee. The company's scheme is being supported by the King's Norton Council, through whose district a portion of the line runs.

Bolton.—The chairman of the Tramways committee (Ald. Nicholson), at the Council meeting on Wednesday, said the three months' experience of the electric tramways had been of great service to them. The troubles in connection with the curves were considerably fewer in number, and he anticipated that in another three months the system would be all that could be desired. Since the last meeting six additional cars had been received and the service had been much improved. The traffic and receipts had proportionately increased. They were anxious that the first year's working of the electric tramways should be worthy of the town.

Bradford.—Sanction to a further loan of £56,000 for electric light extensions is being sought. Messrs. Mawson and Hudson have been appointed architects for the extension of the Valley-road electricity works.

Brussels-Antwerp Electric Tramway Project.—The promoters of this scheme, some particulars of which were given in our last issue, are the Union Elektricitäts Gesellschaft and the Brussels Tramways Co. A syndicate has been formed for the purpose of financing the scheme.

Brynmawr.—The clerk has been instructed to ascertain the cost of obtaining electric lighting powers.

Carlisle.—The Corporation have reconsidered their attitude in regard to the modified tramway scheme of the City of Carlisle Electric Tramways Co., and the company's proposals have now been approved,

Celebration.—The town of Crewe is to celebrate the completion of the four-thousandth locomotive engine from the Crewe works of the London and North Western Railway Co. The honorary freedom of the borough is to be conferred upon Mr. F. W. Webb, the company's able mechanical superintendent.

Cheltenham.—The borough electrical engineer (Mr. Hamilton Kilgour) has reported that in order to supply electric energy to the proposed Cheltenham-Cleeve light railway it would be advisable to replace two of the present 100 kw. alternators by continuous-current dynamos, and to instal a new 500 kw. steam alternator. Tenders had therefore been obtained from four principal manufacturers. He was making inquiries, both in this country and in Germany, as to dynamos for the traction plant. The number of customers connected to the lighting mains was 380, with an equivalent of about 23,300 8 c.p. lamps. The report was adopted.

The Board of Trade have intimated that they are not prepared to dispense with the consent of the Cheltenham Rural Council to the application of the Cheltenham Town Council for a provisional order, and that, inasmuch as the Cheltenham Rural District separates the existing area of the Corporation from the Winchcombe Rural District, the Board are unable to include any portion of the last-named district in the proposed area of supply; and that the Board had decided to proceed with the application in respect of Charlton Kings only. A conference will take place to-day (Friday) at the Board of Trade, to discuss this matter.

Colne.—The borough electrical engineer (Mr. A. G. Cooper) has been instructed to prepare plans and specifications of an electric lighting scheme.

Company Promotion.—During the recent hearing of an action "Baker Syndicate (Limited) and another *v.* J. Wright and Co. (Ltd.)" some curious evidence was given. Mr. H. S. Foster, M.P. for Lowestoft, gave evidence to the effect that he was connected with a number of companies and syndicates, amongst which were the London Founders, Profit and Industrial Corporation, the London Finance Corporation, and the Baker Syndicate. Amongst the companies promoted by these ventures was one for preserving milk, another for working an electric concession for Scotland, and an automatic sash motor company; Lyons' Electric Light Co. was also registered. He had also joined the board of the Singapore (Straits Settlements) Electric Tramway Co., and of Condy's White Lead Co., and one of his ventures took a number of shares in the Audible Telephone Syndicate. All these companies and very many others had passed into liquidation.

Doncaster.—The electricity works were formally opened on Monday by the mayor (Ald. Bentley). The charges for current are 5d. per unit for lighting and 3d. for power.

Dublin.—The protracted inquiry into the application of the Corporation to borrow £254,000 for electric lighting was concluded on Friday last. A report of the proceedings up to Wednesday was given in our last issue. At the conclusion of the evidence for the Corporation on Thursday Mr. T. Healy, M.P. (for the opposition), said the loan was for trade and competitive purposes—for starting a

business to make a profit as traders—and the Corporation should go into the open market forthe loan. He asked why assistance should be given to the Corporation to enable a profit to be reaped. The business of electricity supply was not one that the Corporation could take up at all, if they considered the fact that it had no power to wire premises. The Corporation had already laid out £80,000 on a failure and in order to convenience 250 people. The city got no value for the expenditure. With regard to the proposed scheme, he submitted that it was not Mr. Hammond's scheme at all, but Mr. Ferranti's; and so far as it was a Pigeon House scheme it was a sewage scheme. He submitted that the Corporation had no power to expend money outside its area of supply. The County Council and the Pembroke District Council should be represented at the inquiry, and should have had notice. There was no power to go into the inquiry without the presence of these bodies, and he contended that the proceedings were *ultra vires*. The Tramway Company was engaged in traction work, and as it had to keep its works open for 14 hours a day, it could easily keep open for the few extra hours and do the electric lighting work. He had doubts as to the security which the Corporation would be able to offer for the repayment of the loan. The proposed scheme of electric supply by the Corporation was "unsound financially and unscientific electrically," and the Corporation and the citizens could at much less expense secure for themselves a supply of electric current. Mr. Arthur Wright, for the opposition, stated that he started the first central station in England in 1881, and had been since engaged in electricity supply work. He had made himself acquainted with Mr. Hammond's scheme for Dublin, and, considering the circumstances, believed the city should have its electricity distributed on the continuous-current system, as this system was "easier to handle, cheaper to produce and distribute," more generally applicable to the wants of lighting consumers and motive power users, and capable of giving a more reliable and constant service than the alternating system. He knew several places where the continuous-current system had been substituted for the alternating with good results. The Pigeon House was not the only place where they could obtain water and get coal landed. If a nearer site were available it would mean a great saving in expense for mains, and he could not imagine any extra cost in coal that would be incurred by coming nearer to Dublin. Fleet-street made a capital distributing centre, and if it were the distributing centre practically all the sub-stations proposed in the scheme would be unnecessary. The system proposed was more expensive in first cost and maintenance than the continuous-current system, and witness disagreed with Mr. Hammond as to the capital required, which seemed to him to be inadequate. They could not produce anything like a net profit unless they charged about an average price of 4½d. per unit. A gross profit could not be made unless the charge was something like an average price of 5½d. It was unnecessary to try that huge experiment at this stage of electrical progress. Mr. Thomas Tomlinson, B.E., stated that he had large experience in the designing and erection of electric lighting plant. He had examined Mr. Hammond's scheme, and was of opinion that on the whole it was not a suitable one. The two-phase system of distribution would have got over certain anomalies, and would fit in better with the existing system. A two-phase distribution to the customer was adopted in the only two big electricity stations lately erected in London. He inspected the buildings at the Pigeon House Fort, and his opinion was that the foundations there would not be sufficient to sustain the buildings proposed to be erected with the rotatory and other machinery. Mr. Arthur E. Porte gave evidence as to the difficulty of getting good foundations along the Liffey—along the southern bank particularly. He was of opinion that Mr. Hammond's estimate of £20,000 would go a short way if the foundations were found to be bad. He considered that 500 arc lamps were an extravagant number for a city like Dublin. He did not think suitable provision had been made for motor work, as the general experience in all stations run on the alternating-current system had been that alternating-current motors on the single-phase system had not been taken up. In cross-examination he said he had not been connected with central station work as running engineer for a good many years. Mr. J. Henry, assistant town clerk, gave formal evidence of the receipt of the letters from the Tramway Co. offering to supply electricity, as set out in our last issue. Mr. Horace Parshall, consulting engineer and designer of the Dublin tramway system, explained his objection to various details of Mr. Hammond's scheme. He said all big lighting companies were adopting the continuous current system as fast as they could. As to the offer of the company to deliver electric current "in bulk" to the Corporation at Ringsend and leave the monopoly of distribution to the Corporation, Mr. Parshall said if he were the company he would not bother about it, as it would bring in a less return than their ordinary undertaking. He knew that electric lighting works were largely run by local authorities, but he did not know that they had been successful. He had considered Mr. Hammond's report some time ago with a number of experts, and none of them could make head or tail of it. The whole tendency everywhere was to distribute electricity by continuous current. Mr. T. J. Cotton, public lighting inspector and city gas examiner, gave evidence as to the consumption and price of gas, &c.; and after counsel had addressed the inspector, the inquiry closed, having extended over five days.

Eastern Siberia.—The Russian Government has established a complete survey system for the great river Amour, one of the most important watercourses of Eastern Siberia. This extensive survey system is throughout the night lighted by electricity, and almost weekly a large quantity of electric lighting plant is being added. The demand for this class of plant in this rapidly developing portion of the Russian empire is stated to be very large, as is also the demand for dredging and excavating machinery. The Société Cockerill has so far, it is stated, managed to manipulate the bulk of this business.

Electrically-Driven Dredger.—It is stated that successful trials have been made of the dredger "Beta," built for the Russian Government by the Société Cockerill. The contract for this dredger was made in 1897, and stipulated for a capacity of 1,600 cubic yards per hour, with a premium of half the cost of the dredger if it could deliver 2,400 cubic yards per hour. It is now stated that the "Beta's" official trials in the Scheldt at Antwerp have recorded a capacity of 7,800 cubic yards per hour. The design of the boat was from plans drawn by Mr. L. W. Bates, of Chicago, the first dredger of this type having been built for the United States Government in 1896 for use on the bars in the Mississippi. At this time a committee of engineers was appointed by the Belgian Government to investigate the Bates system of dredging, and their report attracted the attention of the Russian authorities, who required such a vessel for use in removing obstructions in the Volga, which caused serious inconvenience and delay to navigation. Finally arrangements were come to with the Russian Government for the erection of the most powerful dredging machine in the world at a cost of more than £100,000. One of the chief features of interest in connection with the dredges was that it was to be self-propelling by electric power. At the official trials referred to representatives of the German, French, Austrian, Turkish, Belgian, and many other Governments, and a large number of engineers from all parts of Europe, were present. The conditions of these trials were as follows: (1) The dredger on a 2ft. cut 1,000ft. in length to make an output of 1,500 cubic metres (52,974 cubic ft.) per hour. (2) In a three hours continuous run in a cut 3½ft. deep to put out 3,000 cubic metres (105,948 cubic ft.) per hour. The capacity test was of three hours' duration. The measurements were made at Antwerp in excavation. The official record states that the tests showed an average capacity of 7,000 cubic yards an hour. The maximum was at the rate of 10,350, both being one-third in excess of the highest official records attained in the Mississippi. At St. Petersburg the dredger was put through a further series of tests, serving to confirm the first record; and the dredge was consequently accepted by the Russian Government, and is about to proceed to the Volga. It is stated that a large contract for the Queensland Government depended upon the acceptance of the dredger by the Russian Government. As a further result of the trials of the "Beta," it is said that the Calcutta authorities have given an order for a dredger of the same type. Queensland's order is for three dredgers of 10,000 H.P.

Enfield.—The Board of Trade have rejected the application of the Urban Electric Supply Co. for a provisional order.

Exhibitions.—Applications for space at the Glasgow International Exhibition, 1901, must be lodged not later than June 1 with the general manager (Mr. H. A. Hedley). There are in all eight classes, embracing agriculture, mining, industrial design and manufactures, machinery and labour-saving appliances in motion, locomotion and transport, marine engineering and shipbuilding, lighting and heating, science, education, music, sports and sporting appliances.

The Paris Exhibition is to be opened on 14th inst. by the President of the Republic, M. Loubet.

Halifax.—The Gas and Electricity committee have agreed to reduce the charge for electric current for lighting from 5d. to 4d. per unit, with the present scale of discounts, and for traction from 2d. to 1⅞d. per unit.

Indian Import Duties.—Notification has been made by the Government of India that telephone posts imported in the form of tubes are to be classified under the heading of "Telephonic Instruments, Apparatus, and Appliances," and are consequently dutiable at 5 per cent. *ad val.*

Ipswich.—The consulting engineer (Mr. W. C. C. Hawtayne) has been instructed to prepare a report as to applying for a licence to establish a municipal telephone exchange, and in order to save expense a 3in. stoneware pipe is to be laid in the trench of the electric lighting mains. Electric current will be available in the autumn.

Kilmarnock.—The Town Council have decided to proceed with their electric lighting scheme, estimated to cost about £25,000. Mr W. A. Bryson, of Leith, has been appointed consulting engineer.

Lancashire Electric Power Scheme.—The promoters of this bill are gradually disarming the opposition of the local authorities

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by timely concessions. This week it is announced that the St. Helens and Warrington Corporations have decided not to further co-operate with the executive committee of the Municipal Association in their opposition, and it is probable that other authorities, especially those of the smaller towns and districts, will follow suit. Altogether there is a fairly good prospect of the bill being passed.

Leatherhead.—The Council have decided to transfer their provisional order to Messrs. Handcock and Dykes, who offered, on behalf of a syndicate, to take a lease of the order for 42 years at an annual rental of £15, subject to the Council's right of purchase at 25 years or at any subsequent five years. The syndicate also pays all expenses in connection with obtaining the order.

Leeds.—The salary of the assistant electrical engineer for tramways (Mr. H G. Jenkin) has been increased from £175 to £250. The Tramways committee have been authorised to let a contract for the supply of three steam dynamos at £36,000.

Leith.—The advisability of extending the electric lighting cables to Trinity, estimated to cost £10,687, is to be reported upon by the burgh electrical engineer (Mr. W. A. Bryson). A new feeder to Bernard-street is to be laid at a cost of £1,389.

Light Railways.—The Hertford light (electric) railway proposed traction scheme has been withdrawn.

The application of the British Electric Traction Co. for extension of the Spen Valley light railway scheme will be considered by the Light Railway Commissioners on Monday.

The adjourned inquiry into the application to construct a system of light (electric) railways in Loughborough and district was resumed on Monday, and after taking further evidence the whole of the scheme (excepting a short length) was approved. The promoters are the Loughborough and District Electric Traction Syndicate.

Liverpool.—The accounts of the tramways department for the year ended Dec. 31 show that the receipts from the electrical section were £77,653 and the expenditure £36,973, leaving a profit of £40,690, or more than 50 per cent. of the receipts. The aggregate expenditure for the electric and horse trams was £302,159, and the income £365,859, leaving a balance of £63,700. The total expenditure on the lines up to the end of 1898 was £257,821; on tramroads for electric haulage the expenditure was £172,301, nearly all in 1899. Altogether the expenditure on capital account has been £1,161,279, of which £244,756 was spent last year. The assets are estimated at £1,161,279, or precisely the amount actually paid for land, buildings, tramlines, horses, cars, &c., without reckoning depreciation.

Councillor Rutherford, a former chairman of the Tramways committee, has offered on the part of a syndicate to pay £100,000 down as bonus for a 30 years lease of the tramways, and to give a guarantee of £250,000. He undertakes to charge only a penny for any distance, and to prevent overcrowding. He also undertakes to pay off the Corporation debt on the tramways, to extend and complete the electrical equipment of the lines throughout, to take current from the Corporation at present prices, and to hand over the system complete on the expiry of the lease.

London County Council.—At Tuesday's meeting a report was presented by the Highways committee dealing with the letter recently addressed to each member of the Council by Mr. W. E. L. Gaine, general manager of the National Telephone Co. The report states that, as litigation is now pending between the Council and the company, the committee's general comments are deferred; but one point is taken. The committee have all along (the report states) understood that the company had actually obtained the necessary licence from the Postmaster-General for laying their wires underground, but now learn that this is not the case, as proceedings have actually been instituted by the Postmaster-General to restrain the company from breaking up the streets without his licence. The committee urge therefore that the Council is not yet really in a position to legally grant its consent, nor could it grant provisional consent until the pending litigation with the Postmaster-General has been decided. This, the committee urges, disposes of the charge that the Council has stood in the way of the company doing its work and improving its service. Mr. Westacott said he had received a letter from the National Co. which he considered ought to be placed before the Highways committee before the above report was discussed, and he proposed that the discussion should be postponed, which was agreed to.

A loan of £1,576 was approved to the Shoreditch Guardians, to defray the cost of electric lighting at the workhouse and casual wards.

Manchester.—The work of converting the tramways to electric traction has been commenced, and a start has been made with the Cheetham Hill-road route, where centre poles will be used. An order for 7,500 tons of rails has been placed with Messrs. Bolckow, Vaughan and Co., and 450 tramcars have also been ordered, the first delivery to be made in June.

Monmouth.—Application is being made for a loan of £28,000 required to meet excess expenditure on the electric lighting and drainage scheme.

Morrisburgh (Canada).—After many futile efforts, the municipal authorities of Morrisburgh have secured a lease from the Canadian Government for 25 years of water power equal to 250 H.P., which is to be utilised for the development of electric power for industrial enterprises, electric lighting, &c. The installation is to cost about £6,000. It is stated that the extent of these municipal operations may be largely increased in the near future, as the Morrisburgh Council are offering special inducements to manufacturers to establish their works in the district, offering free water, low taxation, and certain bonuses.

Moscow.—The Council were recently recommended to municipalise the tramways, and to purchase the existing horse tramways, if possible. If the undertaking cannot be acquired, the Council are recommended to establish an independent municipal service. In either event electric traction will be adopted.

Municipal Telephony.—The Postmaster-General has granted a licence to the Corporation of Tunbridge Wells to establish and work a municipal telephone exchange. The secretary to the Post Office (Sir G. H. Murray), in the communication conveying the intimation to grant the licence, states that the Postmaster-General will not raise any objection to the period of 25 years proposed by the Corporation, but a licence for 19 years would be sufficient to secure the right of local intercommunication with the system of the National Co. under sec. 3 (5) of the Telegraph Act, 1899; and that under the same section the company will, if they accept the conditions therein specified, be entitled during the whole period of the licence granted to the Corporation to the continuance of agreements with local authorities in the area giving them power to lay underground wires, as well as to an extension of their licence for the area during the same period. The current rate of the National Co. for unlimited user within the area is £10 a year for subscribers whose premises are within one mile of the exchange, with £2 10s. extra for each additional half-mile, and this rate has been fixed in the licence as the maximum. Otherwise the rates proposed by the Corporation have been approved.

Newcastle-upon-Tyne.—The Corporation have adopted the report of the Watch committee to light the thoroughfares through which the electric tramways will run by arc lamps. About 180 lamps of 1,000 c.p. each, placed about 40 yards apart, will be required. The charge for interest on capital expenditure (estimated at £7,500) and sinking fund, and also for electric energy and maintenance (estimated at £18 per lamp), will amount to £3,240 a year. The streets are at present lighted by 308 gas lamps at an annual cost of £758, and 18 electric lamps at £756, total £1,514 a year. In order to provide for future extensions, application for sanction to borrow £10,000 has been made.

The chairman of the Tramways committee (Mr. Cail) announced at the Council meeting on Wednesday that since the contract for the trucks for the new cars had been sealed the sub-contractors (the Brill Co.) who were to supply the trucks to the British Thomson-Houston Co., had telegraphed that in the few days which elapsed between the submission of their tender and the sealing of the contract the market had risen, and they could not supply the trucks at the price quoted. The committee had got an offer from the company at an advance of £1,100. This was agreed to; and the Council also authorised the committee to contract with Mr. Nuttal, the contractor for the permanent way, to lay the cement foundations of the ducts for the wires. In the present state of trade the committee is unable to get a competitive tender for cement and concrete.

A plot of land has been purchased from the Walker Urban Council for the erection of an electric lighting station and refuse destructor works.

Obituary.—The death is announced of Mr. Joseph Warwick, one of the controllers of the telegraph department in Birmingham. Mr. Warwick had been engaged in the telegraph department for nearly 40 years.

Private Bill Legislation.—The Stockport Corporation Tramways and the Southport Extension and Tramways Bills have been read a third time in the House of Commons.

A clause is to be inserted in the Liverpool Corporation Omnibus Bill which empowers the Corporation to fix rosettes, brackets, &c., to any house or building for tramway purposes provided compensation be paid for any injury sustained to the house or building. The bill has been passed by a House of Commons committee, but the clause has not yet been settled.

Provisional Orders.—The Board of Trade has granted provisional electric lighting orders to the Corporations of Basingstoke, Newark, and Penzance, and the Urban District Councils of Brierley Hill, Cleethorpe, Elland, Erdington, Exmouth, Farnham, Leek, Littleborough, Maryport, Nantwich, Ormskirk, Penrith, Prestwich, Redcar, Sowerby Bridge, and Whitefield.

Railway and Tramway Bills.—An official return of the railway and tramway bills before Parliament states that the length of the new lines proposed is 331 miles, against 476 miles in 1899, and the amount of new capital proposed to be raised is £33,984,747, against £28,874,062. The new railway bills number 12, compared with 13 last year; 54 bills relate to tramways, an increase of 14 over

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last year, involving the construction of 504 miles of tramway and the raising of £12,014,255 of capital.

Railway Tunnel Lighting.—In connection with the recent collision on the Glasgow underground section of the North British Railway, resulting in the loss of several lives, the *Daily Chronicle* makes an opportune suggestion that in tunnels of this description, situated within a short distance of a large and busy terminus, it would be advantageous if they were lighted throughout their entire length by electricity.

Rugby.—Tenders are to be invited for the transfer of the Council's provisional order.

Salamanca (Spain).—Application has been made for a concession to introduce electric traction on the local horse tramways.

Salford.—Mr. Haworth, chairman of the Electric Light committee, has tendered his resignation, and at the meeting of the Council on Wednesday a discussion on the cause of the resignation was initiated by Mr. Stephens. Mr. Haworth wrote that he found he could not give the time to or bear the strain of the present work. Mr. Haworth now said the whole matter was a very painful one to him. He explained that three weeks ago he was informed of certain alleged irregularities in connection with a contract. He afterwards saw one of their officials and inquired into the matter. His inquiry satisfied him that the position was such that the Council ought to take severe measures. The Council in the end appointed a special committee to consider the matter and report.

Sheffield.—The Ecclesall-road section of the electric tramways will be opened for traffic at Easter. There were 23 applications for the position of manager of the electric light department, and these are under the consideration of the Electric Light committee.

Ship Lighting.—In addition to the electric lighting installation (between 500 and 600 lights), the new twin-screw steamer "Tunisian," of the Allan line, is provided with electrically-propelled ventilating fans, and among the cooking arrangements is a patent roaster, with an electric motor for turning the joints, &c.

Telephone at Manchester.—A communication from Mr. Prout, district manager of the National Telephone Co., pressing for consideration the company's application to lay underground pipes in certain thoroughfares, and two communications from firms in the Openshaw district complaining of inconvenience caused to traders have been referred to the special Telephone committee. About six months ago the Paving and Highways committee, at the instance of the Council, ceased laying pipes for telephone wires, the Council being of opinion that it was unwise to increase their obligations to the National Co. pending the settlement of the case of the Mutual Co. and the question whether the Council would or would not themselves seek for powers to establish a municipal exchange. Ald. Mainwaring at Wednesday's Council meeting said it was a serious matter for the National Co. A large number of people were greatly inconvenienced by the action or want of action of the Paving committee. Ald. Southern, chairman of the Telephone committee, considered that, whilst the Council were uncertain as to what would be the future arrangements in regard to telephone matters in the city, it would be unwise to increase their obligations and afford additional privileges which it might be necessary to purchase later. He thought there could be no great public inconvenience from the use of overhead wires, which were used for so many years in the centre of the city. Finally, the chairman of the Paving committee (Ald. Milling) said nothing could be done until the resolution passed six months ago was rescinded; and so, after a lengthy debate, no decision was come to.

Torquay.—The Electric Lighting committee's estimates for the half-year to Sept. 30 have been presented and approved. The expenditure is put at £1,640 and, after taking into account £1,219. 10s. balance due to treasurer on March 31, and £583 for interest and sinking fund, the total is £3,442. 11s. The anticipated income is £2,250 for public and private lighting, leaving an estimated deficit of £1,192. 11s. The estimated income is made up of £1,250 for Lady-day quarter, and £500 for each of the Midsummer and Michaelmas quarters. The charge for public arc lamps has been increased from £20 to £22. 10s. per annum. In future the incandescent electric lamps are to be switched off at 1 a.m.

Warwick.—The Warwick and Leamington Tramways Co. have obtained a provisional order for the conversion of the lines within the borough of Warwick to the overhead trolley system. The period of the order is 28 years, but Warwick Corporation have the right of purchase at seven years. The points of difference between the parties have been settled, except that of a rent on profits which has been demanded by the Council, and which the British Electric Traction Co., which has acquired a controlling interest in the local company, is unwilling to concede. The order does not affect Leamington.

West Hartlepool.—Application has been made for sanction to borrow £17,993 for electric lighting.

Wiring Premises in London.—The London County Council have intimated, in reply to the petition of the Poplar District Board of Works, that they intend to promote legislation to enable metropolitan local authorities to borrow money for wiring consumers' premises in the next session of Parliament.

Worcester.—An agreement has been entered into with the British Electric Traction Co. for adopting electric traction on the local tramways and constructing new lines. The company undertake within a year to apply for power to construct light railways from the Cross, in the centre of the city, to Cherry Orchard, and thence to Kempsey, to Red Hill, to the Astwood Cemetery through Lowesmoor, to the city boundary on the Malvern-road (thence to Powick and a branch to the Corporation electricity works), and on to the Henwick railway station. The company will reconstruct the lines from the cross to Barbourne, St. John's, and Shrub Hill station. The whole system is to be converted to electric traction, a 10 minutes service will be given, and penny fares to the city boundary will be adopted. The company will take current from the Corporation: the first 200,000 units at 2d., the second 200,000 at 1¾d., remaining units at 1½d. per unit. The agreement as to price is subject to revision in 14 years. The company will also contribute £5,000 towards the widening of High-street, along which it is intended to construct tramways. The Electricity committee have been authorised to undertake the preliminary negotiations for purchasing a site near the Severn upon which to erect a new generating station, the capacity of the Powick station being insufficient to supply current for lighting and traction.

York.—Sanction to borrow £20,000 for electric lighting extensions is being sought.

PATENT RECORD.

The following list of Applications for Patents and Specifications published has been compiled for this journal by Messrs. J. C. Chapman and Co., *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs, and Trade Marks may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after the acceptance of the complete Specification. The names within parentheses are those of communicators of inventions. When complete specification accompanies application, an asterisk is affixed.*

February 23, 1900.

3,561. W. J. Crossley and J. Atkinson. Manchester. Improvements in electric ignition for internal combustion motors.
3,569. J. F. Moore, E. White, and J. M. Donkin. Sunderland. Maximum demand indicators for electrical circuits.
3,570. F. E. Beeton. Dover. Improvements in electricity meters.
3,576. W. H. Pike. Bristol. Electric roundabouts.
3,588. F. de Mare. London. An improved device for finding the electric poles.
3,600. A. Ellis and W. T. Smith. Manchester. Improvements in switches for overhead electric wires.
3,607. J. H. Cresswell. London. Wire frame for electric lamp shades.

February 24, 1900.

3,643. W. Tattersall. Bradford. Improvements in electrically-driven fans or air propellers.
3,665. J. Fielding and E. Warburton. London. Improvements in or relating to the "trolley-head" employed in connection with electrically-propelled cars or vehicles to ensure of the correct working position being effected when operated by the attendant to stop and start the said cars or vehicles, and apparatus therefor.
3,683. H. Reason and The Reason Manufacturing Co. (Ltd.). London. Improvements in electricity meters.

February 26, 1900.

3,693. H. Korten. London. Improvements in secondary batteries.
3,731. E. Sander. London. Improvements in the manufacture of electrically conducting material.*
3,753. E. N. Commelin and R. A. Vian. London. Improvements in and relating to electrical secondary batteries.*

February 27, 1900.

3,762. F. de Mare and E. Frenny. Glasgow. The application of steatite to electrical purposes as an insulating material.
3,789. E. B. Fahnestock. London. Improvements in telephone transmitters.*
3,821. W. Davey. Kingston-on-Thames. The electrical referee.
3,834. N. W. Storer. London. Improvements in and relating to electric generators and motors. (Date applied for under Patents, &c., Act, 1883, Sec. 103, July 28, 1899, being date of application in United States.)

February 28, 1900.

3,886. T. M. Heaphy. London. Improvements connected with fire alarm thermostats.
3,913. Arthur Wright and The Reason Manufacturing Co. (Ltd.). London. Improvements in or connected with the metering of electricity.
3,917. J. Lorwa. London. Improvements in electricity meters.
3,922. J. H. F. Krull. London. Improvements in holders for electric glow lamps.

March 1, 1900.

3,933. J. W. Oldfield. Bradford. Improvements in the method of and apparatus for reversing the trolley in electric tramcars and other like vehicles.
3,937. W. Thomson, Baron Kelvin. Glasgow. Electric feeder log.
3,949. R. F. Collinge and R. J. Collard. Liverpool. An improved electrical speed indicator.
3,961. F. A. Wilkinson. Manchester. Improvements in and relating to electric traction.
3,968. A. Muirhead and R. H. Edgar. London. Improvements in recording instruments for electric telegraphs.
3,969. W. F. Jones. London. Improvements in electric switches.
3,981. A. F. Biddle. Birmingham. Improvements in apparatus for switching on and off lamps in electrical illumination, particularly in advertising.
3,992. W. L. Wise. London. Improvements in voltmeters (The Actien-Gesellschaft Electricitatswerke (vorm. O. L. Kummer and Co.), Germany.
3,993. W. M. Mordey. London. Improvements in electricity measuring instruments.

March 2, 1900.

4,002. W. S. Brentnall and E. Brentnall. Manchester. Improvements in or connected with electrical switches.
4,022. Eduard, Baron von Mairhofen. London. Improved means for use in the distribution of electric current in electric road traction.
4,026. J. Lea. London. Improvements in electricity meters.
4,038. B. Hopkinson. London. Improvements in electrical resistances.
4,046. C. A. Hemingway and R. J. Coley. London. Improvements in or connected with fusible cut-outs for electric installations.

March 3, 1900.

4,081. H. Sheble. Manchester. Improvements in phonograph or graphophone instruments.*
4,105. B. J. B. Mills. London. Improvements in electric tramways. (E. Bonnet, J. Paufique, and G. Linière, France.)
4,109. F. W. Golby. London. An improved electric clock. (H. Hansen, Germany.)*
4,122. E. Kühlstein and J. Vollmer. London. Improvements in switch contacts for use in electrical ignition devices for multi cylinder explosion motors.*

March 5, 1900.

4,157. B. M. Drake and J. M. Gorham. London. Improvement in electric accumulator traction.
4,168. L. Cerebotani and A. Silbermann. London. Improvements in devices for rapidly transmitting impulses of current.*
4,190. L. Boulard. London. Improvements in solution for galvanic batteries.
4,193. P. M. Justice. London. Improvements in signalling devices for telephone systems. (H. M. Williams, United States.)*
4,198. R de Lamprecht. London. A new or improved time apparatus for making and breaking telephonic and telegraphic circuits.

March 6, 1900.

4,230. H. D. Fitzpatrick. Glasgow. Improvements in electric gas lighters. (C. Hubert, United States.)*
4,236. T. A. Rose. London. Improvements in filaments for incandescent electric lamps.
4,247. G. Harrison, of the firm of D. Young and Co. London. An improved method of and apparatus for galvanising metal strips, sheets, plates, wires and the like. (The New Process Coating Co., United States.)*
4,248. The British Thomson-Houston Co. (Ltd.). London. Improvements in switches or circuit-breakers for high-potential electric circuits. (E. W. Rice, jun., United States.)*
4,262. P. A. Newton. London. Improvements in storage batteries and in the method of making electrodes therefor. (The Knickerbocker Trust Co., United States.)*
4,268. H. H. Lake. London. Improvements in tools for use in the laying of tile conduits for electrical conductors. (American Vitrified Conduit Co., United States.)*
4,287. W. Aitken. London. Improvements in telephonic intercommunication systems.
4,308. R. A. Fessenden. London. Improvements in incandescent lamps. (Date applied for under Patents, &c., Act, 1883, sec. 103, Aug. 7, 1899, being date of application in United States.)*

March 7, 1900.

4,358. H. C. Swindell. Birmingham. Improvements in electric bell pushes.
4,365. D. Shoolbred. London. Improvements in translucent reflectors for incandescent electric lamps and the like.*
4,369. J. J. Rawlings and W. R. Rawlings. London. Improved couplings for electrical connections.*
4,376. E. Emerson. London. Improvements relating to the electrolytic production of metal bars for the manufacture of wire.
4,383. J. C. Lincoln. London. Improvements in and or connected with electric controlling apparatus.*
4,387. C. J. Young. London. Improvements relating to systems of alternating current electrical distribution. (Date applied for under Patents, &c., Act, 1883, sec. 103, Aug. 8, 1899, being date of application in United States.)
4,390. Veritys Ltd. and R. H. Rogers. Birmingham. Improvements in electrical switches.

March 8, 1900.

4,408. J. Dewar. Glasgow. Improvements in and relating to electric fittings.
4,457. W. Schade. London. Improvements in door locks operated by electricity for engaging and disengaging bolts.*
4,461. W. J. Glover. Liverpool. Improvements in or relating to electric cables or conductors.

March 9, 1900.

4,472. A. M. E. Berthier. London. Improvements in electric motors.
4,489. A. M. Young. Manchester. Improvements in primary batteries.
4,500. H. Hirst and J. H. Collings. London. A new or improved self-locking elbow joint for electrical fittings.
4,508. M. Garl. London. Improvements in electric signalling systems for railways.*
4,509. E. H. Tyler. London. Improvements in electric traction.
4,527. C. Adams-Randall. London. Improvements in multiple-contact telephone transmitters and circuits relating thereto.
4,528. C. Adams-Randall. London. Improvements in electric telephony.
4,555. J. G. Lorrain. London. Improvements in or connected with electric distribution. (F. Bedell, United States.)
4,557. W. P. Thompson. London. Improvements in the distribution of electric current, and apparatus therefor. (J. Dulait and O. Garbe, Belgium.)
4,561. A. F. Cothias. Liverpool. Improvements in or connected with electric trolleys and other electrically conducting mechanical parts.*

March 10, 1900.

4,570. W. H. Vaughan and T. Foster. Manchester. Improvements in overhead travelling electric cranes.
4,586. L. Cerebotani and A. Silbermann. London. Improvements in telegraph receivers.*
4,591. P. Warwick-Davies. London. Improvements in electricity meters or measuring apparatus.
4,607. H. von Arnswaldt. Liverpool. Improvements in electrical gas lighters.*
4,617. H. F. K. Picard. London. Improvements in applying electric currents to electric lighting.
4,622. A. Reichwald. London. Improvements in and mechanism for reversing electromotors. (The firm of F. Krupp, Germany.)

SPECIFICATIONS PUBLISHED.

Note.—All Specifications can now be obtained at the uniform price of 8d. each.

1899.

2,849. Kreuser. Electromagnetic apparatus for separating ores.
3,469. Encausse and Encausse. Primary battery.
3,597. Boult (Continental Hall Signal Co.). Electric railway switching and signalling apparatus.
3,746. Murphy. Electric switch.
3,869. Cranston and Williams. Coin controlled and registering telephone apparatus.
4,821. Brookes (Stort). Motor suspension for electrically-driven vehicles.
4,941. Eck. Governing of electric motors.
5,211. Miller. Electric incandescent lamps.
5,392. Earle. Controlling switches for electric motors.
5,486. Allingham and Fennell. Electric incandescence lamps.
5,647. Gladstone and Beckett. Secondary batteries.
5,657. Marconi and Wireless Telegraph and Signal Co. (Ltd) Apparatus employed in wireless telegraphy.
6,149. Voelker. Manufacture of filaments for incandescing electric lamps and means applicable for use in such manufacture.
6,322. Whalley. Electric cables.
6,473. Bollé (Fitzlaff). Electrical apparatus for igniting gas burners from a distance.
7,041. Day. Electric arc lamps.
7,364. Kunkelmann, François and Loubery. Means for controlling and indicating the supply of electrical energy.
7,584. Crompton and Co. (Ltd.) and Dix. Electric switches and cut-outs.
7,618. Abel (Soc. Anon. pour la Transmission de la Force par l'Electricité). Electrical apparatus for diminishing the apparent self-induction of alternating current-circuits, and capable of being used in lieu of condensers.
7,800. Calthrop (Peebles). Fusible electric cut-outs.
8,052. Edmunds. Means for controlling electric circuits which will allow a circuit to be broken and completed from another circuit.
8,053. Edmunds. Device for automatically effecting the breaking of an electric circuit after a predetermined time.
9,938. Petzenbürger and Haisl. Protective conduit for the current conveyers of electric railways.
10,416. Mengarini. Incandescent electric lamps.
11,436. Flohr and Dietze. Rheostats.
12,842. British Thomson-Houston Co. (Ltd.). (Thomson.) Electrostatic measuring instruments.
18,776. Gibbs. Arrangement of driving mechanism for connecting electromotors to machinery.
21,665. British Thomson-Houston Co. (Ltd.). (Fleming) Electric arc lamps.
21,666. British Thomson-Houston Co. (Ltd.). (Steinmetz.) Automatic cut-outs for rotatory electrical converters and for alternators.
21,742. McTighe. Electric railway rail bonds. (Date applied for under International Convention, May 24, 1899.)
21,780. Lake (Nixon). Electric relays.
22,710. Lake. (Stepanov.) Apparatus for the electrolytic extraction of zinc.
23,829. Koppelmann. System for the generation of electric currents at constant potential.
24,148. Lühne. Electric furnaces for making glass and other analogous substances.

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1900.

261. Gover and Moffat. Safety electric fuses.
675. Lake (McCartney). Electric batteries.
1,009. McCabe and Goughenour. Electrically or magnetically operated locks.
1,086. Lawton. Electric heater for heating water or other fluids.
1,147. Jensen (Browning Manufacturing Co.). Electric motors for rotatory dental tools and the like.
1,475. Schiele and Boisselot. Electric igniters for explosion motors.

COMPANIES' MEETINGS AND REPORTS.

National Electric Wiring Co. (Ltd.).

The third ordinary general meeting of this company was held on Monday, under the presidency of Mr. R. Stewart Bain, C.A.

The SECRETARY (Mr. W. B. Cownie) having read the notice calling the meeting,

The CHAIRMAN said: When I addressed you last I expressed the hope that when we next met we might be in a position to recommend a dividend. That hope, I am glad to say, has been fulfilled; and although the dividend is not a large one, it is a beginning, and the promise, I trust, of larger dividends in the future. Considering, too, that it has been earned in the second year of the company's existence, we have every reason to congratulate ourselves. You will notice from the report that our business has shown a steady rate of increase during the year. We completed 1,970 installations, equivalent to an aggregate of 51,774 8 c.p. lamps—an increase of 994 installations, with 27,276 lamps, as compared with the previous fifteen months. Of these 838 installations with 24,654 8 c.p. lamps were free-wired, and 1,132 installations with 27,120 8 c.p. lamps were contract. We had in hand at the end of the year orders for 395 installations with an aggregate of 13,012 8 c.p. lamps, and since the books were closed we have received further orders for 478 installations, equivalent to an aggregate of 13,021 8 c.p. lamps. This is more than double the number we had in hand when we started last year. These new orders are very nearly equally divided between free-wired and contract. It will probably make it clearer, and show the progress we are making, if I say that the orders we have taken for the first three months of the current year more than exceed the whole of the orders we took for the first six months of last year. During the year we entered into free-wiring contracts and opened branches in the following towns: Gloucester, Rathmines and Rathgar, Pembroke, Coventry, Bangor, Greenock, Belfast, Stirling, Crewe, and one or two minor places, and with the following supply companies: The Newmarket Electric Light Co., the Crystal Palace District Electric Supply Co., the Woolwich Electric Light Co. the Northampton Electric Light Co., the Salisbury Electric Light Co., and one or two other small ones. The majority of the free-wiring contracts are of a profitable nature, and these have proved useful as feeders for our contract work. Some of the older ones, however, have not proved as profitable as we expected, and these we have terminated. In addition to the contracts actually concluded, others have been arranged, and in the case of three important districts they are only waiting to be sealed. It will be seen, therefore, that we have no lack of work for the current year. I think I ought to say here that one important contract has been confirmed during the last few days—that with Poplar, which promises to be a profitable one. We have two others which we think will turn out equally well, and I am informed that they will be sealed at the next meetings of the Corporations. If you will now turn to the accounts, it will be seen that our gross revenue for the year was £5,648. 11s. 3d., as compared with £3,244. 11s. 3d. for the previous 15 months. Of this amount £1,439. 18s. 11d. was from free-wired installations, as compared with £735. 6s. 4d. for the previous year, so that the receipts from this source have nearly doubled themselves. It is from this item that we look for a steady annual increase, and every installation we connect is a permanent source of revenue. We started the present year with 1,514 free-wired installations, all of which were revenue earning, as compared with 680 for the preceding year, and our revenue for the quarter ending December last was more than double that for the corresponding quarter of 1898. I think we have every reason, therefore, to take that as a guide in estimating what the following quarters will be this year as compared with last year. Our profit for contract work is £3,386. 11s. 10d., as compared with £2,037. 4s. 4d. for the preceding 15 months—an increase of about 65 per cent., which may be considered satisfactory. We have carried out some important contracts during the year, all of which, I am glad to say, have given satisfaction; and another satisfactory feature is that the cost of installing per 8 c.p. lamp still keeps within the figures which we gave in the prospectus. The receipts from interest, discounts, &c., amount to £840—also a substantial increase as compared with last year. Turning to the other side of the account, it will be seen that our total expenses are £3,862. 18s. 1d., an increase of £1,840. 15s. 1d., as shown in the previous account. This increase is principally in the first item, and is owing to the large number of new branches we have opened during the year. We look upon that increase in the light of sowing seed from which we ultimately hope to reap a good harvest. After referring to the question of directors' fees, the chairman proceeded: We have written off, and provided for, bad and doubtful debts £245. 2s. 1d., which we believe to be a full provision. To the balance then left—£1,785. 13s. 2d.—we have to add the amount brought forward from last year £1,222. 8s. 3d., making a total of £3.008. 1s. 5d. Out of this we have made a provision to cover possible allowances on contracts in course of settlement, £650, and have written off £575. 4s. for depreciation, of which you will see £337. 2s. 10d. is on free-wired installations. We have done this in accordance with our statement in the prospectus that before paying a dividend an amount shall be set aside yearly to form a sinking fund. We wrote £121. 8s. 1d. off this account last year, so that you see while we have declared a dividend we have also provided for depreciation. The balance then remaining is £1,782. 17s. 5d., out of which we recommend that a dividend at the rate of 3 per cent. per annum be paid, which will enable us to carry forward a balance of £281. 1s. 5d. Turning now to the balance-sheet, you will see that the total amount of capital, including the 18,851 shares paid to the vendors, is £69,911. Since the end of the year we have made a call of 2s. 6d. per share, which places us in funds for the present to meet the increase of business in connection with the opening of our new branches. The total amount due by us is £4,399—not a very large sum I venture to think. On the other side you will see that the value of our free-wired installations is £21,282, 11s. 8d., as compared with £9,729. 13s. 3d. in the last balance-sheet, an increase of £11,552. 18s. 5d., which will give you a good idea of the work we have done during the year. Our outlay on contracts in course of completion—namely, £5,581. 1s. 11d.—is slightly less than last year. The next four items—namely, stock (£8,400. 4s. 6d.), furniture and fixtures (£1,412. 5s. 3d.), advertising (£236), and expenses in opening new branches (£742)—all show increases on last year owing to our having opened and stocked some 15 new branches. You will see that in each of these items we have provided for depreciation. The amounts due to us—namely, £9,722 5s. 9d.—for the same reason is more than double. These, however, after making provision for doubtful debts, we believe to be all good. Having now explained the accounts (I hope to your satisfaction), it only remains for me to state that we are greatly indebted to our principal manager, Mr. Cownie, our district managers, and our staff generally, for the zeal and ability with which they have discharged their respective duties. I now move the adoption of the report and accounts and the payment of dividends recommended therein.

Mr. J. W. SWAN, F.R.S., seconded the motion, which was carried unanimously.

The retiring directors, Mr. George Ellis, J.P., and Mr. J. W. Swan were re-elected, and the auditors reappointed, and a cordial vote of thanks to the chairman and directors terminated the proceedings.

Folkestone Electricity Supply Co. (Ltd.).

The annual meeting was held on Saturday, when the chairman (Ald. G. Spurgen, J.P.) said the capital expenditure during the year had been £21,400, increasing the total outlay to over £64,000. The capital was only £54,000, and the directors had decided to issue £25,000 of debentures at 4½ per cent., which he hoped the shareholders would take up. They had had an unprecedented number of applications for electric current during the year, and found they were unable to go on satisfying the demand unless they made provision for additional new machinery, and for the extension of the buildings. The directors had not expected to have to make provision for extensions so soon. When they started they considered that provision for supplying the equivalent of 10,000 or 12,000 8 c.p. lamps would be sufficient for some time; but during last year their business had increased by over 7,000 lamps—from 10,089 to 17,834. During the present year they had put in 1,111 additional lamps, and there was every indication of the demand increasing. They had applications in hand for another 500 odd lights to be put in next month, and therefore they must make provision for the future. Of the lamps wired last year, more than half the total increase (4,540) was connected in the second half of the year, and 1,500 in September. They were starting the year with 17,834, and had installed 1,111 since, and he believed he would be within the mark in saying they would put in 500 new lights a month throughout the year. During the past year the number of units sold was 209,931, and the revenue £4,156. 8s. 6d., giving an average cost to the consumer of about 4¾d. per unit. That was their first year of working, and they proposed to pay a 4 per cent. dividend. In connection with the item of £2,709. 16s. 6d. for installation work for consumers, on which a profit of only £20. 1s. 6d. had been brought into the year's accounts, some shareholders might think this a small profit on such an outlay, but the company were anxious to get as much business as they could, and a great many people said they would like to have the electric light but they could not face the initial cost of the installation. The company had, therefore, put in installations at practically cost price. By this means they had gained many consumers on the supply of current to whom they made a profit. The directors desired to offer an expression of appreciation to Mr. Hesketh, their engineer, and the members of the staff for the assiduous manner in which they had worked for the company. The directors' report was adopted.

Brockie-Pell Arc Lamp (Ltd.).

The report of the directors of this company for the twelve months to Dec. 31 announces that the progress in the company's business shows a further improvement in its profits and management. The profit and loss account, before charging depreciation, shows a credit balance of £1,237. 13s. 7d., against a debit balance of £1,496. 15s. 5d. for the preceding twelve months, which the directors have applied as under: 5 per cent. for two years to depreciation of plant and machinery, furniture and fixtures, tools and patterns, £798. 10s. 3d., leaving £439. 3s. 4d., which is carried forward. The serious and continued increase in the price of metals has affected the company's profits. The sales of the company's patent lamps show an increase over the preceding year, these lamps having during the past year been supplied to the Corporations of South Shields, Ayr, Greenock, and Stirling; to H.M. Government, the L. and N. W. Railway, and to the city of Gloucester and the London Vestries of Lambeth and Poplar.

The directors are increasingly convinced of the great advantage that has accrued to the company from the appointment of Mr. Shrimpton as

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managing director, and consider it is largely due to his ability and devotion to its service, upon a very inadequate remuneration, that the company is in such a different position to that it formerly occupied.

The plant and machinery have been maintained in thorough efficiency, and additions have been made during the past year.

The serious inadequacy of the company's present works has led the directors to secure larger and more suitable premises at 60, Worship-street, Finsbury, E.C., where with increased facilities the directors will not only be able to meet the present increasing demand for the company's patent lamps and to keep the necessary stock, but also to cope with a still larger business they are confidently looking for in the near future.

Willans and Robinson (Ltd.).

The report of the directors of this company for the half-year to Dec. 31 states that, after writing off £5,658. 15s. 10d. for depreciation and paying interest upon debenture stock, the balance profit for the half-year (including £4,944. 2s. 6d. brought forward) is £32,140. 13s. 6d. The directors propose that dividends at the rate of 6 per cent. per annum on the preference and 10 per cent. per annum on the ordinary shares be paid (absorbing £13,324. 4s. 5d.), and a bonus of 2 per cent. upon the ordinary shares for the year 1899 (absorbing £3,193. 6s. 10d.) The sum payable to the original directors is £4,911. 1s. 2d., leaving £10,712. 1s. 1d. From this sum the directors propose to carry £2,000 to debenture redemption and £3,500 to reserve, leaving £5,212. 1s. 1d. to be carried forward. The directors will shortly invite applications from shareholders for 10,000 preference and 10,000 ordinary shares under authority of the resolution passed March 29, 1899.

NEW COMPANIES, STATUTORY RETURNS, &c.

McNAMARA'S BIRMINGHAM (LTD.)—This company was registered on March 30, with a capital of £10,000, in £1 shares (5,000 preference), to acquire the business carried on by McNamara and Co., Birmingham, and to carry on the business of electrical and general engineers, founders, and electrolier manufacturers, &c.

DAY, POOL AND CO. (LTD.)—This company was registered on March 30, with a capital of £5,000, in £1 shares, to acquire the business carried on under the style of Day, Pool and Co., and to carry on the business of electricians and engineers.

ANGLO-AMERICAN TELEGRAPH CO. (LTD.)—The annual return to Feb. 16 shows that the entire capital stock of £7,000,000 has been taken up and paid in full.

CAMBRIDGE ELECTRIC SUPPLY CO. (LTD.).—The annual return to March 2 gives the capital as £100,000, in £10 shares, 9,423 of which have been taken up. £8 per share has been called up on 4,970, and £4 per share on 4,453.

ELECTRICAL LUMINISCRIPTOR CO. (LTD.)—The annual return to Feb. 16 gives the capital as £75,000 in £1 shares, of which 40,761 have been taken up. £1 per share has been called on 4,807, and £35,954 is considered as paid on the remaining shares.

KENSINGTON AND KNIGHTSBRIDGE ELECTRIC LIGHTING CO. (LTD.)—The annual return to Feb. 28 gives the capital as £350,000 in 50,000 ordinary, 10,000 first preference, and 10,000 second preference shares, all of £5 each. 15,000 ordinary and all the first and second preference shares have been taken up. £5 per share has been called on 10,000 ordinary, 10,000 first preference, and 9,131 second preference, and £1. 10s. per share on 869 second preference.

LONDON ELECTRIC WIRE CO. (LTD.)—The annual return to Feb. 13 has been filed. The capital is £100,000 in £5 shares (10,000 preference), of which 7,512 preference and 8,295 ordinary have been taken up. £5 per share has been called up on 3,652 preference and 4,435 ordinary, resulting in the receipt of £40,435. £38,600 is considered as paid up on 3,860 preference and 3,860 ordinary shares.

NATIONAL ELECTRIC SUPPLY CO. (LTD.).—The annual return to Feb. 28 has been filed. The capital is £84,943. 15s. in 9,050 preference shares of £5 each, 10,850 ordinary shares of £3. 12s. 6d. each, and 100 founders' shares of £3. 12s. 6d. each. 3,050 preference, and all the ordinary and founders' shares have been taken up. £5 per share has been called up on the preference, and £3. 12s. 6d. on the ordinary and founders' shares.

NEWCASTLE AND DISTRICT ELECTRIC LIGHTING CO. (LTD.)—In the annual return to Feb. 27 the capital is given at £100,000 in £10 shares, all of which have been taken up, and £9 per share has been called up.

NEWCASTLE-ON-TYNE ELECTRIC SUPPLY CO. (LTD.)—According to annual return to March 8 the capital is £100,000 in £6 shares, 18,595 of which have been taken up. £5 per share has been called up on 11,958 and £3. 15s. per share on 5,964. £86,831. 5s. has been received, including £4,676. 5s. paid in advance. 673 shares are considered as fully paid.

SMITHFIELD MARKETS ELECTRIC SUPPLY CO. (LTD.)—In the annual return to Feb. 23 the capital is given at £100,000 in £5 shares, 12,000 of which have been taken up and paid for in full.

ST. JAMES' AND PALL MALL ELECTRIC LIGHT CO. (LTD.)—According to the annual return to Feb. 27, the capital is £300,000 in 20,000 preference and 40,000 ordinary shares of £5 each, all of which have been taken up and paid for in full.

WESTMINSTER ELECTRIC SUPPLY CORPORATION (LTD.)—The annual return to March 7 gives the capital as £399,500 in £5 shares, all of which have been taken up and paid for in full.

CITY NOTES.

MEMORANDA.—Bank rate 4 per cent. (since Jan. 25, 1900). Price of silver 27½d. per oz. (April 5). Consols (2¾ per cent.) 101¼—101½ for money, 101⅝—101¾ for account; 2½ per cent. 98—98½ (April 5). Stock Exchange Settling Day: Consols, May 4; Stocks and Shares Continuation Days, April 9 and 25; Ticket Days, April 10 and 25; Pay Days, April 11 and 27; Mining Share Carry-over Days, April 6 and 24.

ALLGEMEINE ELEKTRICITATS GESELLSCHAFT.—It is proposed to convert the Austrian business of this company into an independent company with a capital of 5,000,000 marks.

ALLGEMEINE OESTERREICHISCHE ELEKTRICITATS GESELLSCHAFT (WIEN).—A dividend at the rate of 7 per cent. per annum has been declared, the same as last year.

ANGLO-AMERICAN TELEGRAPH CO. (LTD.).—The directors have resolved, after placing £6,000 to credit of renewal fund, to declare an interim dividend for the quarter ended March 31 of 15s. per cent. on the ordinary and £1. 10s. per cent. on the preferred stock, less tax, payable May 1.

ANGLO-ARGENTINE TRAMWAYS CO.—The annual report states that about 2½ miles of track have been renewed during the year with steel girder rails, at a cost of £4,020. The negotiations for an electrical concession have been brought to a satisfactory conclusion. The period of the new concession is 99 years, and relates to several new routes, which should prove of great service in facilitating and developing the traffic when the conversion of the system to electrical working is completed.

BABCOCK AND WILCOX (LTD.).—The directors' report states that the profits for the year to Dec. 31 last, after deducting the amount written off purchase of business account, amounts (with £9,330. 11s. 10d. brought forward) to £115,918. 19s. Interim dividends account for £25,000, and from the remaining £90,918. 19s. the directors recommend a dividend at the rate of 6 per cent. per annum on the preference, and of 20s. per share (10 per cent. tax free) on the ordinary shares, placing £50,000 to reserve and carrying forward £15,918. 19s.

BRITISH INSULATED WIRE CO. (LTD.).—The *Statist*, in its issue of the 31st ult., in a review of this company's financial position, refers to the recent increase of the nominal capital of the company to £1,000,000, and deals with the share capital of the company from the investors' point of view. The article concludes as follows:—

"We called attention to the ordinary shares a year and a half ago, when they were quoted at 8⅜. At the present price of 13½, the yield is nearly 7½ per cent. on a 20 per cent. dividend distribution, as for 1899. It is of course impossible to say how long the business will continue to expand as it is doing at present, and the value of the patents necessarily diminishes as time goes on. On the other hand, the board contains good names, and the fact that the company's business has been prudently and successfully managed during the past three years is a satisfactory augury for the future. The ordinary shares therefore offer decided inducements to those prepared to take some risk, particularly as they will carry rights to the subscription of the new capital, probably on favourable terms. The preference shares we regard as cheap at the present price. An issue of 12,500 of them was subscribed last year at £6, and at 6¼ the yield is over 4¾ per cent. Even if we assume that the whole of the additional preference capital to be authorised is called up at once, making a total of that denomination of £500,000, the amount required in the way of dividend would be only £30,000. From the accounts of 1899 it is shown that, after paying all expenses, debenture interest, depreciation, &c., there remains a balance of £54,000, or nearly double the amount required for dividend on the full preference capital ultimately to be issued. As it is practically certain that the increased capital will lead to considerably larger profits, the position of the preference shareholders is a strong one, and the shares are worth the attention of those who desire a fairly high yield coupled with adequate security."

BRITISH WESTINGHOUSE ELECTRIC AND MFG. CO. (LTD.).—The directors have declared an interim dividend to Jan. 31 on the 100,000 preference shares in respect of £3 per share paid thereon at that date.

DEUTSCHE SEE-TELEGRAPHEN GESELLSCHAFT.—A dividend of 6 per cent. has been declared for the year 1899. The gross profit amounted to 441,478 marks (about £22,000), net profit 257,288 marks (about £12,860).

ELECTROLYTIC ALKALI CO. (LTD.).—The statutory meeting of this company was held on Friday. The chairman (Mr. W. Thomson) said the company had been successfully floated and 14 patents had been purchased from the parent company, to whom £14,480 had been paid for land at Middlewich. The erection of works had been commenced, and brine was being bored for. Mr. Hargreaves, the surviving inventor of the electrolytic process, had been added to the board, and Mr. Davidson had been appointed manager. The manufacture of products was expected to commence before August.

METROPOLITAN DISTRICT RAILWAY CO.—At an extraordinary meeting on Friday, the company's parliamentary bill was approved. Powers are being sought to work the line electrically, to acquire land at Lots-road, Chelsea, for a generating station, and to confer upon the District Co. reciprocal clauses to those which the Metropolitan Co. possess.

ORIENTAL TELEPHONE AND ELECTRIC CO. (LTD.)—Subject to audit, a further dividend of 8d. per share, free of tax, making, with interim dividend, 5 per cent. for the year to Dec. 31 last, is recommended by the directors.

POTTERIES ELECTRIC TRACTION (LTD.).—During the week subscriptions for £125,000 4½ per cent. debenture stock at 103 per cent. have been invited.

SIEMENS AND HALSKE AKTIEN-GESELLSCHAFT.—At the general meeting of this company, to be held on 19th inst., a proposal will be laid before the shareholders for increasing the capital from 45,000,000 marks to 54,500,000 marks (from £2,250,000 to £2,725,000), to enable the company, among other things, to acquire £200,000 worth of shares in Messrs. Siemens Bros. and Co. (Ltd.) (of London) and 2,000,000 roubles

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in the subsidiary company at St. Petersburg, which are at present held by members of the Siemens family at Berlin. The parent company will thus acquire a direct interest in the Russian and English branches.

STOCK EXCHANGE NOTICES.—April 10 has been appointed a special settling day in the full and partly-paid provisional certificates for £120,000 5 per cent. second debenture stock of the *Buenos Ayres and Belgrano Electric Tramways Co. (Ltd.)*. The provisional certificates (£57. 10s. per cent. to be paid) for £120,000 5 per cent. second debenture stock of the same company, as well as the further issue of 18,000 4½ per cent. (£5 fully-paid) preference shares (Nos. 12,001 to 30,000) of *W. T. Henley's Telegraph Works Co. (Ltd.)* have been ordered to be quoted in the official list. Application has been made to appoint a special settling day in and to grant a quotation to £70,000 4½ per cent. debenture stock of the *Bournemouth and Poole Electricity Supply Co. (Ltd.)*, and to allow 60,000 £10 fully-paid ordinary shares (Nos. 1 to 60,000) and 59,987 6 per cent. £10 fully-paid preference shares and £300,000 3½ per cent. mortgage debentures of the *Dublin United Tramways Co. (Ltd.)* to be quoted in the official list.

SUBMARINE CABLES TRUST.—The coupon due on 15th inst. will be paid in full by Messrs. Glyn, Mills and Co., 67, Lombard-street, E.C., on and after Tuesday, 17th inst.

THAMES IRON WORKS, SHIPBUILDING AND ENGINEERING CO. (LTD.).—The first annual report of the directors states that the company has shared in the general trade prosperity of the country, and has succeeded in creating for itself the record of having simultaneously in construction four first-class battleships for the British and the Japanese Governments. The remodelling of the company's new works at Greenwich and Deptford has been satisfactorily completed, the shops have been equipped with the most modern labour-saving tools, the eight hours' day has been established, and as regards high-class machinery, the company is prepared to compete with its most enterprising rivals. Every department has been successful in making a profit on the year's working, and the contracts in hand will keep the company busy for more than two years. In view of the magnitude of present contracts (exceeding £1,500,000 with the Admiralty alone) and the company's constantly increasing business the directors propose an increase of £100,000 of working capital. The profits of the year (£43,731. 7s. 1d.) are to be divided as follows: (*a*) to old company £25,431. 4s. 7d.; (*b*) to new company £18,300. 2s. 6d. From the latter amount the directors recommend a dividend of 5 per cent. (less tax) to Dec. 31, 1899, upon the preference shares, absorbing £4,231. 1s. 10d., leaving £14,069. 0s. 8d. to be carried forward.

UNION ELEKTRICITATS GESELLSCHAFT.—A dividend of 10 per cent. for the past year has been declared.

WESTMINSTER ELECTRIC SUPPLY CORPORATION (LTD.).—An extraordinary meeting will be held at the offices, Eccleston-place, S.W., on 11th inst., to approve the increase of the capital from £399,500 to £500,000 by the creation of 30,100 ordinary shares, of £5 each, and authorising the issue of 20,100 of the shares at £10 per share.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	1900	£	£		£	£
*Birmingham Tramways.	Mar. 31	3,977	− 35	13	51,234	+ 2,430
Blackpool Corporation...	„ 29	156	− 8	52	22,534	+ 4,441
Blackpool and Fleetwood	„ 31	200	− 233	13	2,072	− 448
†Bradford Corporation...	„ 30	242	...	85	28,301	...
Brisbane Trams	Feb. 14	1,834	+ 573	20	41,527	+12,700
*Bristol Trams & Carriage	Mar. 30	2,552	− 194	13	33,346	+ 970
*Buenos Ayres & Belgrano	„ 4	2,393	+ 244	9	21,237	+ 5,435
City & South London Ry.	Apr. 1	1,360	+ 471	13	14,579	+ 1,701
Dover Corporation	Mar. 31	145	− 54	52	10,067	+ 1,023
Dublin United	„ 30	2,935	+ 251	13	36,695	} +3279
Dublin Southern Dist....	„ 30	654	− 8	13	7,662	
*Glasgow Corporation ...	„ 31	8,478	+ 84	...	...	...
*Liverpool Corporation...	„ 24	6,563	+1,012	12	79,506	+ 9,951
Liverpool Overhead Rly.	Apr. 1	1,277	− 128	13	18,137	+ 1,112
*Sheffield Tramways	„ 1	1,890	+ 592	13	23,605	+ 7,724
*South Staffs. Trams.....	Mar. 30	617	+ 45	13	7,827	+ 162

* Partly electrical. † 5 days.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, March 28.	Price Wednesday, April 4.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending April 4. Highest	Lowest
			TELEGRAPHS.			£ s. d.			
£110,900	100	4%	*African Direct Telegraph 4% Mort. Deb. (red.)	100 104	100 104	3 17 4	January and July	...	...
35,000	10	...	Amazon Telegraph	3 4	3 4	...	June and December	...	...
£135,000	100	5%	Do. 5 per Cent. Debentures	85 90	85 90	5 11 1	...	...	...
£375,520	Stock	28/6	Anglo-American	65 68	65 68	5 8 7	Feb., May, Aug., Nov.	...	...
£2,063,240	Stock	20/0	Do. Preferred	117 118	117 118	5 2 7	„ „	117¾	117
£2,063,240	Stock	27/0	Do. Deferred	15 15½	15 15½	8 14 1	...	15⅝	15 15/16
$10,000,000	$100	$1½	Commercial Cable Capital Stock xd	165 175	165 175	4 11 5	Jan., Apr., July, Oct.	...	...
£1,563,078	Stock	4%	* Do. 4 per Cent. Debenture Stock xd	103 105	103 105	3 16 2	„ „	103⅜	...
16,000	10	8/0	Cuba Submarine Ordinary	9 10	9 10	8 0 0	February and August	...	...
6,000	10	10/0	Do. Preference 10 per Cent.	19 20	19 20	5 0 0	„ „	20	...
12,981	5	2/0	Direct Spanish Ordinary xd	4 5	4 5	4 0 0	April and October	...	...
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference ...xd	9 10	9 10	5 0 0	„ „	10	...
£30,000	50	4½%	Do. 4½ per Cent. Debentures	101⅞ 105⅞	101⅞ 105⅞	4 5 9	January and July	...	...
60,710	20	3/0	Direct United States Cable	11⅛ 12	11⅛ 12	5 16 8	Jan., Apr., July, Oct.	11⅜	...
£120,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red.)	100 103	100 103	4 8 0	June and December	...	...
£4,000,000	Stock	5%	Eastern Ordinary	155 160	152 157	4 10 0	Jan., Apr., July, Oct.	155	153
£1,795,000	Stock	3½%	Do. 3½ per Cent. Preference Stock	98 101	98 101	3 9 3	„ „	100¾	99
£1,432,268	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.)	116 121	115 120	3 7 8	May and November	118	116
250,000	10	2/6	Eastern Extension	16 16½	16 16½	4 4 10	Jan., Apr., July, Oct.	16 1/16	16¼
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	115 120	115 120	3 6 8	February and August	116	115
£6,700	100	5%	* Do. 5% (Austln. Gov. Sub.) Deb.,1900 (reg.)	100 103	100 103	4 17 1	January and July	...	...
£26,600	100	5%	Do. (Bearer)	100 103	100 103	4 17 1	„ „	...	...
£200,000	100	4%	*Eastern and S. African 4% Mort. Deb., 1909	100 103	100 103	3 18 5	February and August	...	...
£200,000	25	4%	Do. 4 per Cent. Mauritius Sub. Debs.(red.)	101⅞ 104⅞	101⅞ 104⅞	3 16 10	May and November	...	...
180,227	10	1/9	Globe Telegraph and Trust	11⅛ 12	11⅛ 12	4 7 6	Jan., Apr., July, Oct.	11 1/16	11⅛
180,042	10	3/0	Do. 6 per Cent. Preference	15½ 16	15½ 16	3 15 0	„ „	16	15 15/16
150,000	10	5/0	Great Northern of Copenhagen	32 34	32 34	3 13 6	January and July	33	...
£26,300	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb.(red.)	100 103	100 103	4 8 0	...	...	...
17,000	25	12/6	Indo-European	54 58	54 58	4 6 2	May and November	...	...
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904	105 108	105 108	5 11 7	March and September	..	...
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.)	102 105	102 105	3 16 9	June and December	...	...
11,839	8	4/0	Reuter's	7 8	7 8	5 0 0	April and October	...	...
2,381	£100 Cert.	6%	Submarine Cables Trust	126 131	126 131	4 13 5	„ „	...	...
15,609	10	...	West African Telegraph	2½ 3½	2½ 3½	4 9 3	December and July	...	...
£200,000	100	5%	* Do. 5 per Cent. Debentures (red.)	97 100	97 100	5 0 4	March and September	...	...
30,008	2½	...	West Coast of America	½ 1	½ 1	...	...	...	...
£150,000	100	4%	* Do. 4 per Cent. Debentures	100 103	100 104	3 14 5	January and July	...	...
88,321	10	6d.	West India and Panama	⅞ 1⅛	⅞ 1⅛	...	May and November	...	...
34,563	10	6/0	Do. 6 per Cent. 1st Preference	9½ 9⅝	9½ 9⅝	6 3 1	„ „	9⅝	9 5/8
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	7 8	7 8	7 10 0	„ „	...	...
£80,000	100	5%	* Do. 5 per Cent. Debentures	104 107	104 107	4 13 6	January and July	...	...
£389,731	Stock	4%	Western & Brazilian 4 per Cent. Debenture Stock	100 104	100 104	3 16 11	June and December	...	...
207,930	10	3/0	Western Telegraph (late Brazilian Submarine) ...xd	14½ 15½	14¾ 15½	4 11 10	Mar., June, Oct., Dec.	15	14¾
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1900)	106 109	106 109	4 11 9	June and December	...	...
£158,100	100	6%	*Western Union 6 per Cent. Sterling Bonds (red.)	...	...	5 17 8	March and September	...	...
			TELEPHONES.						
44,000	£5	3/0	Chili Telephone (fully paid)	2 3	2 3	6 13 4	August	...	...
224,850	10s.	0/1½	Consolidated Telephone Const. & Manufacturing	¼ ½	¼ ½	4 15 3	July	...	...
72,680	1	2½%	Monte Video Telephone Ordinary	½ ¾	½ ¾	5 0 0	November	...	...
96,492	1	1 0	Do. 5 per Cent. Preference	¾ 1	¾ 1	5 0 0	„	...	...
490,000	5	3/0	National	5 5½	5 5½	5 14 3	February and August	5⅛	5 1/16
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Preference	14 15	14 15	4 0 0	„ „	14½	...
15,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference	14 15	14 15	4 0 0	„ „	...	...
250,000	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref.	5½ 5½	5¼ 5⅜	4 10 11	„ „	5 7/16	5¼
2,000,000	Stock	3½%	* Do. Debenture Stock 3½ per Cent. (red.)	97 100	97 100	3 10 0	June and December	98½	97
171,504	1	0/4	Oriental	½ 1	½ 1	5 0 0	April and October	...	...
58,000	5	2/6	United River Plate	4¾ 5¼	4¾ 5¼	7 2 10	July	...	...
16,639	5	1/4	Do. 5% Cumulative Preference	4¾ 5¼	4¾ 5¼	4 15 3	June and December	...	...
£179,947	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	103 106	103 103	4 14 4	„ „	...	...

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, March 28.		Price Wednesday, April 4.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending April 4.	
								£ s. d.		Highest	Lowest
			ELECTRICITY SUPPLY COMPANIES.								
100,000	1	...	Bl'ckh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.)	⅞	1	⅞	1	...	...	1⅛	⅞
6,000	10	10/0	Bournemouth and Poole Elec. Supply Ord. ... xd	12	13	11⅞	12⅞	3 11 3	...	...	...
6,000	10	4/6	Do. 4½ per Cent. Cumulative Pref.	10	11	10	11	4 1 10	...	...	...
19,661	5	3/6	Brompton & Kensington Electricity Supply Ord. xd	7	8	7	8	3 15 0	...	7⅛	...
12,000	5	3/6	Do. 7 per Cent. Preference ... xd	8¼	9¼	8¼	9¼	3 13 8	March and September	8⅝	...
20,000	5	...	Calcutta Elec. Supply Ordinary (fully paid) ...	7	7½	7	7½	...	...	7⅞	7⅝
50,000	5	5/0	Charing Cross & Strand Electricity Supply Corp. ...	9⅛	10⅛	9⅛	10⅛	4 5 9	February and August	10⅛	...
20,000	5	2/3	Do. 4½ per Cent. Preference ...	5⅛	6	5⅛	6	3 15 0	,, ,,	...	...
34,000	5	3/6	Chelsea Electricity Supply Ordinary ...	7	8	7	8	3 15 0	March ...	...	...
£150,000	Stock	4½%	* Do. 4½ per Cent. Debenture Stock (red.) ...	110	112	108	111	4 2 2	June and December...	...	...
$1,200,000	$1,000	5%	Chicago Edison 1st Mort. 5% 30 yr. Gold Bonds (red.) ..	100	110	100	110	4 10 11	April and October...	...	...
60,000	10	8/0	City of London Electric Lighting Ord. ... xd & x new	10	11	10	11	3 13 9	February and August	10⅛	9⅛
40,000	10	6%	Do. 6 per Cent. Cumulative Pref. .xd & x new	13	14	12⅛	13⅛	4 8 11	January and July...	13⅛	...
£100,000	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.) ...	122	127	122	127	3 18 9	June and December ...	127	125
40,000	10	8/0	County of London and Brush Prov. Ordinary ... xd	9⅛	10⅛	9⅛	10⅛	3 16 2	...	10⅛	10
20,000	10	6/0	Do. 6 per Cent. Cumulative Preference ... xd	12⅛	13⅛	12⅛	13⅛	4 8 11	March and September	...	...
£200,000	Stock	4½%	Do. 4½% Deb. Stock Certs. (all pd.) (red.) ...	109	112	109	112	4 0 11	...	...	...
15,000	5	10%	Kensington and Knightsbridge Ordinary ...	12⅛	13⅛	12⅛	13⅛	4 1 6	...	...	...
10,000	5	6%	Do. 6 per Cent. 1st Preference ...	7	7½	7	7½	4 0 0	January and July...	...	...
110,000	3	...	London Electric Supply Ordinary ...	1⅝	2⅛	1⅝	2⅛	...	...	...	...
48,050	5	3/0	Do. 6 per Cent. Preference ...	4⅛	5⅛	4⅛	5	6 0 0	...	...	...
£250,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures ...	100	103	100	103	3 19 3	Mar., June, Sept., Dec.	...	...
85,000	10	5/0	Metropolitan Elec. Supply Ord. ...	14	15	14	15	3 6 8	April and October ...	14⅞	14⅛
£220,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage ...	114	117	114	117	3 16 11	June and December ...	...	...
£125,000	Stock	24/8	Do. 3½ per Cent. Mort. Deb. Stock (red.) ...	96	98	96	98	3 11 10	...	97⅛	97⅛
6,452	10	8/0	Notting Hill Electric Ordinary ...	15½	16½	15½	16½	4 4 10	March ...	...	...
10,000	5	5/0	Oxford Electric Ordinary ...	6⅝	7	6⅝	7	3 11 5	,,	...	...
300,000	1	8%	Rand Electric ...	⅞	1	⅞	1	10 13 4	...	...	...
£130,070	Stock	5%	River Plate El. Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb. ...	75	85	75	85	5 18 0	...	...	...
150,000	$100	$2	Royal Electric Company of Montreal Shares ...	150	170	170	190	4 5 1	...	...	...
£123,200	100	4½%	* Do. 4½ per Cent. 1st Mortgage Debentures xd	104	106	103	105	4 5 9	April and October...	...	...
40,000	5	9/6	St. James's and Pall Mall Electric Ordinary ...	14	15	14⅛	15⅛	4 13 7	February and August	14⅞	14⅛
20,000	5	3/6	Do. 7 per Cent. Preference ...	8½	9½	8½	9½	3 13 8	,, ,,	9	...
12,000	5	...	Smithfield Markets Electric Supply Ordinary ...	2⅛	2⅝	2⅛	2⅝	...	...	2	...
£50,000	Stock	...	Do. 4% Debentures ...	85	95	85	95	...	...	...	...
85,000	5	...	South London Electric Supply Ordinary (fully paid)	4	4½	4	4½	...	...	4⅛	...
79,900	5	8/0	Westminster Electric Supply Ordinary ...	13½	14½	14½	15½	4 3 10	March and September	13⅝	14⅛
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
125,000	1	7½d.	Aron Electricity Meter 6 per Cent. Cum. Pref. ... xd	⅞	1	⅞	1	7 7 8	...	...	...
45,000	1	...	British Electric Works Co. Ordinary ...	⅝	1	⅝	1	...	...	...	...
50,000	1	...	Do. 5 per Cent. Cumulative Preference ...	⅝	1	⅝	1	...	...	...	...
£50,000	100	4½%	Do. First Mortgage Debentures ...	99	101	99	101	...	...	...	...
40,000	5	15/0	British Insulated Wire Ordinary ...	11	12	11	12	4 3 4	...	...	...
27,500	5	3/0	Do. 6 per Cent. Preference ...	6	6½	6	6½	4 12 4	...	6⅝	...
100,000	5	...	British Westinghouse 6% Preference ...	4⅜	5⅛	4⅜	5⅛	...	...	...	...
90,000	2	1/2⅜	Brush Electrical Engineering ... xd & x new	1⅝	2⅛	1⅞	2	4 0 0	September ...	2	1⅝
90,000	2	1/2⅜	Do. 6 per Cent. Pref. Non-Cum. ... xd & x new	2⅛	2⅝	2⅛	2⅝	5 1 1	,,	2⅝	2⅛
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Deb. Stock ...	103	113	109	113	3 19 8	February and August	...	...
£108,710	Stock	19/1	* Do. 2nd Debenture Stock (red.) ...	103	105	103	105	4 5 9	June and December ...	...	...
20,000	5	5/0	Callender's Cable Construction Ordinary ...	14⅛	15⅛	14⅛	15⅛	4 16 9	,, ,,	15⅜	14⅛
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference ...	5⅛	6	5⅛	6	4 3 4	...	...	...
£90,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb. (red.) ...	112	116	112	116	3 18 5	November and May ...	...	...
300,000	1	0/9⅜	Castner-Kellner Alkali Co. (fully paid) ...	1⅛	1⅜	1⅛	1⅜	5 16 5	...	1⅛	...
60,000	1	0/7⅛	Chadburn's Ship Telegraph Ordinary ...	⅝	1⅛	⅝	1⅛	5 6 8	...	...	...
60,000	1	0/7⅛	Do. 6 per Cent. Cumulative Preference ... xd	⅝	1⅛	⅝	1⅛	5 6 8	...	...	...
32,098	3	1/9⅜	Crompton and Co. (Nos. 1 to 32,098) ...	3½	4	3½	4	4 10 9	January and July...	...	...
£100,000	100	5%	* Do. 5 per Cent. First Mortgage Deb. (red.) ...	98	101	98	101	4 19 0	,, ,,	...	...
60,000	1	0/7⅛	Davis and Timmins 6 per Cent. Cum. Pref. ... xd	⅞	1⅛	⅞	1⅛	5 6 8	...	...	...
99,261	5	1/9⅜	Edison and Swan United ("A" Shares) (£3 paid) ...	2	2⅛	2	2⅛	7 3 9	February and August	...	...
17,139	5	2/9⅜	Do. (£5 paid) ...	3½	4⅛	3½	4⅛	6 13 4	,, ,,	...	...
£344,023	Stock	4%	Do. 4 per Cent. Mortgage Deb. Stock (red.) ...	93	95	93	95	4 4 3	June and December ...	...	...
26,100	5	5/11⅛	Edmundson's Electric Corporation Ord. (fully pd.) ...	4⅛	5⅛	4⅛	5⅛	5 14 3	Half-yearly ...	...	...
112,100	2	1/2⅜	Electric Construction Co. (Limited) ...	2⅛	2⅜	2⅛	2⅜	4 16 0	January and July...	2⅛	...
25,000	2	2/9⅜	Do. 7 per Cent. Cumulative Preference ...	2⅛	3⅛	2⅛	3⅛	4 6 2	July ...	...	...
182,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.) ...	104	107	104	107	3 15 2	January and July...	...	...
91,195	1	...	Elmore's Patent Copper Depositing ...	⅜	⅝	⅜	⅝	...	...	...	...
30,000	5	11 0	Henley's Telegraph Works Ordinary ...	13½	14⅛	13½	14½	3 15 10	February and August	14⅛	13⅝
30,000	5	1/8	Do. 4½ per Cent. Preference ...	5½	5⅞	5½	5⅞	3 18 3	,, ,,	5⅞	...
£50,000	Stock	4½%	Do. 4½ per Cent. Mortgage Deb. Stock (red.) ...	110	114	110	114	3 18 11	,, ,,	...	...
50,000	10	10/0	India Rubber, Gutta Percha, &c., Works ...	21	22	21	22	4 11 10	,, ,,	...	...
£300,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.) ... xd	100	101	100	103	3 17 6	March and September	...	...
37,350	12	24/0	Telegraph Construction and Maintenance ...	36	40	38	40	4 9 11	March and July...	...	...
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909 ...	102	105	102	105	3 16 2	...	...	...
20,000	5	3/0	Do. Manufacturing Ordinary ...	9	10	9⅛	10⅛	3 6 8	...	10⅛	10⅛
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference ... xd	5⅛	6	5⅛	5⅞	4 6 11	...	...	...
30,000	5	5/0	Willans and Robinson Ordinary ...	11	12	12	13	3 9 3	April and October...	13	11
30,000	5	3/0	Do. 6 per Cent. Cumulative Preference ...	7⅛	7⅞	7⅛	7⅞	3 17 5	,, ,,	7⅝	...
£100,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Debentures ...	104	106	104	106	4 0 3	May and November ...	...	...
			ELECTRIC RAILWAYS, TRAMWAYS, &c.								
12,000	10	10/0	Blackpool and Fleetwood Tramways ...	17	18	17	18	4 8 11	...	...	...
£167,900	100	5%	Brisbane Tramway 5 per Cent. Debentures ...	104	106	104	106	4 14 4	...	...	...
50,000	10	8%	Bristol Tramways and Carriage Ordinary ... xd	22½	23½	22½	23½	...	February and August	...	...
25,000	10	4%	Do. Cumulative Preference (£8 paid) ...	6¼	6¾	8¼	8¾	...	...	...	...
£100,000	Stock	4%	Do. 4 per Cent. Debentures ...	117	118	117	118	3 7 3	...	...	...
12,000	10	...	British Columbia Electric Railway 5% Pref. ...	10½	10¾	10½	10¾	...	...	10⅝	10⅜
30,000	10	9/0	British Electric Traction Ordinary (Nos. 1 to 30,000)	17	18	17	18	3 6 8	...	17⅛	17⅛
£15,000	10	...	Do. (Nos. 60,001 to 75,000) ...	15⅜	17⅜	16⅜	17⅜	...	...	...	...
30,000	10	6/0	Do. 6% Cum. Pref. (Nos. 30,001 to 60,000) ...	13	13⅜	12⅞	13⅛	4 10 7	...	13⅛	12⅞
£200,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures ... xd	126	127	124	127	3 18 9	...	...	...
40,000	5	1/9	Buenos Ayres & Belgrano 6% "A" Cum. Pref. ...	4⅞	5⅛	4⅞	5⅛	5 17 1	...	...	...
27,500	5	...	Do. "B" ...	4	4⅜	4	4⅜	...	...	...	...
320,000	Stock	5%	Do. 5 per Cent. Debentures ...	105	108	105	108	4 12 7	...	...	...
213,553	10	3/0	Central London Ordinary ...	10	10⅛	10⅛	10⅞	2 15 10	June and December ...	10⅛	...
£855,000	Stock	1½%	City and South London Railway Con. Ordinary ...	67	70	67	70	2 13 11	January and July...	68⅛	67⅞
37,500	10	...	Do. (Nos. 22,501 to 60,000) (£5. 10s. paid) ...	4½	5⅛	6	7	...	...	...	...
£150,000	Stock	5%	Do. 5 per Cent. Perpetual Preference (1891) ...	140	145	140	145	3 9 0	January and July...	...	...
£200,000	Stock	5%	Do. (1896) ...	132	137	132	137	3 13 0	...	...	...
£187,701	Stock	4%	Do. 4 per Cent. Perpetual Debenture ...	125	130	125	130	3 1 11	May and November ...	125⅛	...
20,000	10	8⅛%	†Imperial Tramways Ordinary ... xd	22⅛	24⅛	22⅛	23⅛	3 6 8	March and September	...	...
10,000	10	6%	† Do. 6 per Cent. Preference ... xd	14⅞	15⅞	14⅞	15⅞	3 17 5	,, ,,	...	...
£300,000	Stock	4½%	† Do. 4½ per Cent. Debenture ...	113	116	113	115	3 17 11	January and July...	...	...
30,000	10	1/3	Kidderminster & District E. L. & Tr'ct'n 5% Pref. ...	10	10⅜	10	10⅜	4 15 3	May and November ...	...	...
37,500	10	2½%	Liverpool Overhead Railway Ordinary ...	8⅜	8⅝	8⅜	8⅝	4 4 6	February and August	...	...
10,000	10	5%	Do. 5 per Cent. Preference ...	13	13½	13⅛	13⅜	3 14 1	,, ,,	...	...
125,000	Stock	4%	Do. 4 per Cent. Debenture ...	105	107	105	107	3 15 1	January and July...	...	...
24,000	5	...	New General Traction Ordinary ...	3¾	4⅛	3¾	4⅛	...	...	...	...
30,000	5	6/0	Do. 6 per Cent. Cumulative Preference ...	5	5⅜	5	5⅛	5 9 1	May ...	...	...
4,000	10	...	Oldham, Ashton and Hyde Elec. Tramway Ord. ...	18	19	16	18	...	February and August	...	...
4,000	10	5/0	Do. 5 per Cent. Preference ...	10⅜	10¾	10⅜	10⅞	4 13 0	,, ,,	...	...
13,334	10	...	Potteries Electric Traction Ordinary ...	11⅛	12⅛	11⅛	12⅛	...	...	...	...
20,000	10	5/0	Do. 5 per Cent. Cumulative Preference ...	10	11	10	11	4 10 11	...	...	...
£540,000	Stock	3%	Waterloo and City Ordinary ...	101	104	101	104	3 17 8	June and December ...	106½	102

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption.

† The London Stock Exchange Committee refuses to quote these.

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THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,143. [No. 25. Vol. XLIV.] FRIDAY, APRIL 13, 1900. PRICE SIXPENCE (by post, 6½d.), Abroad, 8d., or 15 cents, or 30 fr., or 70 pf.

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NOTES.

DRASTIC indeed, if not absolutely prohibitive, are the conditions with regard to change-over from 100 volts to a higher pressure upon which the London County Council's Highways Committee have induced the Council to consent to the modification projected by the City of London Electric Lighting Co. for its Southwark area of supply. These conditions are set out in another column this week. Among them it will be found that the company is to carry out the changes in wiring of consumers' premises, &c., at its own cost; is to allow not less than 15 per cent. reduction in price of electrical supply to all consumers changed over; is to impose no extra charge on consumers who object to change; and is to make good any defect arising from a change-over within a year of the date when the wiring is altered or the pressure is raised, whichever is the later date. These are some samples of the conditions it is sought to impose, conditions which, we repeat, make a change-over practically prohibitive from the company's point of view, and are unnecessarily drastic as regards the safeguarding of public interests. Of course, the company can appeal to the Board of Trade.

THE first public claim to a block of ether, in London, has been staked out by the London County Council, who have decided to adopt a wireless telegraph apparatus at a fire station they have recently placed in Mitcham-lane, Streatham, S.W. This will be in communication with the street station on Streatham Green. The Wireless Telegraph and Signal Co. have agreed to instal the apparatus for two years for £50 per annum, which compares favourably with the estimate of £280 for a telephone and call-bell installation. Thus has commenced that municipalisation of the ether which we foresaw in the early days of wireless telegraphy, and who shall say how long it will be before the monopoly of the ether is claimed by local authorities as their own inalienable right?

WHILE activity is being shown in the projected development of the single-rail system of traction between Liverpool and Manchester in this country, no less activity has been exhibited and a further stage of progress has been reached in Germany, where a single-rail overhead railway, eight miles in length, has already been constructed between Barmen and Vohwinkel, passing *en route* through the town of Elberfeld. This railway, like the English one, is to be worked electrically; in fact, it will be put in operation shortly. There are important differences in the construction of the German line and of the projected Liverpool-Manchester express line. The latter is on the Lartigue system, which has been tried on an experimental scale between Listowel and Ballybunion, in Ireland. The Barmen-Elberfeld line has been built by Messrs. SIEMENS and HALSKE on the system devised by EUGEN LANGEN. In the Lartigue system the car or train straddles the rail and rides upon it; in the Langen system the car is suspended vertically beneath the rail, the truck carrying the motor and driving wheels being attached to the roof of the car.

THE latter form appears to us to possess the advantage of imparting greater stability to the car when in motion, especially for high-speed working; but the construction required for the Langen railway would probably cost considerably more than for a Lartigue line of equal carrying capacity and running at the same speed, unless, indeed, the Lartigue line were to be built at the high elevation above the ground essential on the Langen system. It will be easier, however, to compare the merits of the two systems when both these lines shall have been running for a length of time; although, unfortunately, the very low speed—only some 30 miles an hour—adopted for the Barmen-Elberfeld line will render comparison in some respects difficult.

ELECTRIC traction undoubtedly facilitates the construction and working of single-rail railways. The small weight of each moving unit, and the high speeds and accelerations, which the introduction of the electric motor has rendered possible, must soon bring into prominence the advantages of this type of line wherever "rapid transit" and cheap construction are desired. Nothing better, for example,

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than a single-rail system could have been adopted for the line which, if constructed, is to provide a frequent service of express cars between Liverpool and Manchester, though we are not sure that the particular single-rail system chosen is best suited to the purpose.

Our contemporary, the *Engineer*, publishes an interesting but hardly conclusive note on some tests made to determine the order of the increase in the resistance of copper wire during its manufacture into cable. It is known that the handling of copper wire tends to increase its specific resistance, independently of the stretching that takes place during stranding; but from the brief description of the tests it would seem that the large relative increase noted in the resistance must have been due to both these causes. Besides the stretching and consequent decrease in diameter, it is also possible that the resistance may have been increased by the fact of the individual wires being longer than the finished cable owing to the spiral course of each strand. The copper wire had originally a conductivity of 101 to 102 per cent. of Matthiessen's standard, and it is stated that the completed 91-strand cable was found to have a conductivity of but 98 per cent. Accurate tests to determine independently the decrease in conductance of annealed copper due to ordinary handling, stretching in the stranding machine, compressing under the stamping machine, and that due to "loss in lay" in the strand, would be most useful.

King's College (London).—The special evening course of lectures and laboratory work on alternating currents commences on 30th inst.

Municipal Electrical Association.—The annual convention of this Association will take place at Huddersfield, from June 20th to 23rd inclusive. Mr. A. B. Mountain is to be President this year.

The Electrical Engineers (R.E.) Volunteers.—It is announced that a second detachment of E.E. Volunteers from Chelmsford will sail from Southampton on the 14th inst. by the s.s. "Canada."

Telephone Statistics.—It is estimated, from statistics recently published in America, that there are nearly 1,200,000 miles of copper wire used in the telephone service in the United States, and that close on 4,000,000 effective calls are made daily in the various exchanges.

Protection of Public Buildings from Lightning.—A Paper on this subject, with special reference to the rearrangements of the lightning conductors of St. Paul's Cathedral, will be read by Mr. Killingworth Hedges at the Royal Institute of British Architects, on April 23rd.

German Atlantic Cable.—Two vessels, having on board the Emden-Fayal (Azores) section of the German Atlantic cable, will proceed to sea about May 1st to lay this section. The vessels will most probably be the "Anglia" and the "Britannia," of the Telegraph Construction and Maintenance Co.'s fleet.

Cable Interruptions and Repairs:—

	Date of Interruption.	Date of Repair.
Latakia—Cyprus	June 21, 1899 ...	—
Cayenne—Pinhieros	Oct. 11, 1899 ...	—
Tangier—Tarifa	Jan. 3, 1900 ...	—
Paramaribo—Cayenne	Feb. 16, 1900 ..	—
Ceara—Maranham	Feb. 20, 1900 ...	—
Para—Maranham	Mar. 2, 1900 ...	—
Môle-St. Nicolas—Cap Haitien	Mar. 7, 1900 ...	—
Emden—Vigo	Mar. 26, 1900 ...	April 6, 1900
Trinidad—Demerara	Mar. 30, 1900 ...	—

The Royal Institution.—Among the lecture arrangements at the Royal Institution after Easter are the following: Prof. Dewar, four lectures on "A Century of Chemistry in the Royal Institution." The Friday evening discourses will be resumed on April 27, when a discourse will be given by the Right Hon. Lord Kelvin on "Nineteenth Century Clouds over the Dynamical Theory of Heat and Light." Succeeding discourses will probably be given by Prof. T. E. Thorpe, by Prof. J. A. Ewing on "The Structure of Metals," and others.

Rapid Spark Discharges.—According to a German contemporary, experiments have been carried out at Göttingen, by Herr H. T. Simon, to photograph successive spark discharges passing over parallel paths. It was found that a spark follows the same path as a preceding one if the interval between the two does not exceed 0·0028 seconds. If this interval is larger the spark follows a new zigzag path. This time-interval appears to be independent of the length of the spark-gap and of the materials of the terminals.

The Royal Meteorological Society's Jubilee.—On Tuesday the 3rd inst. the Royal Meteorological Society celebrated its jubilee. A commemoration meeting was held in the afternoon at the Institution of Civil Engineers, Great George-street, Westminster, Dr. C. Theodore Williams being in the chair. There was a large attendance, including delegates from a number of other scientific societies. Dr. Williams read an address by the late Mr. Symons, giving a brief history of the Society, and added some remarks in appreciation of Mr. Symons and also on the work of the Society. Brief congratulatory addresses were delivered by Prof. J. J. Thomson, F.R.S., on behalf of the Royal Society; by Mr. E. B. Knobel, President, on behalf of the Royal Astronomical Society; by Mr. J. J. H. Teall, F.R.S., President, on behalf of the Geological Society; by Mr. R. C. Mossman, F.R.S.E., on behalf of the Scottish Meteorological Society; and by Mr. A. Wynter Blyth, M.R.C.S., on behalf of the Sanitary Institute. Prof. Dr. G. Hellmann presented an address from the German Meteorological Society.

Obituary.—By the death on the 6th inst. of Mr. Charles Vincent Boys, in his 73rd year, after a short attack of bronchitis, there passed away a man who in the early days of telegraphy filled a somewhat unique position. Mr. Boys, after leaving school, commenced his career as a clerk in the British consulate at Frankfort up to 1847, when he entered the service of the Electric Telegraph Co., about a year after its incorporation. The directors of that company, finding it desirable to educate the public as to the value of the new system of speedy intercommunication, inaugurated an intelligence department for the purveying of news to the provincial Press, exchange news-rooms and reading-rooms, and placed the management of this department under Mr. Boys' control, he having by his attention to the interests of the company secured the high opinion of the chairman and directors. Mr. Boys held this position until the taking over of the companies by the Post Office in 1870, when he retired upon a handsome pension, and devoted his leisure for some years to literary and artistic pursuits. He was highly esteemed amongst his associates, both old and new, as a genial companion, somewhat of an oddity, and full of anecdotes of the numerous celebrities with whom his position in the Electric Telegraph Co. had brought him into contact. He was a true Bohemian, and occasionally visited his old haunts at the Savage Club and kindred rendezvous.

A Recent Marconi Patent.—In the transmission of messages by wireless telegraphy, where Marconi's aerial conductor method is used, some difficulty is experienced owing to this vertical wire becoming charged with atmospheric electricity. The operator thus becomes liable to receive shocks when changing over the vertical wire from the transmitting to the receiving circuit. This difficulty is overcome by the device described in the patent (5,657/1899) taken out by Mr. Marconi and the Wireless Telegraph and Signal Co. The principal feature of this invention consists in arranging the induction coil for producing the sparks with the secondary across the spark terminals for receiving as well as for transmitting. One of these terminals being connected to the vertical wire and the other to earth, there is thus a continual discharge to earth, and any accumulation of atmospheric electrification is thus prevented. A slightly modified form of Morse key for use in wireless

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telegraphy is also described. In this the forearm of the key is bent upwards beyond the pivot, and has fixed at its extremity a contact piece, which can make contact to a metal stud fixed to the base. The key is designed so as to enable the change-over of the vertical wire from the transmitting to the receiving circuit to be made automatically. The arrangement of the circuit for this purpose is as follows: One terminal of the spark-gap is connected to the vertical wire, and the other to earth; the secondary of the induction coil is connected across the spark-gap, through a small choking coil, and the primary is connected to the middle terminal of the key and the front contact point through the battery. When the key is released it falls back by its own weight and completes a circuit through the vertical wire and the receiver to earth. The secondary is now shunted across the coherer. It is recommended also that the line connecting the key to the receiving apparatus be contained in a metallic tube, to obviate any effects due to local transmitting signals. Besides the protection from shocks due to atmospheric electrification, which this method gives, it is further claimed that the operator is prevented from accidentally operating his transmitter at the same time as the aerial conductor at the operator's station is being used as a receiver.

A Central Battery Telephone System.—The following notes on the change-over of the Brooklyn exchange of the New York and New Jersey Telephone Co. are taken from an address delivered by the chief engineer and traffic manager of the exchange on the occasion of a recent visit of the New York Electrical Society. In this exchange district, to which about 3,000 subscribers are connected, the local battery has been removed from each subscriber's station, and current is furnished by a series of 11 storage cells of 1,250 ampere-hours capacity, located in the exchange. In the old or magneto system the subscriber's station was furnished with a magneto hand generator, and the exchange was on the ordinary multiple system with answering jacks and ring-off drops. The exchange has now a common-battery board of the multiple type, and on which the signals are lamps controlled by relays. A subscriber, on removing his receiver from the hook, lights a small incandescent lamp, known as the line lamp, located next to the answering jack of this subscriber's line, immediately before the operator. The operator makes the connection with a pair of connecting cords in the same manner as in and the magneto system, automatically extinguishing the line lamp. Each pair of connecting cords is provided with two keyboard signals, which are miniature incandescent lamps, and the operator, by their being lighted or unlighted, can tell whether the subscribers connected on these cords have their telephones on or off the hook. A lamp is lighted when the cord is connected to a subscriber's line and the receiver is on the hook. The lamp is extinguished while the telephone is off the hook, indicating that the line is in use. In connecting between two common-battery central offices this method of signalling is extended so that junction operators are informed automatically when the junction line shall be disconnected. In the temporary condition of affairs, when some exchanges are on the magneto system and some on the common-battery system, the full advantages of automatic signalling cannot be obtained. The underground cables carrying lines from subscribers' stations enter the building through iron pipes, and are connected to the main distributing rack on which the protective apparatus for the central office is placed. This rack has an ultimate capacity for 13,200 metallic circuits, and is arranged so that any pair of cable conductors can be cross-connected to any subscriber's line in the switchboard. From the main rack lead-covered, wool-insulated cables carry the lines to the intermediate distributing rack on the sixth floor, where the switchboard is located. The purpose of the intermediate rack is to enable subscribers' lines to be arranged in such groups on the switchboard as may be desired. On the same floor is a relay rack upon which the relays controlling the line and other signal lamps are placed. From the intermediate rack, lines are carried through the multiple board in cables containing 64 wires each, with silk and cotton insulation. Cables containing 84 wires each also run from this rack to the answering jacks and signals. The switchboard and auxiliary apparatus is designed for an ultimate capacity for 4,900 subscribers' lines and 950 junction lines. It is at present equipped with 3,000 subscribers' lines and 500 junction lines. The repeating coils in the cord circuits are placed on the rack in the power room, in which are also located the units for charging the storage battery, the storage battery itself, and the motor generators for ringing telephone bells and for other signalling purposes. The storage battery has sufficient capacity to supply current for two or three days in case of a breakdown, and the charging sets and signal machines are in duplicate.

British Insulated Wire Co.'s Staff Dinner.—On Friday last the British Insulated Wire Co.'s annual staff dinner was held at the Adelphi Hotel, Liverpool, about 100 being present. Besides the directors of the company and the staff, a number of guests had been invited, including a large number of municipal electrical engineers. After the loyal toasts had been responded to enthusiastically, Mr. Thomas Parker proposed "The Electrical Industry" in a characteristic speech, in which he deplored that so much electrical machinery that might have been manufactured in this country was ordered in America and Germany. He remembered in 1893, on the occasion of the opening of the Liverpool Overhead Railway, having prophesied that something of the sort would soon occur. He attributed this state of affairs to the Electric Lighting Act of 1882 (an Act which even Lord Salisbury had referred to afterwards as a "very silly" Act of Parliament), which had practically postponed the starting of the electrical industry in this country until the passing of the amended Act of 1888. When the Blackpool slotted conduit tramway was opened, he had shown American visitors over the line, and even in 1892 this country had no one before it; but now things had altered. He concluded by hoping that we might "get a little pace on." Mr. Ferranti responded to this lugubrious speech in a more cheerful tone. He referred sarcastically to the prefix "British," which, with, however, one notable exception in the British Insulated Wire Co., usually now implied a firm selling foreign-made machinery. Since he had replied to the same toast last year everyone had "put his house in order," and now the electrical industry was in a much better position to supply plant. English engineers, however, still made visits to America, and then thought it was the thing to order plant there. He concluded by referring to the fact that the same vested interests, against which electricity had had to fight in the early days, now desired a monopoly themselves, as instanced by their opposition to the large power schemes. Sir William Preece, in responding to the toast of the visitors (proposed by Alderman Snape), referred to the progress of the works since he first visited them in 1894. Then 70 men were employed; now there were 1,600, and the turn-over had increased ten times. After some interesting reminiscences of Faraday and rushlights, he came to the subject of Mr. Parker's speech, and cordially disagreed with that gentleman. He thought the Act of 1882 was most beneficial, in that it had checked wild speculative enterprises without checking the progress of the industry. The toast of the evening was proposed by Mr. A. H. Walton and responded to by the general manager, Mr. J. B. Atherton. Mr. Atherton mentioned that Mr. Ferranti had for some time past been directing his attention to the invention of a paper submarine cable. In proposing the health of the directors, Mr. G. H. Nisbett, the engineer-in-chief, referred to the cordiality and good feeling existing between all the members of the staff and the directors and management. One of the next additions at Prescot will be a technical school for the workpeople.—On Saturday morning an excursion was made to the works. (A description of these appeared in *The Electrician*, Vol. XLIII., p. 865.) There were evidences that the company was very busy, for hardly a machine was standing still. Some of the larger machines were occupied with a heavy three-core cable for the Manchester three-phase work. The latest addition to the works is a small wire-drawing plant, which has only been at work for a few days. At present it will not supply all the copper the works require, but it is already considerably more than an experiment.

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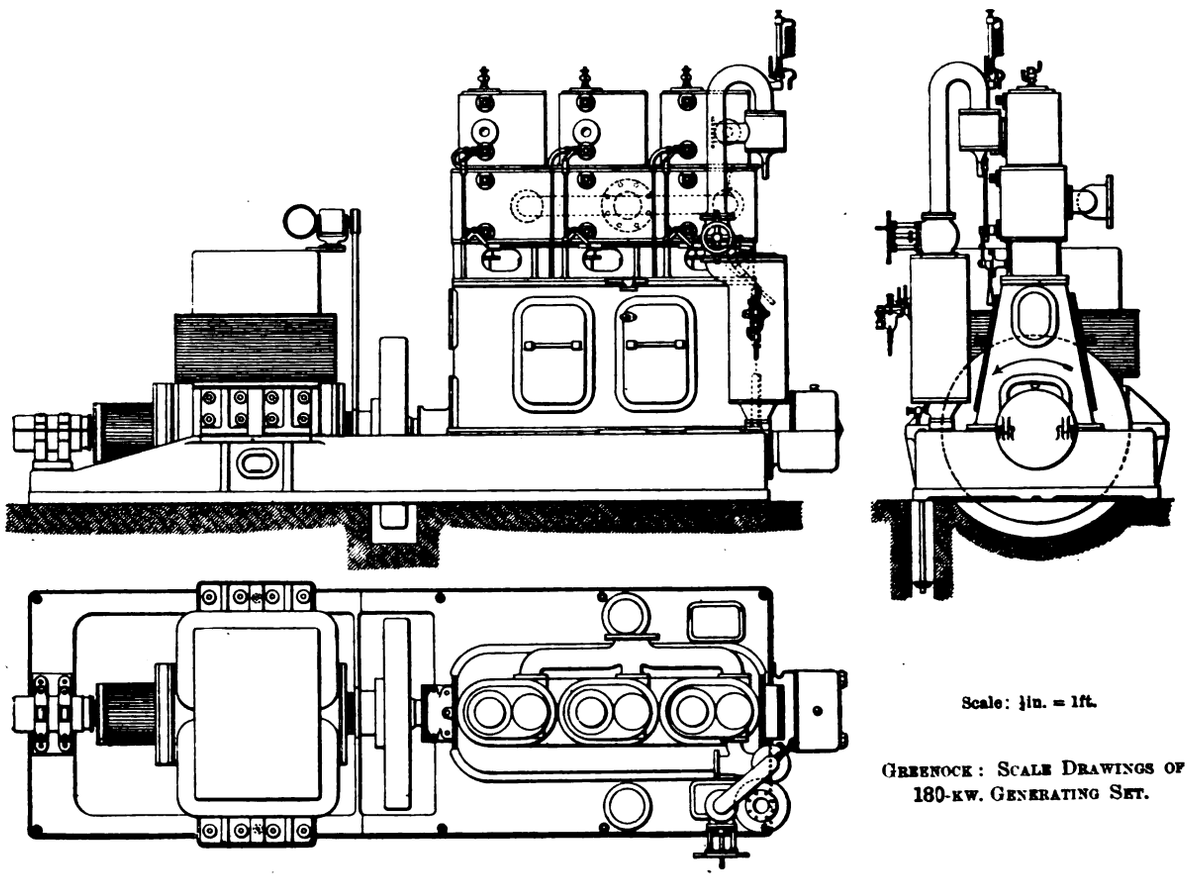
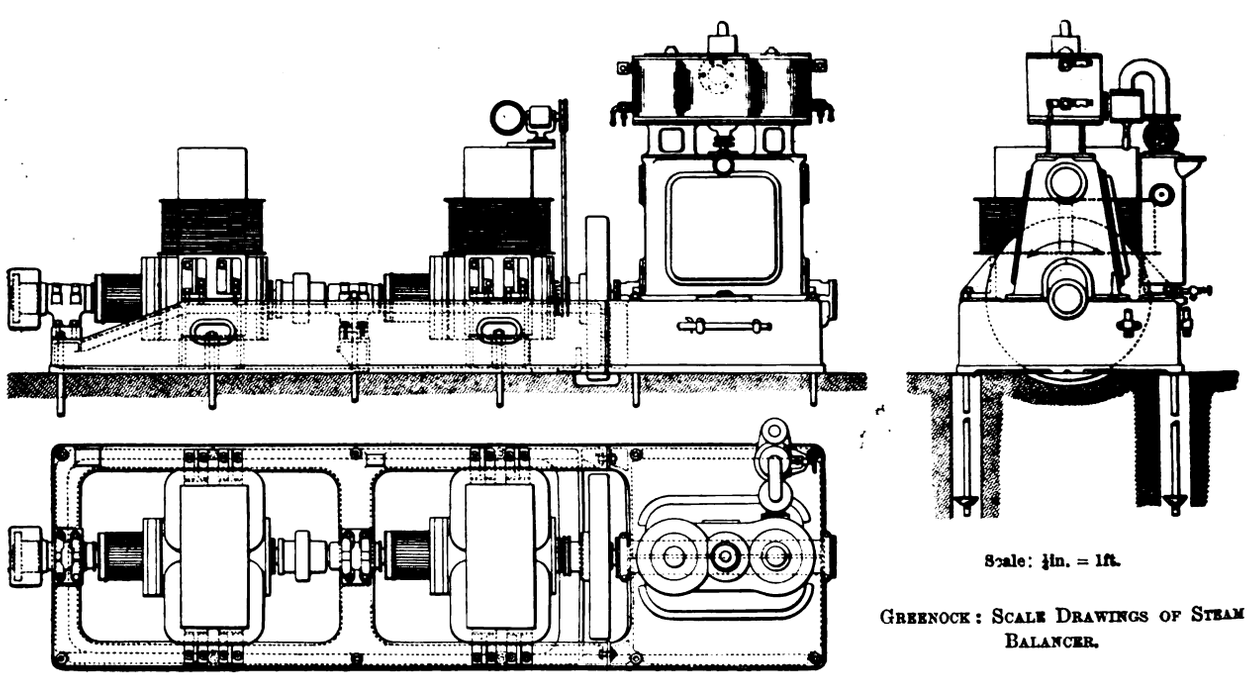
GREENOCK CORPORATION ELECTRICITY SUPPLY WORKS.

The history of the electric lighting in Greenock is of more than passing interest, in view of the fact that Greenock was one of the first, if not the very first, town in Scotland to obtain a provisional order and to erect public electric street lamps. A provisional order was obtained in May, 1883, and the experimental station was erected on a hill at the back of the town, the motive power being water from one of the numerous burns. Cables were carried down to the square and the Custom House Quay, where a few arc lamps were erected. The undertaking, however, was not very successful, and the lighting was discontinued after a short time. Although the town still held the provisional order, nothing further was done for a period of nearly 12 years, until the applications of two companies, one supported by leading local business men, forced the Corporation to take action. This they did by appointing a sub-committee, whose movements were accelerated by notice from the Board of Trade that, unless the powers vested in them were utilised within a reasonable time,



Scale: ½in. = 1ft.

GREENOCK: SCALE DRAWINGS OF 180-KW. GENERATING SET.



Scale: ½in. = 1ft.

GREENOCK: SCALE DRAWINGS OF STEAM BALANCER.

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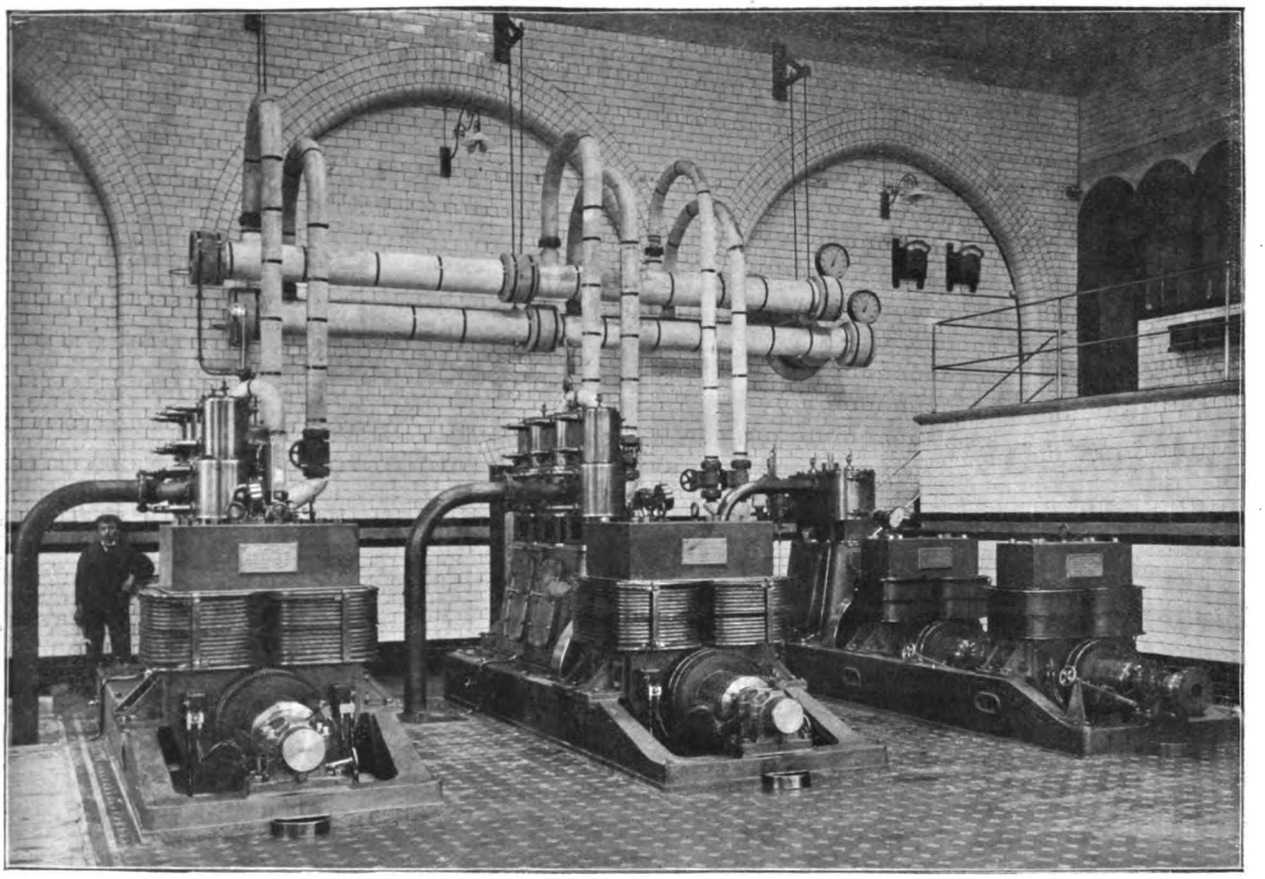
the order would be revoked and powers given to one of the rival companies; and this awakened the Greenock Corporation to a sense of their duty.

The first proceeding was to appoint an engineer, and the Council wisely decided to appoint a man of some eminence, so that he should act not only as resident engineer, but should also be qualified to design and carry out the whole station. The choice ultimately fell upon Mr. S. E. Fedden, late chief assistant at the Edinburgh Corporation station, and a more satisfactory choice could not have been made. After his appointment Mr. Fedden lost no time in maturing his scheme, the cost of which would be about £80,000, and submitting it to his committee, by whom it was adopted. Specifications were issued to the various contractors, and after tenders were received it was found that the total cost would reach £81,700. Tenders were accepted about the end of March, 1899, and a start was made with the buildings on the 17th April last. The works were opened for supply during last November, so that they were completed in about seven months; and it is here worthy of note that at the time of letting the contracts Mr. Fedden promised his committee that he would give them the light by Christmas, so that, contrary to their expectations, he was nearly a month ahead of his promise.

The works are laid down in Hunter-place, on an extensive site belonging to the Corporation, situated in the very centre of the supply area. The new buildings are a solid-looking structure, constructed of brick throughout, having steel girders and cement floors, the whole being practically fireproof. They are so arranged that the plant in them can be about doubled without additions to the buildings, although there is ground available for twice the existing buildings if needed in the future. The boiler house is on the ground level, and has an iron and glass roof. Leading from this at rather a higher level is the engine house, the general appearance of which will be seen from the illustrations. The west wall is at present only temporary, in view of future extensions. The office block consists of a ground floor and three storeys. The bottom floor is utilised as an accumulator room, and on this floor is also fitted a bath room with hot and cold water for use of the staff. The rooms for the chief engineer, assistant engineer, as well as the general offices, &c., are placed on the first floor; while the offices for the draughtsmen, superintendent of mains, superintendent of meters, &c., are placed on the second floor. The top flat is utilised for a meter and testing department, as well as a store room for the arc lamps. Some considerable difficulty was experienced with the foundations for the plant, owing to the fact that the station is built on the site of a disused tannery, and it was expected that a score or so of old tan pits would have to be uncovered and filled up. As it turned out, however, it was found that these drawbacks were far more numerous than anticipated—no fewer than 150 having been encountered by the workmen during their excavations! The outer walls of the engine room are 3ft. 6in. thick, and are built in cement, the gable end, as already noted, being only temporarily thrown up. The whole surface of the interior was first of all laid with 3ft. of concrete, and on the top of this block of concrete has been built the foundations upon which the engines now stand. At the east end of the engine room is an erection 9ft. high, upon which is placed the switchboard. Across and near the roof of the engine room is placed a powerful travelling crane made by Messrs. Carrick and Ritchie of Edinburgh, which is capable of easily lifting 15 tons, and which has been used for the erection of the whole of the machinery. The interior of this department presents a sweet and clean appearance, the walls being lined with white glazed bricks, while the floor space between the machinery is neatly laid with tiles.



GREENOCK: VIEW OF MACHINERY ROOM

The generating plant consists of two Silvertown 180 kw. steam dynamos, each giving an output of 300 amperes at 500 to 600 volts at 420 revs., and capable of an overload of 30 per cent. The dynamos have large commutators with carbon brushes, and are specially designed to meet Mr. Fedden's specification with respect to non-sparking at any load with the brushes in a fixed position. This condition is perfectly fulfilled. A special feature in the magnet windings is the division of the bobbins into two portions by means of an

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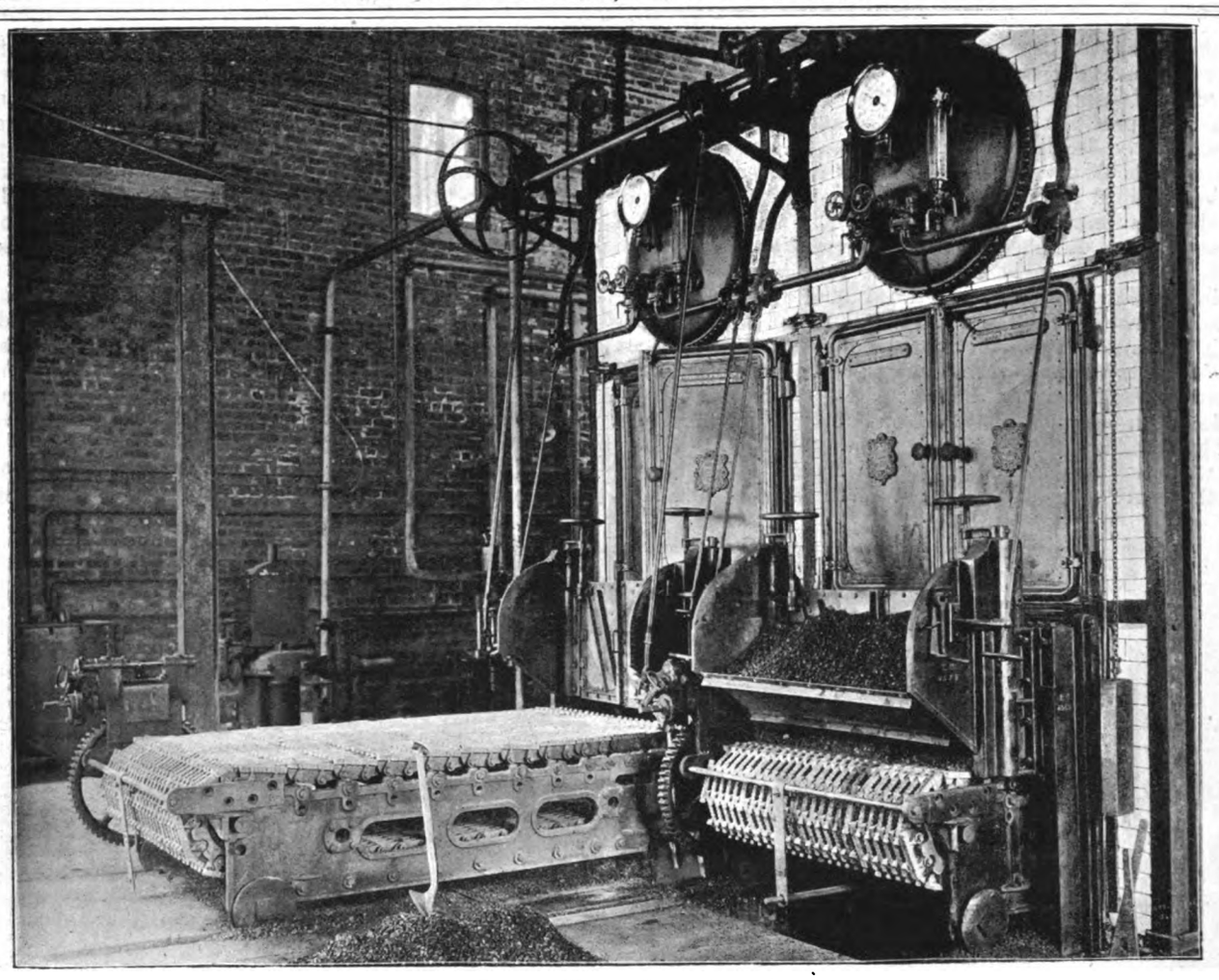
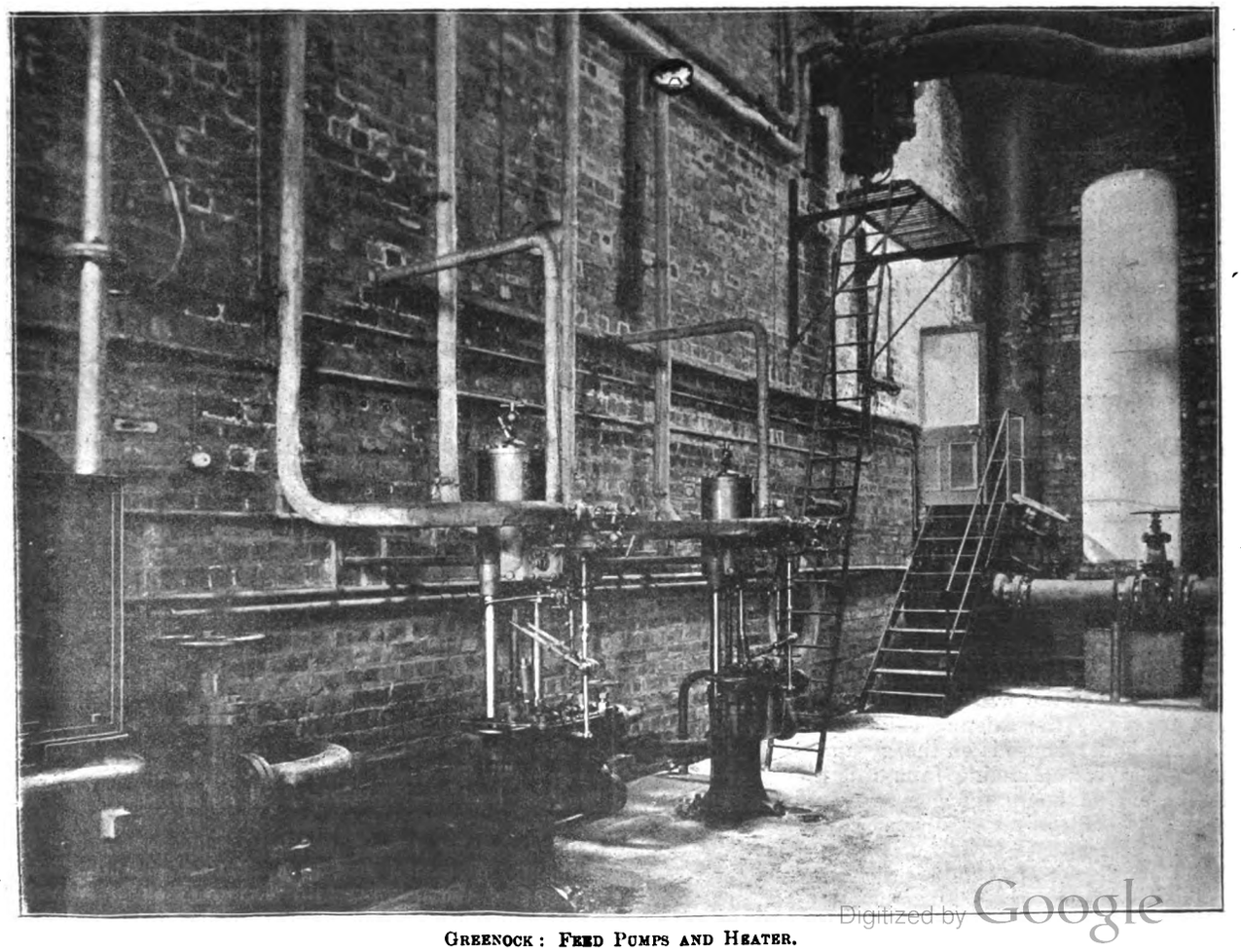


GREENOCK: BABCOCK-WILCOX CHAIN-GRATE BOILERS.



GREENOCK: FEED PUMPS AND HEATER.

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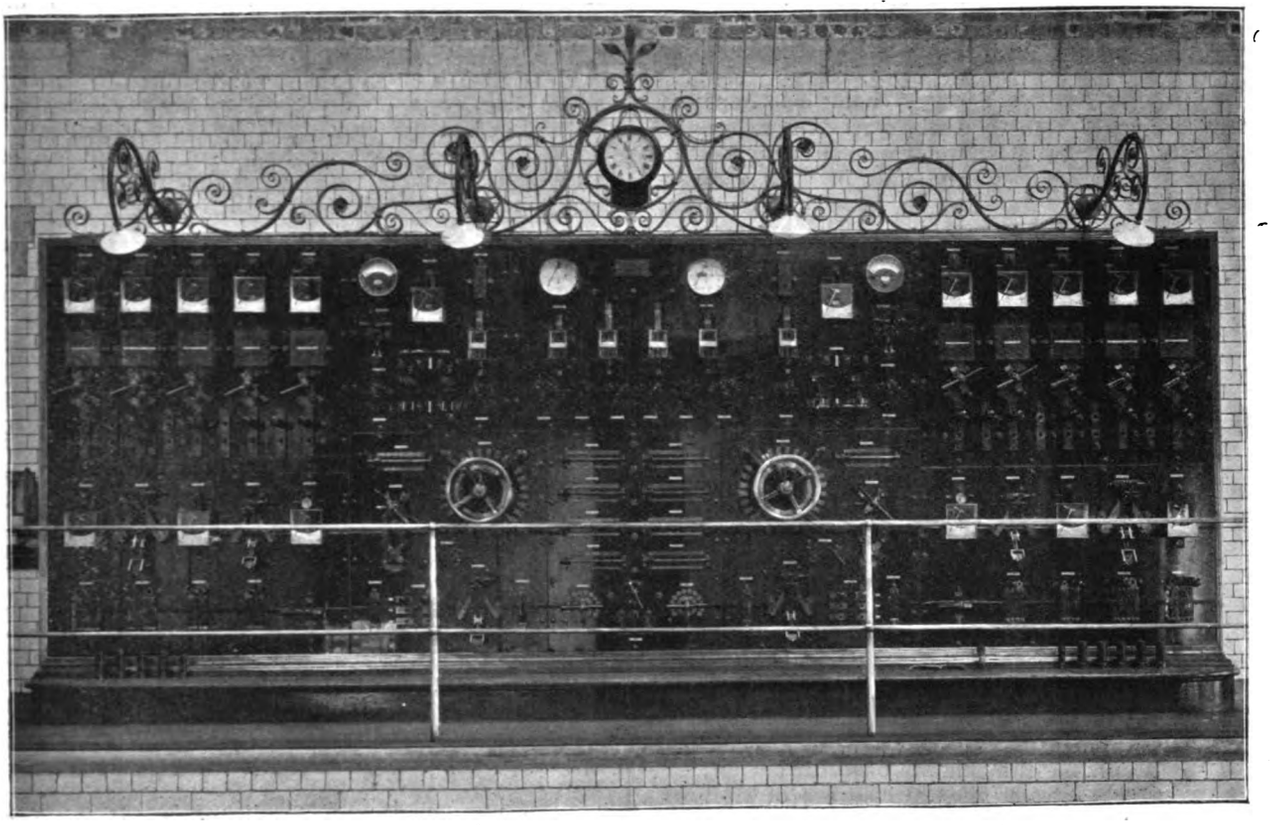
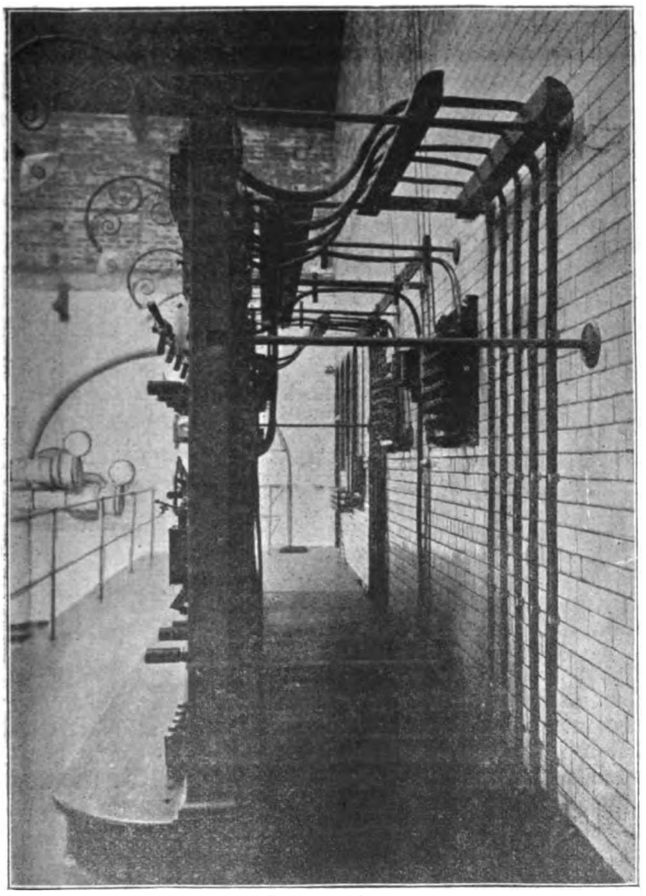
ebonite flange, the object being to reduce the tendency to short circuit by limiting the difference of potential between the various layers of the shunt windings. Series windings are also provided, with a view to future tramway work. The engines are of Messrs. Belliss and Morcom's three-crank equal-angle self-lubricating type, running at 420 revs. per min, and are of sufficient size to drive easily the dynamos under the above overload.

The steam balancer consists of two Silvertown dynamos coupled tandem, and driven by means of a two-crank Belliss and Morcom engine. Each dynamo is capable of an output of 200 amperes at 300 volts when driven at a speed of 450 revs. per min., and, like the larger machines, is fitted with carbon brushes. These balancing dynamos are connected to throw-over switches on the switchboard arranged to allow of either dynamo being put on to the + or − side of the system as required, or in case of any necessity both balancers can be run on one side. Each dynamo is connected to the switchboard through an Aron meter.

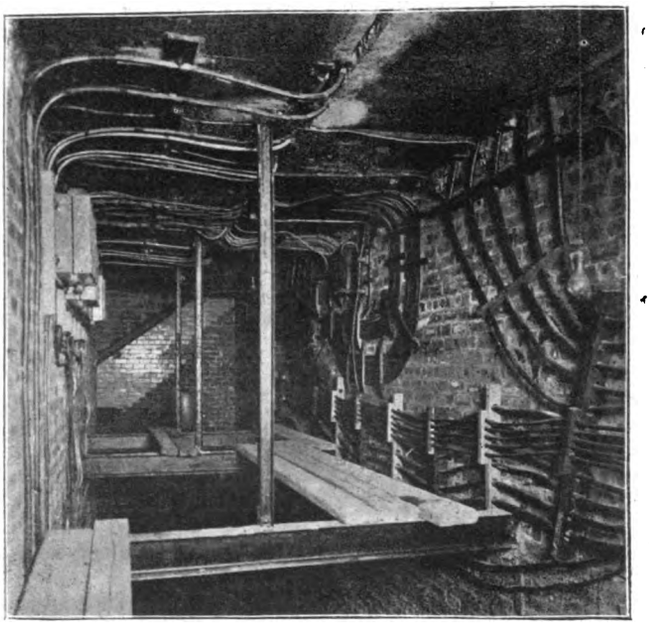
Two motor-driven boosters are provided, each having an output of 150 amperes at 50 to 150 volts. They are put down



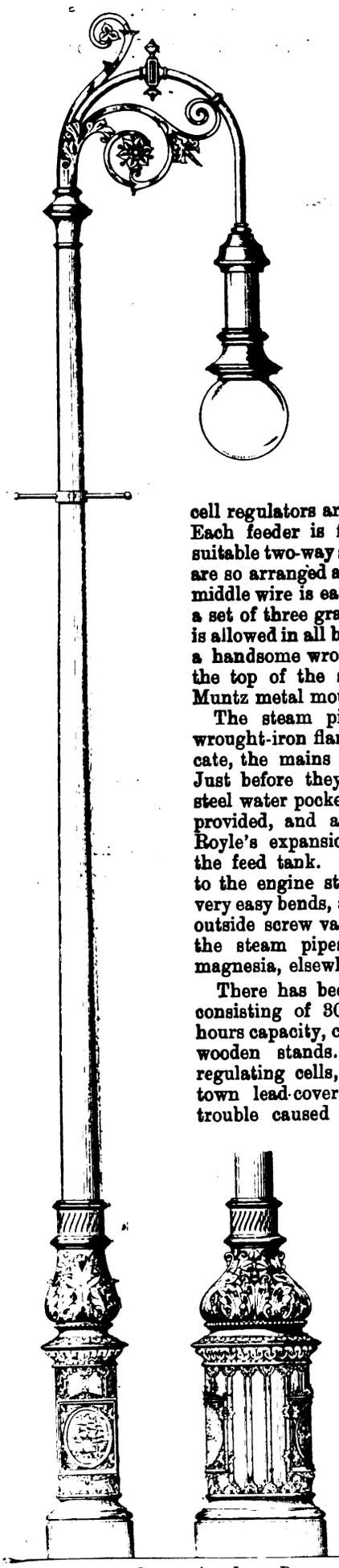
GREENOCK: FRONT VIEW OF SWITCHBOARD.



GREENOCK: BACK OF SWITCHBOARD.



GREENOCK: RESISTANCE AND CABLE CHAMBER UNDER SWITCHBOARD.



GREENOCK: STREET ARC LAMP POST.

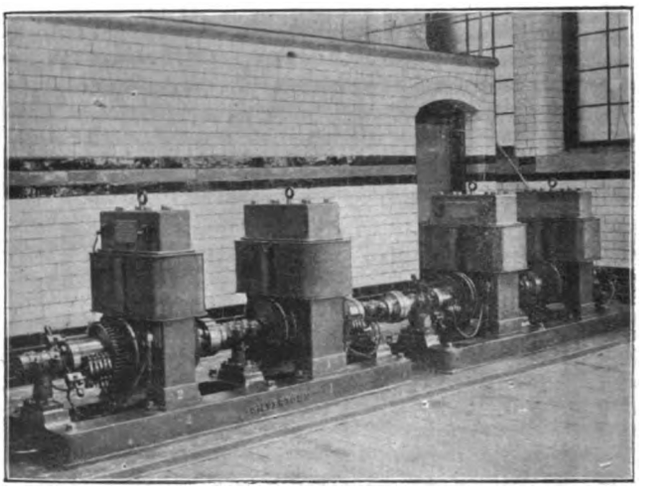
with the shafts in line, provision being made for coupling them together for use as a booster-balancer.

The switchboard is of very handsome design, and is well arranged. The panels are of slate, enamelled front and back, carried in a wrought-iron frame strongly stayed to the wall in such a manner as to leave a clear passage behind. The amperemeters and dynamo voltmeters are of Kelvin type, the voltmeters for the boosters and feeders being of the Weston pattern. Silvertown zero cutouts are provided for each dynamo, as also for the boosters. The shunt regulating switches are of the rectangular type, and together with the motor starting switches and 25 point cell regulators are mounted on the switchboard. Each feeder is fitted with a duplex fuse and suitable two-way switch. The voltmeter switches are so arranged as to duplex any reading. The middle wire is earthed through an ammeter and a set of three graduated fuses. Ample section is allowed in all bars, connections, and switches; a handsome wrought-iron scroll is fitted across the top of the switchboard, which has also a Muntz metal moulding round the outside.

The steam pipes, which are of steel with wrought-iron flanges welded on, are in duplicate, the mains being 10in. internal diameter. Just before they enter the engine room cast steel water pockets fitted with water gauges are provided, and are drained by means of two Royle's expansion traps which discharge into the feed tank. The branches from the mains to the engine steam inlets are of copper with very easy bends, and are fitted with Hopkinson's outside screw valves. Inside the engine house the steam pipes are covered with sectional magnesia, elsewhere with sky diatomite.

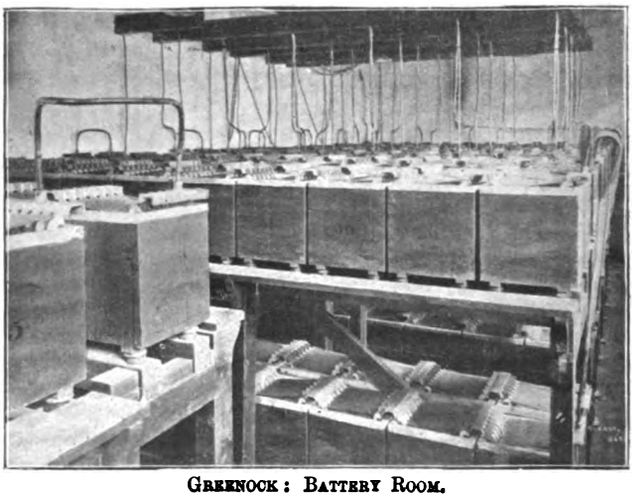
There has been provided a storage battery consisting of 304 Tudor cells of 800 ampere-hours capacity, carried in two tiers on insulated wooden stands. The connections from the regulating cells, 100 in number, are of Silvertown lead-covered cable. In order to avoid trouble caused by impurities in the water, Mr. Fedden has arranged a special apparatus to give a supply of distilled water from the boilers to replace that lost by evaporation.

There are two boilers, of Messrs. Babcock and Wilcox's regular construction, each containing 1,827 sq. ft. of heating surface, and constructed for a daily working pressure of 200lb. per sq. in. Each is capable of evaporating 7,000lb. of water per hour. The boilers are fitted with Babcock and Wilcox's chain grates, driven by a Silvertown enclosed 5 B.H.P. motor. The whole grate and stoker can be run out clear of the boiler for examination, gearing being provided for this purpose. The boilers, as usual with this make, are composed entirely of mild steel, with the exception of the tubes, which are lap-welded wrought-iron. These chain grates deserve rather more than passing mention, as it is a type that will shortly be used in connection with the Babcock boiler, several stations now trying them with satisfactory results. As will be seen from the illustration, the coal from the hopper falls on the travelling endless chain grate, the depth of the fire being regulated by the height of the fire door. The feed of the coal is so slow that the quantity of gas evolved from the fresh fuel coming under the front end of the arch has time to complete its combustion by the radiated heat from the farther end of the arch



GREENOCK BOOSTERS.

before coming into contact with the boiler surface: thus the fuel is coked and is gradually consumed as it travels the length of the grate, falling over the dumping plate at the back end into the clinker pit, the dumping plate of which is opened by gearing, at such intervals as may be required, from the front of the boilers. The speed of travel is regulated by a ratchet and pawl attachment on the driving worm, which latter gears into a worm-wheel, on the shaft of which are drums which revolve the grate. The depth of the fire can also be regulated at will, and thus the machine can be in



GREENOCK: BATTERY ROOM.

a moment adjusted to any kind of fuel at any rate of combustion. The stoker, as fitted at Greenwich, although usually driven by a Silvertown motor, can also be worked by hand by a crank placed on the end of the worm shaft if the motive power breaks down; or it can be worked as a stationary grate, as the fire door, which is made in halves, can be opened just the same as the fire door of an ordinary hand-firing furnace. Undue admission of air at the back of the grate is prevented; and there being no necessity for touching the fire with firing tools in ordinary working, the process of coking of the coal is quite undisturbed. Babcock and Wilcox steam superheaters are also fitted, being placed in a position where

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there is practically no deteriorating condensation of the gases, and where the temperature is sufficiently high to ensure the steam getting from 100°F. to 150°F. of superheat. The superheater is not subjected to the immediate action of the fire, as the furnace gases must first pass through the front part of the boiler.

The feed pumps, two in number, are by Messrs. G. and J. Weir, and are each capable of delivering 1,500 gallons of water per hour against the full boiler pressure. The feed pipe arrangements are very complete, allowing of a hot feed either through a Berryman exhaust steam feed water heater direct to boiler, or through both feed water heater and economiser, or through economiser only, or a cold feed direct. Two water meters are provided, one measuring all the water used in the station, and the other that pumped into the boilers. The economiser has 256 tubes, the scraping gear being driven by a Silvertown 2 B.H.P. motor,

The pillars for the street lighting were supplied by Messrs. McDowall, Steven and Co. (Ltd.), and consist of a tapered steel tubular pole having cast-iron base, cast-iron overhanging bracket, carrying the Brockie-Pell arc lamp and wrought-iron ladder arms. The cast iron base is oblong in shape, to allow sufficient space for instruments on either side of the steel pole, and is fitted on both sides with a door, having the municipal coat of arms cast on.

The arc lamps are of the double carbon type, with extra long carbons, and are fitted with certain modifications in accordance with the extensive experience Mr. Fedden gained when in charge of the large system of street lighting at Edinburgh. The lamps are run 11 in series off the 500 volt supply. A noticeable point in connection with the erection of the pillars is the fact that as far as possible they are arranged at the corners of the side streets, and the bracket arms are placed at an angle, so as to throw light up the side street without the shadow of the pillar itself being apparent. It may also be noted that shortly all the brackets will require to be shifted round to an angle, as the intention is to use these pillars for tramway purposes to carry the trolley wires, and it is for this reason that they are made of steel. At present the total number of lamps amounts to 44, but already there are suggestions for extending the lighting to other streets.

The mains contract has been carried out by the Callender's Cable and Construction Co. (Ltd.), who also supplied the lamp posts and arc lamps. The cables have been laid on the solid system, except in certain cases where the Callender-Webber system of casing has been employed. Up to the present there have been about 29,600 yards of cable laid on the solid system. Five feeders are laid from the works to feeding points. Three of these feeders are two-wire feeders, each conductor being ¼ sq. in. sectional area. The remaining two feeders are three-wire, the first having the following sections: 0·4, 0·2, and 0·4 sq. in., while the second is larger, having sections of 0·5, 0·2, and 0·5 sq. in. Altogether the total amount of cables drawn in, including arc and potential leads, approximates about 38,000 yards. The cables for arc lighting are single conductor vulcanised bitumen 7/16 S.W.G. cables lead-covered, and these are either drawn into the Callender-Webber casing or into iron pipes. The potential leads consist of three-core 7/20 lead-covered cables, drawn into Callender-Webber casing. The Callender type of iron feeder and network boxes have also been used, and these are placed in brick pits.

The following is a list of the various contractors and sub-contractors who have been employed upon these works:—

Contractor for buildings		J. McEwan, Greenock.
Contractors for boilers, &c.....		Babcock and Wilcox (Ltd.).
Contractors for engine-house plant		The India Rubber, Gutta Percha and Telegraph Works Co. (Ltd).
Sub-contractors	Engines	Belliss and Morcom (Ltd.).
	Feed heater...	Berryman.
	Feed pumps...	G. and J. Weir.
	Battery	Tudor Accumulator Co.
	Instruments...	James White and Elliott Bros. and Co.
Contractors for the cable and street work		Callender's Cable and Construction Co., Erith, London.
Sub-contractors	Arc lamps ...	The Brockie-Pell Arc Lamp (Ltd.).
	Meters	The Aron Electricity Meter (Ltd.).
	Max. demand indicators	Reason Manufacturing Co. (Ltd.).
	Pillars	McDowall, Steven and Co.

STORAGE BATTERY PROBLEMS.

DISCUSSION.

(Continued from page 859).

Prof. W. F. AYRTON thought he was not exaggerating when he said that this Paper was probably one of the best that it had been their good fortune to listen to for many a long day. He did not give expression to this appreciation of the Paper in consequence of any feeling of necessity to follow a time-honoured custom of complimenting an author, but because he felt sure that at the present time we should have known much more about storage cells, and perhaps, what was more important, we should have had much better storage cells, had we in the past been favoured with many Papers like Mr. Wade's, combining the same clearness of thought, lucidity of expression, and emphatic direction as to what they should aim at in order to improve the accumulator. He spoke perhaps somewhat warmly, but since their chairman that evening (Prof. Perry) and himself were the engineers to the first accumulator company that existed, he had taken a very great interest in the subject, and he felt therefore, in saying what he had, he was only expressing the appreciation which they should all feel of the admirable way in which the subject had been put before them. Dr. Armstrong had mentioned those very interesting experiments of Mr. Robertson's carried out in 1890 on the analysis of the plugs in the porous plate. He (Prof. Ayrton) had brought with him the original curves (Figs. 1, 2, 3, below) of those experi-

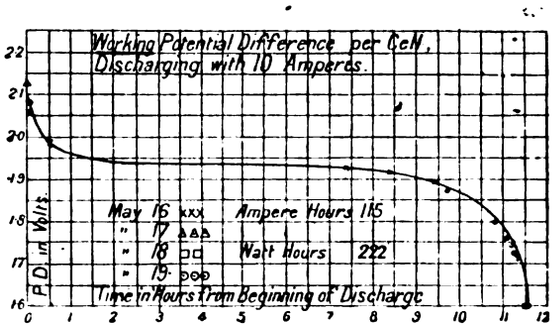

FIG. 3.

ments, which had been exhibited at the discussion adjourned from the Edinburgh Exhibition meeting of the Institution, as he wished to refer to a matter which appeared to him of very great practical importance. Referring to these experiments, Mr. Wade had stated in his Paper that "in this special instance the previous treatment of the cell was exceptionally favourable, and as on a 12-hour discharge rate its capacity came out about 33 per cent. above listed value, it had evidently been worked up to a state of efficiency but seldom attained, still less maintained." Why, asked Prof. Ayrton, was this statement absolutely true? Why was this cell in a state of efficiency seldom attained, still less maintained? Was it because he had been dealing with a perfectly brand new cell or with a cell provided by the E.P.S. Co. especially for his experiments? The reason had been indicated in that Paper, or he had tried to do so, though his colleagues and himself probably had not succeeded in impressing upon the world 10 years ago what were the conditions necessary for obtaining success with pasted accumulators. The cell which gave these results had been in daily use in his laboratory for two years before

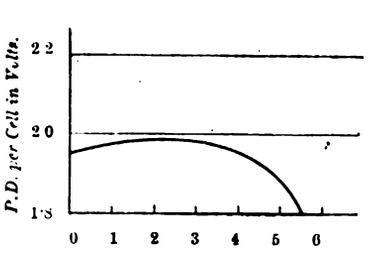

FIG. 4.

the experiments were carried out, and in the Paper on "Notes on the Chemistry of Secondary Cells," read late in 1890, they said "The cell selected to remove the plugs from had the same size as the cells employed in the investigations described in the previous communication, and was one of the batch of 50 purchased for the Central Institution about the middle of 1888. Since it first came into our possession it had never been overcharged, never been left discharged, nor permitted to send more than the maximum current allowed by the makers for cells of this size—viz., 10 amperes—and consequently, at the beginning of the present investigation in June of this year, the cell was in excellent condition"; and he might emphasise now what was stated at that time—viz., that the proportion of liquid to plates was much larger than is usual. At the commencement of these experiments, 10 years ago, for reasons explained in their Paper, they subjected the cells to successive charge and discharge day after week, day and night absolutely without

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intermission, in order to get each cell into its perfectly normal condition. The cells were charged and discharged by automatic machinery, and the discharge limit was fixed, for a reason given in the Paper, at 1·6 volts initially (see Fig. 3); but they found they were ruining the cells. It soon became difficult to charge the cells, because the P.D. rose so rapidly, and it was found to be impossible to get any important amount of energy out of the cells. After a number of experiments, which were described in the earlier Paper read in the summer of 1890 (*The Electrician*, Vols. XXV. and XXVI.), they found it was because they were allowing this P.D. to go down too low, and discovered that if they stopped the discharge at 1 8 volts they were able to make the cell repeat the same cycle with absolute exactness; and then it was that they published the result that the discharge should be stopped when the P.D. fell to 1·8 volts. They also mentioned in this first Paper that Dr. Louis Duncan and Mr. H. Wiegand, experimenting in the John Hopkins University, had arrived at the same result. Why did he lay so much stress on the fact that discharge should stop at 1·8 and not 1·6 in order to keep the cells in good order and not ruin them? It was because within the last fortnight he had been told by two persons—he did not know how far their information was authoritative—that this very fact explained the ruin of the London Electrical Cab Co. They must all have been astonished at a controversy which took place in the electrical press last year to the following effect. The Electrical Power Storage Co. had entered into an undertaking to keep the cells of the cabs up to a certain percentage of their normal capacity for three years. The Cab Co. came, however, to an abrupt end, for reasons which it had been alleged were due to the "peculiarities" of cabmen. One of the electrical papers suggested that it was not the peculiarities of cabmen but of accumulators, and they rather implied that the Electrical Power Storage Co. had not fulfilled its obligations. The Electrical Power Storage Co. wrote a letter to the paper, which was duly published with a proper—and very proper—apology, to the effect that the company *had* carried out its obligation absolutely and to the letter. Yet there still remained the fact that the Cab Co. had ceased to exist a year before the maintenance contract had expired. He had been told that the explanation was that the Electrical Power Storage Co. agreed to maintain the accumulators at a certain fraction of their initial capacity for a payment of 20 per cent. of the prime cost per annum (the cells being used every day and charged every night), provided they were not allowed to run below 1·8 volts per cell. This was a clause in the contract, but unfortunately the Cab Co. did not in the least appreciate the importance of that condition, and the result was that when the cells began to wear out they were tested on being brought in at night, and were found to have been run lower than 1·8 volts per cell. The Electrical Power Storage Co. therefore were able to say quite strictly that that particular cab was "out-

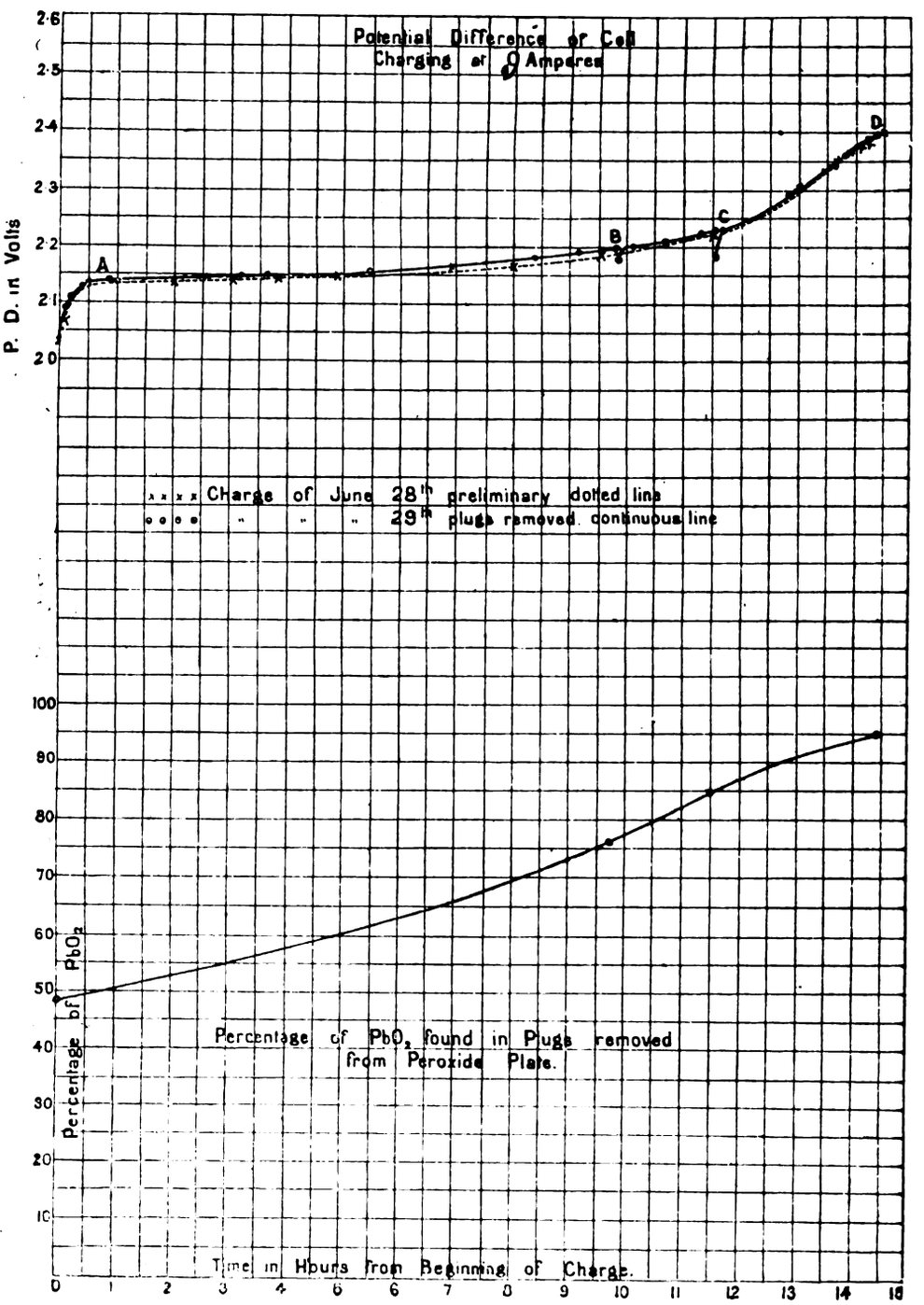

FIG. 1.

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side" the contract; and so cab after cab went outside the contract until the whole of the cabs were outside the contract, though the Electrical Power Storage Co. had been quite willing to keep them in order if the condition had been fulfilled. It was quite possible that this was a fact. The Tudor Co., to whom he had mentioned this matter, told him that they also believed it was a fact; and that they, in their own maintenance contracts, always insisted on the cell being stopped at 1·8 and not allowed to fall to an appreciably lower number of volts. If this were so, if the experiments he and his colleagues had carried out were borne out by all this experience, why did not people realise that adding that little bit to the discharge energy, represented by the portion of the curve (Fig. 3) to the right of ordinate passing through 11 hours in that particular curve meant ruin to the cell, ruin to the company? Why not have put voltmeters on the splashboards of the cabs, and have told the drivers on pain of their lives to go home when they saw the pointer at 1·8 volts per cell. He now came to another interesting point in the Paper—viz., that the failure of the cell was mainly due to the want of porosity. There were certain reasons which bore out this theory, and certain reasons which the author might think did not bear his theory out, and he would like to put these reasons before Mr. Wade, in order that he might express his views upon them. The first point was that in an ordinary discharge the P.D. of a cell fell very rapidly at the beginning if the current was kept constant, then slowly, and again very rapidly (see Fig. 3). This first rapid fall which occurred in the first half hour or so did not exist at all in a cell if it had been left charged for a considerable time. Suppose they got a cell into a perfectly normal condition, and then, after carefully insulating it and leaving it for a fortnight they discharged it, they would get a different shape discharge curve, which he exhibited (Fig. 4), because the strong acid put into the pores during the charging had had plenty of time to diffuse throughout the cell. The curve, instead of coming down, actually rose a little. The absence of the first fall in the curve would tend to bear out the idea that the strong acid put into the pores in charging had had time to diffuse. But what about the subsequent rise in the curve that he had alluded to? How was this explained? They could hardly imagine that the discharge of the cell (which they knew produced sulphate by using up the sulphuric acid) in any way strengthened the acid, and therefore there did not appear to be any special reason why the P.D. for constant current should begin to rise. Another thing was still more important. There were two ways, of course, in which cells could be charged. They were usually charged with something like constant current, but they could charge a cell by a method which was now gaining favour because of its great importance—viz., at constant potential.

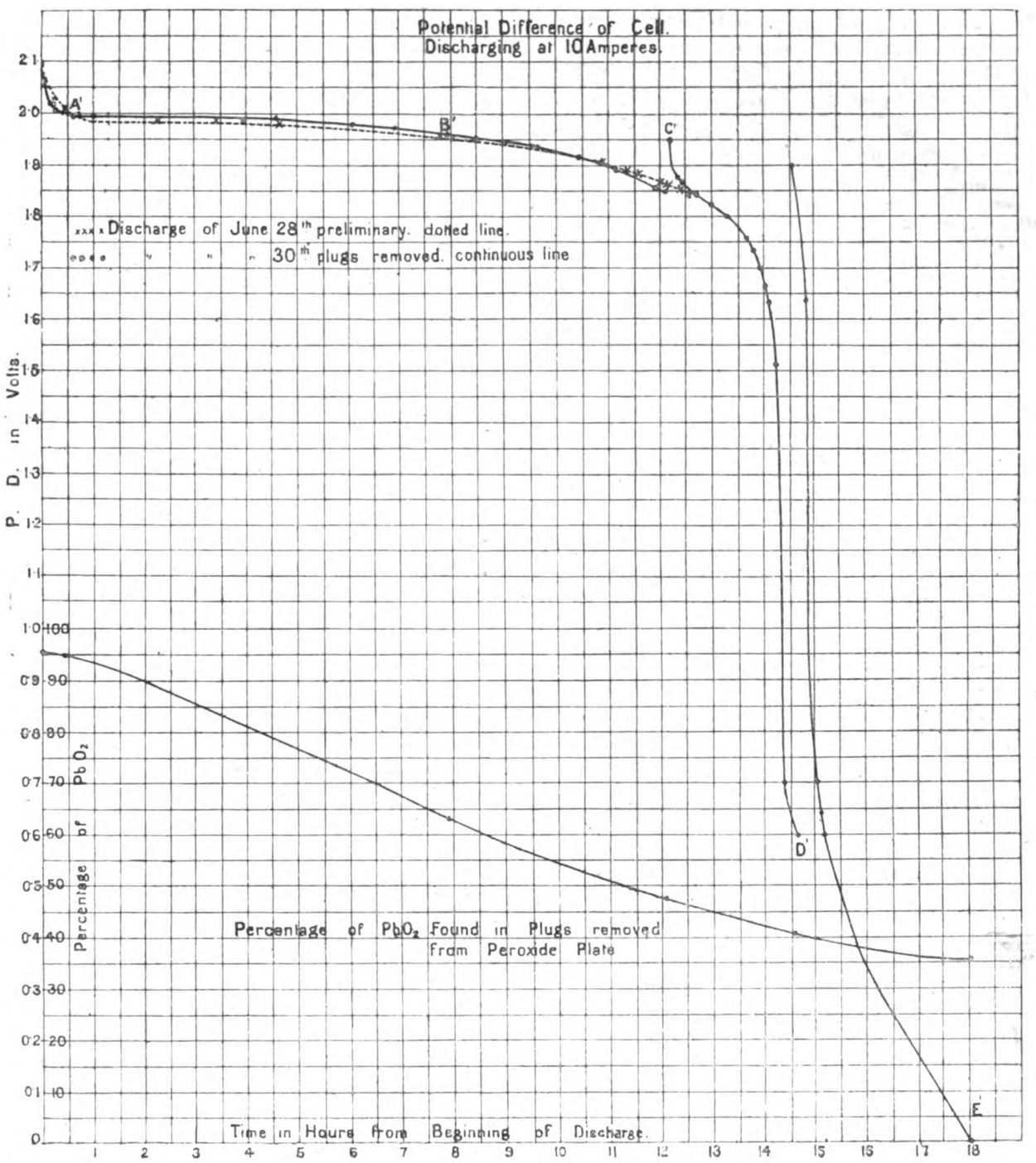
Potential Difference of Cell.
Discharging at 10 Amperes.
A'
B'
C'
D'
E'
xxxx Discharge of June 28th preliminary. dotted line.
eeee " " " 30th plugs removed. continuous line
P. D. in Volts.
Percentage of PbO2
Percentage of PbO2 Found in Plugs removed from Peroxide Plate
Time in Hours from Beginning of Discharge.

FIG. 2.

(To be concluded.)

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Telephone: 949 Holborn. *Telegrams:* "Electrician Newspaper London."

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POLYPHASE v. CONTINUOUS CURRENT AT DUBLIN.

An array of conflicting expert evidence is a phenomenon not unknown to legal and other authorities who have had to face electrical problems; but the disagreement between experts at the recent inquiry in connection with the electric supply scheme for Dublin must have more than usually puzzled the Local Government Board. Who shall decide when doctors disagree; and how is Pilate's historic question to be answered when we find Dr. Silvanus Thompson, Mr. Robert Hammond, and Mr. S. Z. de Ferranti ranged, on a vital point of electrical practice, against Mr. Arthur Wright, Mr. H. F. Parshall, and Mr. T. Tomlinson? To say nothing of Mr. T. M. Healy, M.P., who represented the opposition. Such a formidable tussle must needs occupy, if not waste, a considerable amount of time—and the inquiry lasted over five days. We have already given our readers a detailed account of the proceedings in our last two issues (see *The Electrician*, March 30, p. 835, and April 6, p. 876). But there are several matters arising out of the evidence which it will be profitable to discuss.

Broadly speaking, the case stands as follows: The Corporation of Dublin applied to the Local Government Board for power to borrow £254,000 to carry out Mr. Hammond's scheme of three-phase generation and transmission from a new power station to be erected at Pigeon House Fort, outside the city, the present single-phase system to be fed from sub-stations. The counsel for the opposition was Mr. Healy, M.P., who produced Mr. Arthur Wright as an expert witness; and the Dublin United Tramways Co.'s representative electrical engineer was the redoubtable Mr. Parshall. The objections raised by Mr. Healy in his speech, notwithstanding his assertion that the scheme was "unsound financially and unscientific electrically," are of little or no importance, electrically speaking; but in the person of Mr. Wright, his electrical adviser, the adoption of an alternate current system was criticised, and the view advanced that continuous current would have been easier to handle and more generally suited to requirements. In this latter respect the opponents were in general agreement with the tramway company, who, however, appear to have favoured a continuous current system because they would have liked to supply the commodity themselves. But Mr. Parshall, the company's electrical expert, said that if he were the company he would not be bothered with a business that would be less profitable

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than their tramway business; and we are inclined to think he was right.

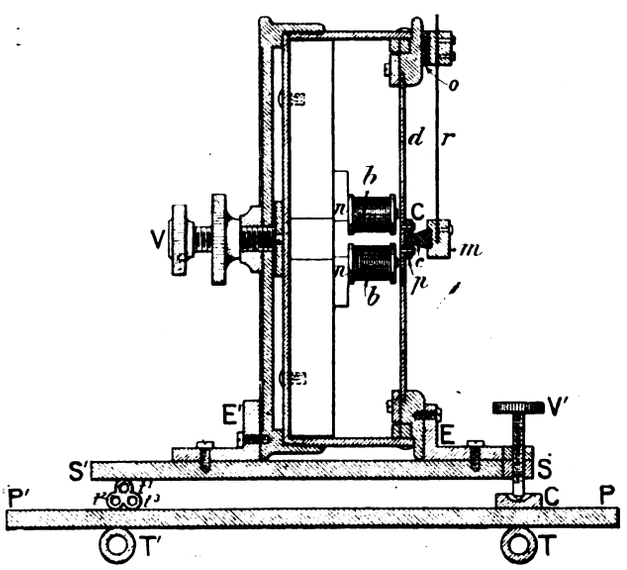
We have repeatedly advanced the opinion, which is being more and more strengthened by financial facts as time goes on, that while it will generally be advantageous to an ordinary electric supply undertaking to include electric tramway supply, it is not generally other than a distinct financial disadvantage for an electric tramway undertaking to take on the business of electric lighting and public supply. Nothing in the circumstances attending the problem of electric supply at Dublin leads us to regard that city as presenting any exception to this general rule. This, we apprehend, is Mr. PARSHALL'S position; and we consider the tramway company would be badly advised to persist in its endeavour to include the public supply of the city in its business. This, of course, is from the shareholders' point of view; but, conversely, the Corporation might reap considerable advantage to the general public by taking ready-made electric energy at a low price from the tramway company, instead of spending money in erecting a separate power station. Nor would this of necessity involve the immediate abolition of the existing single-phase system of mains, for that could be fed from sub-stations worked by motor-alternators, analogously to Mr. HAMMOND'S proposal to work it from polyphase sub-stations. Viewed from the standpoint of the Dublin ratepayer, therefore, there is much to be advanced in favour of a combined lighting and tramway system, especially when regard is paid to the prospect of the tramway system ultimately being taken over by the Corporation. This consideration, we think, emphasises the inexpediency of Mr. WRIGHT'S proposal that the Corporation should erect its own continuous-current power station, employing its existing site at Fleet-street for the purpose. The absurdity of separate systems for tramways and electric supply reaches its climax when both are worked from precisely similar power stations. To adopt Mr. WRIGHT'S proposal would be short-sighted and foolish, for the only possible justification we can find for a separate Corporation station lies in the conceivable truth of the contention that a polyphase station is preferable to one on the continuous current system.

The choice therefore really lies between closing with the tramway company and erecting a polyphase station, broadly on the lines of Mr. HAMMOND'S scheme. And the factor which should lead to a decision between these alternatives is mainly as to whether the polyphase or the continuous current system is the more likely to survive. All other questions, such as the suitability of the Pigeon House site, are subsidiary. It is a question of the survival of the fittest; and electrical engineering is not yet advanced sufficiently for it to be confidently asserted which of the two rival systems will outlive the other. Their chances turn upon very evenly balanced advantages and disadvantages; and it is probable that, in the event of a decisive victory, destiny will manifest itself in the shape of a radically new invention—such for example, as the highly efficient secondary battery so often talked of but so dimly foreseen. Building their faith on Continental works, there has arisen in this country a school of prophets who have pronounced already in favour of the ultimate triumph of the polyphase system; but, heedless of their clamour, many a sober-minded electrical engineer is steadily converting his alternate-current station into one for continuous current, or supplementing it with machinery for the latter with a view to its ultimate complete adoption. The problem presented to the Local Government Board, in deciding whether to sanction a loan for Mr. HAMMOND'S scheme, is therefore, one of peculiar difficulty, and its solution will be awaited with exceptional interest.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

Differential Telemicrophonic Relay.—Since devising his system of multiplex telegraphy E. Mercadier has added to the transmitting tuning-forks and the receiving "monotelephones" an instrument which collects at either end all the signals made on a base line of sinusoidal currents of periods varying from 480 to 900 per second. These currents constitute 12 notes differing from each other by a semitone, and extending from si_3 to la_4. The apparatus consists of a telephone (*see* diagram), whose diaphragm d is 10cm. in diameter. Round the core n of the electromagnet b are wound two identical wires. To the telephone is attached a microphone consisting of a small plate of carbon p screwed to the diaphragm, and another carbon C attached to a metallic mass m fixed to a flat spring r insulated from the frame by an ebonite plate o. The telephone rests on caoutchouc tubes TT' t to deaden foreign disturbances. One of the wires of the electromagnet n is connected with the line circuit, the other with an artificial circuit, in order to eliminate the effects of transmission upon the receivers at the sending station, after the "differential" method of continuous-current duplex telegraphy. The microphone is inserted into the circuit of a cell and the primary of an induction coil, and the secondary wire of the latter is led through the 12



receivers, which correspond to the 12 transmitters. Each receiver picks out its own note with perfect accuracy without responding to the neighbouring ones. No disturbance or confusion is produced by the six transformations of energy involved. Signals have been successfully sent between Paris, Toulouse, and Bordeaux. Intermediate stations may be interpolated with safety. The number of simultaneous signals can be increased to 48.

[E. MERCADIER, *Comptes Rendus*, March 19, 1900.]

Lichtenberg Figures.—K. Bürker has discovered a new mixture of powders which gives results very much superior to the usual sulphur and red lead combination. He powders up five volumes of flowers of sulphur with one volume of solid carmine as used in histology, and adds three volumes of lycopodium seed to the mixture. When this powder is dusted on to a brass plate coated with asphalte the positively charged parts appear a beautiful dark red, the negative parts bright yellow, both regions being sharply marked off from each other. The colours are reversed with respect to the ordinary Lichtenberg figures, the polarity of the sulphur being evidently reversed in the mixture. The positive figure exhibits, besides the main red circle, a yellow centre and a yellow outer halo, while the negative figure shows distinctly a red centre and a red outer halo. The mixture is therefore more sensitive than that of Villarsy. It is also less dangerous

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to health, as red lead must necessarily be inhaled to a slight extent with the old mixture. The addition of lycopodium to the latter improves it also, and instead of carmine other organic and inorganic pigments may be used.

[K. Bürker, *Ann. der Phys.*, No. 3, 1900.]

Analysis of Condenser Discharges.—In analysing the discharges of a Leyden jar by means of a Braun cathode-ray tube and a revolving mirror, F. Richarz and W. Ziegler noticed that successive sparks gave rise to a kind of herring-bone figure, the permanent fluorescent patch, drawn out by the mirror, making the centre line, and each discharge being represented by one upper and one lower rib (Fig. 1). By introducing a large inductance they were able to see that this

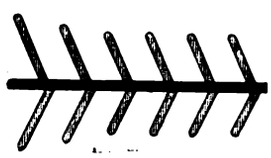

Fig. 1.

Fig. 2.

curious appearance was due to the coalescence of the tops and bottoms, or turning points, of the discharge curve, where the motion is slowest and the track brightest.

[Richarz and Ziegler, *Ann. der Phys.*, No 3, 1900.]

Absorption of Light by Glowing Gas.—Kirchhoff's law makes the ratio of the emission of a gas to its absorption constant, and equal to the emission of an absolutely blank body at the same temperature. This law, as we know, holds for all flames so far examined. The question whether it applies to electrically glowing gases in a vacuum tube has been raised by M. Cantor, and answered in the negative by an important experiment. He sent a strong beam of light through a vacuum tube from end to end and back, and compared its intensity with a beam passing through air under normal pressure. After making suitable allowance for the illumination due to the vacuum tube itself, he found that the beam of light suffered no absorption in the electrically glowing gas. This result is of far-reaching importance. It could only be squared with Kirchhoff's law by supposing the gas to possess an extremely high temperature. This, as we know, it does not possess. Its temperature is more like that of boiling water. Therefore we must conclude that we have here a case of emission practically without absorption, and that the light-yielding mechanism is of a totally different nature from that of ordinary flames.

[M. Cantor, *Ann. der Phys.*, No. 3, 1900.]

Quartz Thermometers.—Since Boys' experiments it is known that quartz becomes pasty before it melts, and A. Dufour has therefore tried to work it like ordinary glass. The point at which it begins to soften is between 1,000deg. and 1,200deg., the temperature of the interior of the oxy-hydrogen blowpipe flame. The working of quartz has shown itself to be perfectly feasible, and it may become an important substance where a highly refractory body is required which has a definite chemical constitution, is not hygrometric, cannot be oxidised, and cannot easily be reduced. Besides, it always remains transparent, and does not, like glass, evolve gases on melting. The author's first application was to thermometry He constructed a thermometer tube of quartz, and filled it with tin. It worked very well between 240deg. and 580deg. The walls of the bulb had to be thick, as the solidifying tin otherwise pulled them together. The author is now making quartz vacuum tubes, which may possibly not occlude gases in their walls. It would then be possible to test the question as to what is the actual vehicle of vacuum discharges. Perhaps there is also an opening for incandescent lamps made of quartz.

[A. Dufour, *Comptes Rendus*, March 19, 1900.]

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Bath (Municipal)	Feb. 9, 1900	Leeds (Municipal)	Dec. 1, 1899
Bedford (Municipal)	May 19, 1899	Leicester (Municipal)	Jan. 26, 1900
Belfast (Municipal)	Sept. 15, ,,	Leyton (Municipal)	Sept. 8, 1899
Birmingham (Company)	Sept. 15, ,,	Liverpool (Municipal)	June 9, ,,
Blackburn (Municipal)	Jan. 19, 1900	Londonderry (Municipal)	Feb. 16, 1900
Blackpool (Municipal)	Sept. 29, 1899	Manchester (Municipal)	Aug. 11, 1899
Bournemouth (Company)	April 28, ,,	Newcastle and District (Co.)	Oct. 6, ,,
Bolton (Municipal)	Nov. 24, ,,	Newcastle-upon-Tyne (Co.)	April 14, ,,
Bradford (Municipal)	April 14, ,,	Newport (Mon.) (Municipal)	Dec. 15, ,,
Brighton (Municipal)	May 12, ,,	Northampton (Company)	Oct. 20, ,,
Bristol (Municipal)	July 14, ,,	Norwich (Company)	Nov. 17, ,,
Brompton & Kensington (Co.)	Mar. 23, 1900	Notting Hill (Company)	Mar. 16, 1900
Burnley (Municipal)	Aug. 25, 1899	Nottingham (Municipal)	July 21, 1899
Burton-upon-Trent (Mun.)	April 21, ,,	Oldham (Municipal)	Dec. 1, ,,
Bury (Municipal)	Sept. 22, ,,	Oxford (Company)	May 19, ,,
Cambridge (Company)	Mar. 10, ,,	Pontypool (Company)	May 5, ,,
Cardiff (Municipal)	Dec. 15, ,,	Portsmouth (Municipal)	July 14, ,,
Charing Cross (Municipal)	Mar. 9, 1900	Prescot (Company)	Dec. 8, ,,
Chelsea (London) (Co.)	Mar. 23, ,,	Preston (Company)	Sept. 29, ,,
Cheltenham (Municipal)	Nov. 10, 1899	Reading (Company)	Oct. 13, ,,
Chester (Municipal)	June 23, ,,	Richmond (Company)	Oct. 13, ,,
City of London (Company)	May 12, ,,	Salford (Municipal)	Feb. 23, 1900
Clerkenwell (Company)	Aug. 18, ,,	Scarborough (Company)	Nov. 3, 1899
Coventry (Municipal)	Feb. 23, 1900	St. Helens (Municipal)	Dec. 8, ,,
Croydon (Municipal)	Feb. 9, ,,	St. James' & Pall Mall (Co.)	Feb. 16, 1900
Derby (Municipal)	Jan. 26, ,,	St. Pancras (Vestry)	May 26, 1899
Dewsbury (Municipal)	Nov. 24, 1899	Sheffield (Municipal)	Dec. 29, ,,
Dover (Company)	June 2, ,,	Shoreditch (Vestry)	Oct. 27, ,,
Dundee (Municipal)	Jan. 12, 1900	Southampton (Municipal)	Nov. 10, ,,
Eastbourne (Company)	Feb. 2, ,,	Southport (Municipal)	July 7, ,,
Edinburgh (Municipal)	Nov. 17, 1899	South Shields (Municipal)	July 7, ,,
Exeter (Municipal)	Aug. 5, 1898	Stafford (Municipal)	Dec. 29, ,,
Glasgow (Municipal)	Sept. 1, 1899	Sunderland (Municipal)	July 28, ,,
Guildford (Company)	May 5, ,,	Taunton (Municipal)	June 16, ,,
Halifax (Municipal)	July 21, ,,	Tunbridge Wells (Mun.)	Sept. 1, ,,
Hammersmith (Vestry)	May 26, ,,	Wakefield (Municipal)	Dec. 1, ,,
Hampstead (Vestry)	Aug. 25, ,,	Walsall (Municipal)	June 23, ,,
Hanley (Municipal)	April 28, ,,	Wandsworth (Company)	Aug. 12, ,,
Harrogate (Municipal)	Oct. 20, ,,	Westminster (Municipal)	Mar. 9, 1900
Harrow (Company)	June 16, ,,	Whitehaven (Municipal)	July 28, 1899
Hast'gs & St. Leonards (Co.)	Feb. 2, 1900	Windsor (Company)	Dec. 22, ,,
Hove (Company)	Mar. 10, 1899	Woking (Company)	Dec. 22, ,,
Huddersfield (Municipal)	Oct. 6, ,,	Wolverhampton (Municipal)	June 30, ,,
Islington (Vestry)	Oct. 27, ,,	Woolwich (Company)	Jan. 12, ,,
Kens'gton & Knightsbr'(Co.)	Mar. 16, 1900	Worcester (Municipal)	April 7, ,,
Kingston-upon-Hull (Mun.)	June 9, 1899	Yarmouth (Municipal)	Nov. 8, ,,

The Oxford Electric Co. (Ltd.).

The accounts of the Oxford Co.'s undertaking for 1899 present a by no means brilliant aspect. As the following table indicates, at no period has the progress of the concern been anything very rapid, but the results which are summarised in our first table this week partake, we fear, rather of the nature of a retrogression :—

Year.	No. of consumers.	Equiv. 8c.p. lamp connections.	Output. Units sold.	Plant capacity. Kilowatts.
1893	...	7,670	103,895	240
1894	...	11,206	157,257	240
1895	225	15,003	207,633	340
1896	270	19,058	291,640	600
1897	340	21,364	343,567	630
1898	420	25,928	374,033	630
1899	500	29,538	426,720	630

It will be noticed that the lamp connections last year show a relapse in the rate of increase from about 21·4 per cent. in 1898 to not quite 14 per cent. The increase in the output shows an improvement from not quite 9 per cent. to over 14 per cent. On the other hand, the load factor has very materially fallen in value—viz., from the 12·2 per cent. of 1898 to 10·2 per cent. last year. Perhaps this is the reason for the slight increase in the aggregate costs. These latter are, in the circumstances, not abnormal.

Looking down the items of generating charges, our attention is arrested by the rather high fuel charge, and by the excessive and increasing "repairs and maintenance" item. The former is perhaps explained by Oxford's situation. The persistently high repairs item is, however, an unfortunate sign. The two other generation charges present very satisfactory figures.

Owing to the slight increase in the average revenue, the percentage to it of the total costs has been slightly lowered and the gross profit well maintained. It is satisfactory to find that £1,000 has been placed to the "reserve and renewal of plant account." Interest charges absorbed £1,742; £185 was written off the prime cost of the hire purchase installations, and £53 from office furniture. The balance available for

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	OXFORD.	CAMBRIDGE.
Undertaking Worked by	The Oxford Electric Co. (Ltd.)	The Cambridge Electric Supply Co. (Ltd.)
Date of Commencement of Supply	June, 1892.	November, 1892.
System of Supply	High-pressure continuous-current transformers.	Alt.-curr. trans. sub-stations and house trans.
Chief Engineer	P. J. Rea.	John H. Barker.

YEAR ENDED	DEC. 31, 1898.	DEC. 31, 1899.	DEC. 31, 1898.	DEC. 31, 1899.
QUANTITIES—				
Units generated	522,835	575,867	435,383	454,092
„ SOLD (TOTAL)	374,033	426,720	260,307	298,392
„ sold to consumers	328,977	380,489	24,669	297,204
„ sold for public lighting, &c.	45,056	46,231	1,638	1,188
„ used on works	—		6,494	11,517
UNITS SOLD PER 8 C.P. LAMP CAPACITY	19·0	21·7	15·9	18·2
Maximum supply demanded	349 kilowatts	480 kilowatts	751 kilowatts	845 kilowatts
Number of public lamps	32 arc, 48 glow	32 arc, 48 glow	1 arc	1 arc
Number of consumers	420	500	365	383
Connections to mains in 8-c.p. lamps	25,928	29,538	25,080	28,123
CAPACITY OF PLANT IN 8-C.P. LAMPS	19,700	19,700	16,400	16,400
CAPACITY OF PLANT IN KILOWATTS	630	630	525	525
CAPITAL—	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.
AUTHORISED (TOTAL)	£150,000 / £238	£150,000 / £238	£100,000 / £190	— / —
Share	100,000 / 159	100,000 / 159	100,000 / £190	£100,000 / £190
Loan (including Debenture charges)	50,000 / 79·4	50,000 / 79·4	— / —	— / —
RECEIVED (TOTAL)	91,150 / 145	95,200 / 151	48,729 / 92·8	57,572 / 110
Share	50,000 / 79·4	50,000 / 79·4	48,665 / 92·6	57,572 / 110
Loan (including Debenture charges)	41,150 / 65·3	45,200 / 71·8	— / —	— / —
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	58,850 / 93·4	54,800 / 87·0	51,334 / 97·7	42,428 / 80·8
Share (unissued)	50,000 / 79·4	50,000 / 79·4	5,770 / 11·0	5,770 / 11·0
Share (uncalled)	nil / —	— / —	45,564 / 86·7	36,658 / 69·9
Loan (including Debentures)	8,850 / 14·0	4,800 / 7·62	— / —	— / —
REPAID (TOTAL)	— / —	— / —	— / —	— / —
RESERVE OR SINKING FUND	nil / —	— / —	— / —	— / —
DEPRECIATION FUND	750 / 1·19	1,750 / 2·78	1,000 / 1·90	1,750 / 3·33
EXPENDED (TOTAL)	90,037 / 143	95,682 / 152	46,875 / 89·3	59,185 / 113
Lands and buildings	7,585 / 12·0	7,585 / 12·0	10,305 / 19·6	11,267 / 21·5
Plant	44,977[a] / 71·4	47,188[f] / 74·9	19,480 / 37·1	26,713 / 50·9
Mains	33,930 / 53·9	36,558 / 58·1	15,205 / 29·0	19,372 / 36·9
Miscellaneous	3,545 / 5·63	4,351 / 6·91	1,885 / 3·59	1,833 / 3·49
BALANCE OF CAPITAL ACCOUNT	+1,113 / 1·77	−482[g] / 0·77	1,854 / 3·53	−1,613[g] / −3·07
REVENUE—	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.
TOTAL	£9,341 / 5·998d.	£10,684 / 6·010d.	£7,382 / 6·807d.	£8,694 / 6·990d.
Revenue from supply	8,619 / 5·530d.	9,711 / 5·462d.	6,769 / 6·242d.	7,716 / 6·205d.
„ meters, &c.	153 / 0·098d.	186 / 0·105d.	318 / 0·293d.	348 / 0·280d.
„ public lighting	441 / 0·283d.	475 / 0·267d.	23 / 0·021d.	18 / 0·014d.
„ sale of lamps, &c.	— / —	25 / 0·014d.	— / —	— / —
„ miscellaneous sources	128 / 0·082d.	286 / 0·161d.	272 / 0·251d.	612[f] / 0·492d.
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	£4,667 / 2·932d.	£5,270 / 2·965d.	£3,564 / 3·287d.	£3,779 / 3·040d.
WORKS COSTS	3,164 / 2·032d.	3,672 / 2·065d.	2,592 / 2·390d.	2,710 / 2·180d.
Generation of electricity	*2,388 / 1·854d.*	*3,428 / 1·930d.*	*2,537 / 2·340d.*	*2,635 / 2·120d.*
Fuel (including cartage, &c.)	1,015 / 0·652d.	1,126 / 0·634d.	1,189 / 1·097d.	1,256 / 1·010d.
Oil, waste, water, stores	84 / 0·054d.	102 / 0·057d.	173 / 0·160d.	182 / 0·146d.
Wages at station	861 / 0·552d.	878 / 0·494d.	858 / 0·792d.	806 / 0·648d.
Repairs and maintenance at station	928 / 0·595d.	1,321 / 0·743d.	317 / 0·292d.	391 / 0·315d.
Distribution of electricity	*276 / 0·177d.*	*244 / 0·137d.*	*55 / 0·051d.*	*75 / 0·060d.*
Wages, &c.	194 / 0·125d.	179 / 0·101d.	55 / 0·051d.	75 / 0·060d.
Repairs, renewals of mains, &c.	82 / 0·053d.	64 / 0·036d.	— / —	— / —
Public lighting	—[b] / —	—[b] / —	— / —	— / —
Attendance	— / —	— / —	— / —	— / —
Renewals	— / —	— / —	— / —	— / —
MANAGEMENT AND PROPERTY CHARGES	1,503 / 0·964d.	1,598 / 0·899d.	972 / 0·896d.	1,069 / 0·860d.
Royalties	*nil* / —	*nil* / —	— / —	— / —
Rent, rates, taxes	*328 / 0·211d.*	*322 / 0·181d.*	*408 / 0·376d.*	*457 / 0·368d.*
Management	*1,175 / 0·754d.*	*1,276 / 0·718d.*	*564 / 0·520d.*	*612 / 0·492d.*
Salaries	817[c] / 0·525d.	856 / 0·482d.	404 / 0·373d.	450 / 0·362d.
Stationery, &c.	85 / 0·055d.	55 / 0·031d.	101 / 0·093d.	60 / 0·048d.
Establishment charges	127 / 0·082d.	180 / 0·101d.		
Law charges, &c.	146[d] / 0·094d.	185[h] / 0·104d.	59[a] / 0·054d.	102[g] / 0·082d.
FINANCIAL RESULTS—	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded
WORKING PROFIT FOR YEAR	£4,674 / 5·36%	£5,416 / 5·83%	£3,818 / 8·41%	£4,915 / 9·27%
Sum carried to Depreciation Fund	250 / 0·286%	1,000 / 1·08%	300 / 0·660%	750 / 1·41%
Sum carried to Reserve or Sinking Fund	25 / 0·029%	238 / 0·256%	— / —	— / —
Net interest on loans (incl. Debenture charges)	1,614 / 1·85%	1,742 / 1·88%	71 / 0·156%	68 / 0·128%
BALANCE FROM LAST ACCOUNT	19 / 0·022%	85 / 0·092%	146[b] / 0·322%	124 / 0·234%
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	2,585[e] / 2·96%	2,573[i] / 2·77%	3,259[c] / 7·180%	3,822[h] / 7·21%
Deficit	— / —	— / —	— / —	— / —
ORDINARY DIVIDEND PAID	5% / —	5% / —	7% / —	7% / —
PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE	50%	49·3%	48·3%	43·5%
Expenditure per kilowatt capacity	£7. 8s. 2d.	£8. 7s. 5d.	£6. 15s. 10d.	£7. 4s. 0d.
REVENUE PER KILOWATT CAPACITY	£14. 16s. 7d.	£16. 18s. 10d.	£14. 1s. 2d.	£16. 11s. 0d.
Expenditure per 8-c. lamp capacity	4s. 8¾d.	5s. 4d.	4s. 4d.	4s. 7¼d.
REVENUE PER 8-C.P. LAMP CAPACITY	9s. 6d.	10s. 10d.	9s. 0d.	10s. 7¼d.
REVENUE PER 8-C.P. LAMP CONNECTED	7s. 2½d.	7s. 2½d.	5s. 10¾d.	6s. 2d.
Price charged for lighting, per unit	7d.	7d.	7d. to 5¼d.[d]	7d. to 5¼d.[d]
Price charged for power, per unit	5d. [per ann.	4d. [price		
Price charged for public lighting	£24 & £18. 10s. per arc	£652 per ann. contract	£22. 18s. 6d. per arc	£22. 18s. 6d. per arc

OXFORD.—REMARKS—*a* Inclusive of £1,333 on public lamps. *b* Not separately rendered. *c* Includes directors' fees, £415. *d* Inclusive of £65 insurance, £32 auditing, £10 advertising, and £26 "carriage and carting." *e* After deducting £218 net expenses attending issue of capital. *f* Includes £1,333 on public lamps, £2,965 on accumulators, and £4,339 on meters. *g* Over-expended. *h* Includes £48 to insurance, £32 auditing and £87 "carriage and carting." *i* Inclusive of £52 premiums on debenture stock.

CAMBRIDGE.—REMARKS—*a* Includes £26 to auditing and £23 to insurance. *b* After deducting £147 directors' remuneration for 1897, in arrear. *c* After deducting £250 towards reduction of preliminary expenses and £84 written off suspense account. *d* By discounts. *e* Over-expended. *f* By cash discounts and sundry receipts. *g* Includes £26 to auditing, £25 to insurance, and £52 to law. *h* After deducting £250 written off preliminary expenses and £150 written off suspense account.

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distribution—swelled by £85 brought forward and £52 premium on debentures—afforded an ordinary dividend of 5 per cent.

The Cambridge Electric Supply Co. (Ltd.).

It is highly gratifying to note the steady and uninterrupted progress which is being made by this concern. During last year the equivalent lamp connections rose slightly over 12 per cent., the equivalent of 3,043 8 c.p. lamps being added to the circuit. The output shows an increase of about 14·6 per cent. over that of 1898, the total number of units sold being 298,892, for which an average total revenue of 6·99d. per unit was received. This is rather a high average price, and we imagine it would be politic somewhat to reduce the tariff in force, especially in view of the perceptible drop which has occurred not only in the rate of increase of the output, but also of the lamp connections.

With the exception of repairs and maintenance at the station, all the important items of cost have suffered reduction. The figures presented by the several items of the Cambridge cost sheet for last year are representative of or slightly under the average values obtaining in company undertakings of similar magnitude in 1898. The total costs stand at about 0·25d. below the average.

A working profit of £4,915 was made, out of which £750 was placed to the depreciation fund, the interest charges amounting to £68. After further deductions in respect of the suspense account and preliminary expenses, there remained a balance available for distribution of £3,822, permitting of a repetition of the previous year's dividend of 7 per cent.

The following table furnishes an idea of the progress made since 1894 :—

Year.	No. of consumers.	Equiv. lamp connections.	Output. Units sold.	Total costs per unit.	Ordinary dividend.
1894	250	11,644	112,084	...	2½%
1895	269	14,660	150,510	4·53d.	3½%
1896	287	18,633	197,615	3·80d.	5%
1897	329	21,195	221,507	3·75d.	6%
1898	365	25,080	260,307	3·29d.	7%
1899	383	28,123	298,392	3·04d.	7%

THE "PARTRIDGE" HIGH-VOLTAGE SAFETY DEVICE.

The protection of electrical circuits from abnormally high voltage, arising from accidental or other causes, probably had its earliest illustration in the lightning guard, the necessity for which arose when aerial wires were first used in connection with telegraphy. Since the introduction of the telephone, the electric light, and circuits for the transmission of power and for electric traction, similar protecting devices for guarding against the effects of lightning have from time to time been rendered necessary where aerial wires have been used. But where the circuits carry a large amount of power, the ordinary spark-gap apparatus is insufficient to guard the circuit from breakdown, for the flash across the gap breaks a path for the electrical power of the circuit, and a continuous flash across the gap takes place, the line being very speedily broken down from this cause. In order to obviate this, various devices have been introduced, such as spark-gaps between two metallic horns so constructed that the convection currents caused by the spark raise the spark upwards to a point where the gap is so wide that the voltage is no longer able to maintain the spark. This form of self-extinguishing lightning protector has been extensively used on electric power circuits with aerial lines. The abolition of aerial conductors on systems of electric supply mains in this country has not, however, removed from these mains the dangers which arise from excessive high voltage momentarily occurring. It is true that lightning does not affect these mains, but an equivalent effect is produced by the inductance and capacity of the cables and the apparatus connected to them whenever any portion of the circuit is connected or removed from the rest of the circuit. Thus, for example, in a system of high-voltage alternate-current distribution mains the connection or removal of a section of the circuit at the switchboard is liable to cause momentarily as much as a 50 per cent. or even greater rise in the pressure on the mains. The danger of even a temporary rise of this magnitude is considerable, owing to the liability of breaking down of transformers and other plant placed across the mains.

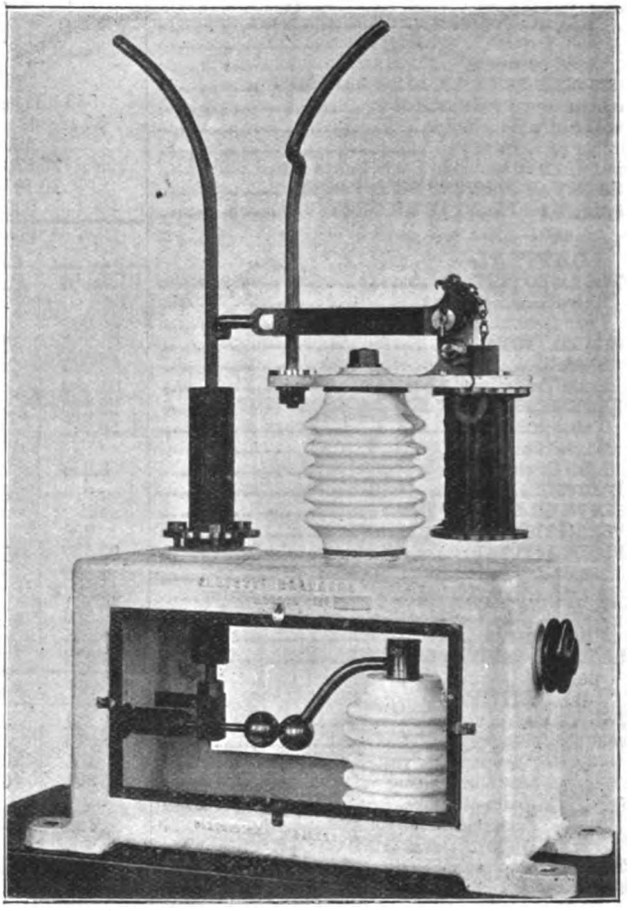

FIG. 1.—The "Partridge" High-Voltage Safety Device.

The problem of providing a reliable and quick-acting device to guard against this evil has occupied for some time the attention of Mr. G. W. Partridge, chief engineer to the London

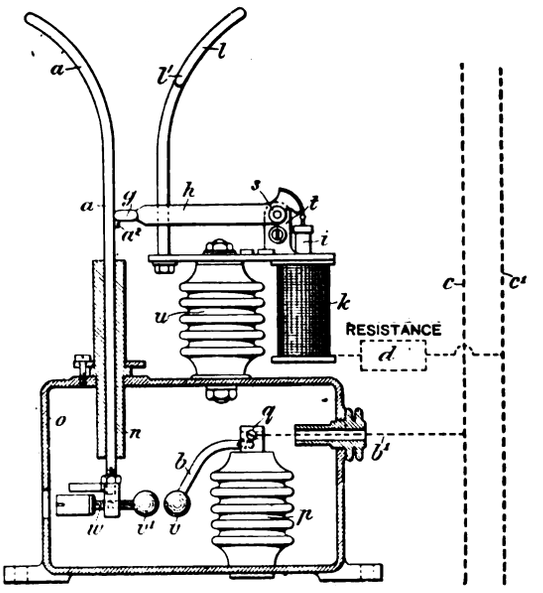

FIG. 2.

Electric Supply Corporation, with the result that a very ingenious and perfect form of apparatus has been evolved by him. The final form of this instrument is shown in Fig. 1, which is engraved from a photograph of an instrument we recently

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had an opportunity of observing in operation at the transformer station of the London Electric Supply Corporation at 25A, Cockspur-street, London, S.W. The action of this instrument is best explained by reference to Fig. 2, which gives a diagram of the internal connections of the instrument and shows its connections to the cables. In this figure c is the inner and c_1 the outer conductor of a concentric cable to be protected. Connection is made from the inner conductor c through a gland in the box to an insulated nob, v, which makes, with the nob v_1, an adjustable spark gap. The path of the spark after leaping the gap is from v_1 to a, one of a pair of metallic horns, the width between which increases with increasing height. The other horn is shown at l. The gap between these two horns is normally short-circuited by a metallic lever, h, which is pivoted at s, the other arm of the lever carrying an iron core, i, which is suspended at the mouth of a solenoid, k. The circuit of the spark is therefore first across the gap, then by the horn a and along the lever h, whence it passes through the coils of the solenoid k and finally through a resistance, d, to the outer conductor c_1. It will thus be seen that the passage of any considerable discharge across the gap will energise the solenoid and attract the iron core, thus lifting the tip g of the lever until this strikes the outer horn l at the point l_1. The torrent or flash which will be produced between the horn a and the tip g will at this point, l_1, be transferred to the two horns at a point where the gap is sufficiently wide to allow the convection currents to lift the flash bodily upwards until it is extinguished by the widening between the upper part of the horns. In operation this piece of apparatus is remarkably prompt. We saw portions of the circuit rapidly connected and disconnected from the mains; and whenever the pressure rose more than 25 per cent. above the 10,000 volts normal pressure the apparatus promptly set itself in action, and in a small fraction of a second the earth discharge was effectively extinguished. We may mention that the percentage rise above the normal pressure required to put the apparatus in action is adjustable, the spark-gap between the nobs v and v_1 being adjusted by means of a set screw. It is further to be noticed that in this form of apparatus the whole of the exposed parts are normally dead, being connected to the outer concentric cable; all the live parts are contained within the box and also being carefully insulated.

CORRESPONDENCE.

MOTIVE POWER FROM PUBLIC SUPPLY MAINS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: On reading through your leading article on the above subject in the current issue of the journal, I find that there are some statements and many deductions which are inaccurate and convey wrong impressions. I hasten to point these out, as I am quite sure that you desire equally with myself that facts alone should be relied upon. I am quite at a loss to know how you arrived at the conclusion that the figures given for the costs in Table III. of my Paper are merely estimates based upon an assumption, as the very opposite is the case, and is so stated clearly in the Paper.

No one deprecates assumed figures and estimates based thereon more than myself, and I have been a practical protest against such a basis of argument or even for illustration in all my Papers and writings. Had my figures been as you assume, the Paper would not have been worth while bringing before any institution. In addition, I list the following remarks to your comments:—

1. The price per unit for motive power in Bradford is 1d. for all purposes other than warehouse cranes. These are charged at 2d.

2. There has been no sliding scale from 2½d. to 1d. for motive power in Bradford for nearly 12 months.

3. The price of gas is 2s. 8d. per 1,000 cubic ft, as stated.

4. The entire figures in Table III. are actual accounts as rendered by the different departments of the Corporation.

5. The "Remarks" are those of the consumers whose names are given.

6. The case of the printer, upon which you comment, is merely an accentuated instance of what losses small printers must incur when running shafting all day. Nothing further is pretended, in this or other instances, than a record of fact.

I enclose another copy of my Paper on "Electrical Driving in Factories," and a table showing the progress of the Corporation electricity undertaking at Bradford.—Yours, &c.,

Bradford, April 9. ALFRED H. GIBBINGS.

[Our data for the price of electric power at Bradford were taken from particulars furnished us by the Bradford Corporation electrical engineer at the commencement of this year. With regard to the Table III. of sample installations at Bradford, we reprint below Mr. Gibbings' remarks on this table, from which it will be seen that the table is said to be based on "rough calculation," and in which we venture to assert there is no explicit statement that 1d. per unit is actually charged for power at Bradford:—

"I am personally acquainted with the details of machinery and operation in each of the instances given in this list, and I may therefore state that some rough calculation was made in each case as to the possible economy to be effected in changing from the one form of power to the other. With the exception of the last four consumers, the economy proved in practice is far more than that anticipated, and such a result indicates conclusively that the losses due to running shafting and other gear in connection with and necessary to it are very much greater and of more importance than it is possible to calculate. In the last four instances given in Table III. the users elected to continue to use their shafting, merely replacing the gas engine with one electric motor. It serves to prove at least that electricity at 1d. per unit is no more expensive for power purposes than gas at 2s. 3d. per 1,000 cubic ft. under similar conditions, but it is regrettable to find consumers quite satisfied to pay more for the actual power they require than there is any necessity for."
—ED. *E.*]

LEGAL INTELLIGENCE.

Eastern and South African Telegraph Co. v. The Capetown Tramway Companies.

JUDGMENT.

On Tuesday, March 13, judgment in this action was delivered in the Supreme Court at Capetown by the Chief Justice (the Right Hon. Sir J. H. de Villiers, K.C.M.G.), who said: The plaintiffs carry on the business of transmitting telegraphic messages by cable between Capetown and Europe, and the defendants carry on the business of conveying passengers in Capetown and its suburbs in cars propelled by electric power. The entire system of the tramways in Capetown is worked from one generating station. Current is conveyed to the car by overhead wire with a pressure of electricity far higher than the earth or the rails. The cars take their power by means of a rod on the top of each car, which runs underneath the high-pressure trolley wire. The electric current goes down the rod, passes through the motors on the car, and is returned to the generating station through the rails. In the course of this return a portion of the current escapes into the earth and causes electrical disturbances at a considerable distance from the place of escape. The effect of these disturbances upon the telegraph cable used by plaintiffs is a peculiar one. When the earth current reaches the outside sheathing of the plaintiffs' cable lying on the bottom of the sea within the area of disturbance, this sheathing picks up a portion of the escaped current. So long as this current flowing along the sheathing is steady and of constant magnitude and direction, no effect is produced on the electrical apparatus for signalling the messages at the plaintiffs' Capetown station. But if the tramcars are constantly starting and stopping, the current in the sheathing is constantly changing its magnitude and direction, with the result that the copper conductor or core inside the cable has a current induced in it, which has a disturbing effect on the signalling apparatus. The plaintiffs, by laying a second cable as nearly as possible parallel and near to the existing cable as far as Robben Island, have succeeded to a considerable extent in reducing the disturbing effect of this induced current, but allege that in the meantime they had sustained considerable damage from loss of business occasioned by the delays in transmitting messages. A completely efficacious mode of neutralising the effect of the disturbance would have been to lay what is described as a twin-core cable some distance into the sea. The twin core is enclosed in the same sheathing, but one of the cores is fastened to the sheathing of the cable some distance out to sea. The going and returning conductors being thus placed as closely together as possible, become subject to the same disturbance produced by any outside cause, and induction is thus prevented. There is some difference of opinion among the experts as to what the length of such twin-core cable should be to overcome the electrical disturbances of the plaintiffs' instruments, but it is generally agreed that such a cable, if of sufficient length, is the only certain remedy. Accordingly, plaintiffs in their claim for £50,000 as damages include the cost of laying a twin-core cable to Robben Island and the capitalised cost of maintaining such a cable, in addition to damages for loss of business and for expenditure

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incurred by them in experimenting and laying the parallel cables on to Robben Island. They also ask for an interdict restraining defendants from so working their tramways as to injure plaintiffs in their business. The Acts under which defendants have constructed their tramways are those of 1895 (two) and 1896, but no legislative authority was ever asked for or obtained for the construction of a comparatively short section of the tramway, namely from the Toll to Mowbray, although that section connects the other portions of the system for which due authority has been obtained. As to the escape of electric current from this section, plaintiffs rely upon the common law as entitling them to relief, and as to the remaining portion of the system, upon the provisions of the fourth section, sub-section (*d*), of Act No. 22 of 1895, and corresponding provisions of other Acts of Parliament. The terms of this sub-section (*d*) are as follows: The company shall, subject to the provisions of this Act, have the right—

(*d*) To erect, maintain, and work all necessary power and stations . . . subject to the approval and in accordance with any resolution or standing order of the Council. . . . Provided that . . . the company specially undertakes that in the event of any electric leak taking place and any damage being thereby caused at any time by electrolysis or otherwise, it will reimburse and make good to the Council or other body or person all costs, damages, and expenses to which the Council or other body or person may be put by reason thereof; and provided, further, that nothing in this Act contained shall entitle the company to use the rails of any of the said lines of tramway as a part of its system of conductors for the return electric current without the consent of the Council first had and obtained.

In the other Acts the consent of the road authority is required, and it is admitted that for the whole of the defendants' system of tramways the consent of the Council or other road authority has been duly had and obtained. The first question, then, which arises is whether the damage said to have been done to plaintiffs is covered by the words "in the event of any electric leak taking place and any damage being thereby caused by electrolysis or otherwise." It is reasonably clear from the evidence that it would be practically impossible so to insulate the rails as to prevent a portion of the current returning to the generating station from escaping. That this danger was present to the mind of the Legislature is clear from the proviso that the rails should not be used as part of the system of conductors for the return electric current without the consent of the road authority. The effect of such consent, when given, would be the same as if the Legislature had expressly and directly authorised the use of the rails for the return current. Now, supposing the Legislature had given such authority, it is extremely improbable that it would have required an undertaking from defendants to be liable for any damage whatever that may be caused by any escape of current from the rails. At all events, if such was the intention of the Legislature, nothing would have been easier than to find appropriate words for the purpose. For instance, if the fourth section had enacted that the company "undertakes that in the event of any portion of the electric current escaping and causing damage, the company will reimburse the damages," and so on, the last proviso would not have protected the defendants. But the undertaking is more strictly limited, for it is confined to the case of a "leak" causing damage "by electrolysis or otherwise." According to Dr. Johnson, a leak is "a breach or hole which lets in water." According to Webster also, this is the primary meaning of the substantive, but the secondary meaning is "the oozing or passing of water or other fluid through a crack, fissure, or aperture." The Imperial Dictionary gives practically the same definition of the term. The word "leakage" no doubt has a somewhat wider meaning, but that is not the word used in the Acts. Electricians have applied both words to the passing of an electric current from a conductor, but there is a difference of opinion among the experts who have given evidence in the present case as to whether the word "leak" is applicable to a general and gradual escape of the electric current from the rails. No good purpose would be served by an analysis of their evidence, and I accept Mr. Jacob's views as substantially correct. Being asked whether he would call an escape of electricity from the rails, uninsulated, on its way to the earth, an electric leak, he answered, "No, I should not call it a leak, because we do not call it a leak when it is going into an actual conductor. It is forming a mass of conducting area which is better than the other mass of conductor, that is all. You can hardly call it a leak, because you cannot possibly stop it. We would call a leak a hole in the gutta-percha or some other insulation which we could mend at any time." Being asked to illustrate what he meant by a "leak," he said, "I should take it to be a hole in the gutta-perch round the cable, or the touching of one of the trolley wires by another wire, causing a leak to earth." Mr. Jacob further pointed out that complete insulation of the rails would be practically impossible, and that it would be positively dangerous, "because you would get exactly the same current as from the trolley wire." Mr. Jacob was asked: "As Mr. H. D. Wilkinson admitted, quite apart from accidents, if the iron-tyred wheel of a cart drove over the rail, that would send the current to earth?" *Answer:* "Of course it would; you would be connecting the whole system to earth. It is not the difference of voltage that now exists between the rail and the earth; it is the whole of the voltage you would get, exactly as if you touched an electric wire that is all insulated." I am clearly of opinion that the Legislature, having sanctioned the use of the rails for the return current, did not intend to comprise in the term "leak" the necessary escape of current from such rails. But assuming that the term has the wider meaning contended for by plaintiffs, the question still remains whether the disturbances to their signalling apparatus can be fairly regarded as "damage caused by electrolysis or otherwise." Several cases have been cited as to the proper construction of general words following terms more specific, but it is difficult to lay down any rule of construction which shall be applicable to all cases. The general words must be read by the light of the statute as a whole, but the fact that they immediately follow some particular and specific word cannot be lost sight of. The Legislature would not have specified "electrolysis" as one of the forms of damage for which the defendants should be liable if it had intended that the liability should extend to every possible form of damage. The general scope of the statute as a whole, and of sec. 4 in particular, satisfies me that the term "or otherwise" should be confined to forms of damage of a similar kind to electrolysis. It must be a physical damage, such as the fusion of some metal, and not a mere electrical disturbance of signalling apparatus caused by induction. I am of opinion, therefore, that the Acts on which plaintiffs rely do not assist them in fixing liability upon defendants. The question still remains whether under the common law defendants are liable for the disturbance so far as it proceeded from the short section of tramway for the construction of which no legislative authority has been given. They are not trespassers on the roadway, for they have the sanction of the proper road authority for the laying of the tramline and the running of cars on the line. So long as they carry on their business in such a manner as not to endanger the public or interfere with its use of the roadway, they must be regarded as carrying on a lawful and honest business, as if the land on which the rails are laid were their own. The rule would apply to them, as it does to every owner of property, that they must use their property in such a manner as not to injure the rights of others. The question still to be determined is whether the rights of plaintiffs have been in any way injured by the acts of defendants. It is difficult to ascertain at the outset what particular legal right of plaintiffs has been injured. There is an escape of electricity from defendants' rails which spreads over a vast area of the earth; this current is taken up by the sheath which surrounds plaintiffs' conductor, and by a process known as induction a disturbance takes place on plaintiffs' delicate signalling apparatus on the sudden stoppage of defendants' cars. The quantity of electricity which causes this disturbance is infinitesimal as compared with the total quantity transmitted through defendants' rails, and does no damage to anyone beyond disturbing the sensitive instrument used by plaintiffs for transmitting telegraphic messages. That no doubt caused some loss to plaintiffs' business, but does that damage constitute an injury for which defendants are liable? In the case of "Struben *v.* Capetown District Waterworks Co." it was held that a person who, by digging a well in his own land for the bonâ fide purpose of improving the value of such land, abstracts underground water finding its way in undefined channels, is entitled to such water, although the abstraction may cause a diminution in the supply of other wells, or even of a public stream. The owners of the other wells are damaged by the loss of water, but as they have no legal right to claim that water percolating in undefined channels shall not be disturbed, they have no remedy against the person who disturbed it in the exercise of his legal rights. It may be said, however, that plaintiffs do not complain of something being taken from them, and that the analogy of water being accumulated by one owner and let loose on the land of another would be more to the point. In the case of the "Victoria Diamond Mining Co." it was held that defendants, who, by piercing a barrier left in a tunnel connecting a shaft outside a diamond mine with their claims within the mine, had thrown a body of water on the plaintiffs' claims, which would not have come to such claims in the ordinary course, were guilty of negligence and liable in damages. The English case of "Fletcher *v.* Rylands" was cited, but the decision of the Appeal Court was founded upon the well-known action aquae pluviae arcendae of Roman law as adopted by the law of Holland. That action was originally applied only to the case of rain water, and was extended by this court to the case of water accumulating in a mine, but there appears to me to be no analogy between the direct damage caused by a rush of water accumulated by the negligence of an upper proprietor and the indirect damage caused by the subtle escape of electric current into the earth with no other tangible effect than the disturbance of delicate telegraphic apparatus. The damage must be the direct consequence of the negligence. The analogy between such direct damage and the incidental damages resulting from defendants' operations is very far sought. But even if the analogy were complete, it is by no means clear to me that there was such a degree of culpa on the part of defendants as to render them liable under the law. They had the right to use the rails for the transmission of the electric current over portion of their system, but they had the consent of the proper road authority to lay the rails, at all events on the portion for the construction of which they have no legislative authority. The business they were carrying on was lawful and beneficial to the public, and on the short section in question they made use of the method authorised by the Legislature for the remaining portions of their system. That method of employing electricity as a motive power appears on the whole to be the best hitherto invented. The plaintiffs mainly rely upon the decision of the House of Lords in "Fletcher *v.* Rylands," where it was held that if the owner of land brings upon it anything which would not naturally come upon it, and which in itself is dangerous, and may become mischievous if not kept under proper control, though in so doing he may act without personal wilfulness or negligence, he will be liable in damages for any mischief thereby occasioned. That was a case of direct injury to the lessee of certain mines under land adjoining a close belonging to a mill owner. The mill owner employed competent persons, an engineer and a contractor, to construct a reservoir, but they took no care to block certain vertical shafts which communicated with the land above. The result was that the water introduced into the reservoir broke through some of the shafts, and after flowing through certain old passages flooded the mine. There seems to have been such want of due care and skill on the part of the engineer and contractor as would under our law render the mill owner liable, but the decision proceeded on the wider ground that if a person brings or accumulates on his land anything which, if it should escape, may cause damage to his neighbours, he does so at his own peril. I cannot find any authority in our law which goes quite as far. No doubt the facts of the escape and damage would afford prima facie evidence of negligence, but where it is proved that the person causing the damage could not have reasonably expected that the work would damage his neighbour, and that he and those employed by him have used all due skill and care in the

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execution of it, the presumption of negligence would be ebutted. In the case of "National Telephone Co. *v.* Baker"* Mr. Justice Kekewich expressed it as his opinion that a person who creates on his land an electric current for his own purposes, and discharges it into the earth beyond his control, is, on the principle of "Fletcher *v.* Rylands," as responsible for the damage caused by that current as he would have been if he had discharged a stream of water. This opinion, however, was not necessary for the decision, which was in favour of the tramway company on the ground that the company had acted under a provisional order of the Board of Trade, and had used the best known system of electric traction, being the same system as that used by defendants in the present case.

"American law," continues Mr. Justice Kekewich, "apparently holds the owner of land used for a non-natural or extraordinary purpose responsible for the consequences of such user to his neighbour only when they result from that owner's negligence. . . . It seems to me that if the principle of 'Fletcher *v.* Rylands' had been fully adopted in America, the conclusion of the court in the Cumberland company case must have been different. I believe that in Scotland, too, the principle of 'Fletcher *v.* Rylands' has not been accepted, and is not regarded as consistent with justice between man and man. It does not fall to me to consider so large a proposition. The principle is thoroughly well settled here, and my duty is merely to consider whether it is applicable. . . . The electric current may be more erratic than water, and it may be more difficult to calculate or to control its direction or force, but when once it is established that the particular current is the creation of or owes its special existence to the defendant and is discharged by him, I hold that if it finds its way on to a neighbour's land and there damages the neighbour, the latter has a cause of action."

If Mr. Justice Kekewich was right in holding that the question of negligence did not enter into the decision of the case of "Fletcher *v.* Rylands," I should certainly not be prepared to hold that it is a binding authority in this court. But even if it were a binding authority, it does not appear to me to follow that defendants would be liable for the indirect and remote consequences of an escape of electricity from their rails. Water dammed up in a reservoir is palpably a source of danger to lower proprietors. In the same way the transmission of a powerful current of electricity through the trolley wire and the rails may be the means—under certain circumstances—of seriously damaging property in the neighbourhood of the road by the direct action of conduction. There would be no difficulty in holding that the legal rights of the owner of such property would be infringed by any damage thus done. But the legal right of plaintiffs to be protected against the slightest disturbance of their delicate apparatus caused by the indirect effect of induction is by no means clear. That right becomes still more doubtful when it is borne in mind that, by laying a few miles of twin-core cable, plaintiffs could have prevented the disturbance. It is quite true that plaintiffs were in the field before the defendants, but when they first laid down their cable plaintiffs could not reasonably have expected that, in the ordinary course of scientific invention and improvement, the whole area through which the cable went would always remain free from electric disturbance. The utility of the twin-core cable seems then already to have been known, but even if it had not then been known, plaintiffs, whose business it is to lay and use cables, might well have been expected, upon the discovery being being made known to them, to lay the short and comparatively inexpensive twin-core cable required to render their instruments safe against disturbance. The American case to which Mr. Justice Kekewich referred was for an interdict at the suit of a telephone company against a tramway company, which had legislative authority to use electric traction for its cars along its whole line, but in other respects it bore a resemblance to the present case. The opinion of the Court, after entering into an elaborate examination of the American and some English cases, concludes as follows :—

"The substance of all the cases we have met in our examination of this question is that where a person is making lawful use of his own property or of a public franchise in such a manner as to occasion injury to another, the question of his liability will depend upon the fact whether he has made use of the means which, in the progress of science and improvement, have been shown by experience to be the best; but he is not bound to experiment with recent inventions not generally known, or to adopt expensive devices, when it lies in the power of the person injured to make use of an effective and inexpensive method of prevention. . . . The damage incidentally done to the complainant is not such as is justly chargeable to the defendants, unless we are to hold that the telephone company has a monopoly of the use of the earth, and of all the earth within the city of Nashville, for its feeble current, not only as against the defendants but as against all forms of electrical energy which, in the progress of science and invention, may hereafter require its use. . . . We place our denial of an injunction upon the grounds: (1) That the defendants are making lawful use of the franchise conferred upon them by the State, in a manner contemplated by the statute itself, and that such an act cannot be considered a nuisance in itself. (2) That, in the exercise of such franchise, no negligence has been shown, and no wanton or unnecessary disregard of the rights of the complainant. (3) That the damages occasioned to complainant are not the direct consequence of the construction of defendants' rails, but are incidental damages resulting from their operation, and are not recoverable."

For the reasons which I have already stated, plaintiffs are not entitled, in my opinion, to succeed in their action either for damages or for an interdict, and the judgment of the Court must be for defendants, with costs.

Mr. Justice BUCHANAN said: At the close of the arguments the only part of the case on which I had any doubt was as to the use of that portion of the tramway company's line which was not authorised by statute. After considering the case fully and carefully, and in consultation with my brethren, I have come to the conclusion that the law as laid down by his lordship in his judgment now delivered is quite correct, and I fully concur in giving judgment for defendants, with costs.

Mr. Justice LAURENCE said: This is an action for damages alleged to have been sustained by plaintiff company in the working of their electric submarine telegraph cable by reason of the working of defendants' electric tramways. They claim for loss of business, for the cost of certain investigations, for that of remedies which they have already tried and others which they now propose to adopt. There is no doubt that they have sustained damage and that their signals have been disturbed. The nature and causes of the disturbance have been clearly explained by the witnesses (by Mr. H. D. Wilkinson among others in the earlier portion of his evidence). There is also no doubt that plaintiffs can remedy this trouble by laying a twin-core cable and earthing the second core at some distance out at sea, though there is considerable difference of opinion as to the length of this cable required in order to protect plaintiffs from any serious disturbance in the future such as has occurred since the tramways were first worked by electricity in the latter part of 1896. The question for decision is whether defendants are liable to compensate plaintiffs for this damage and expense. Plaintiffs allege that defendant companies carry on their operations under Parliamentary powers; but it appeared at the trial that, as regards one small section of the line, between Woodstock and Mowbray, for a distance, I think, of about a mile and a half, this is not the case, but that the line has there been laid on the main road with the permission of the Divisional Council, but without statutory authority. The real question is whether defendants, in working their system, either with or without Parliamentary powers, have done plaintiffs a legal injury or actionable wrong. Several statutes have been cited, but in the material portions they closely resemble one another, and I may take the Metropolitan Tramways Act, 22, 1895, as typical. The plaintiffs rely in their declaration on sec. 28 (*f*) and sec. 4 (*d*). They do not specially rely on sec. 16, which does not seem to extend the liability, though it may to some extent be of assistance in the construction of sec. 4. Defendants in their plea specifically deny any damage within the meaning of these sections, and generally any liability to compensate plaintiffs. The plaintiff company, it may be observed, have not based their case on any allegation of negligence. I do not think they could have done so merely on the ground that defendants, after obtaining permission, as required by the Act, had utilised their rails for the return current, instead of adopting one of the other methods which might have been employed. It seems that their system—especially where there is only a single line of rails—is probably, in the present state of electrical science, on the whole the most advantageous and convenient system, and at all events one which it is quite legitimate to employ. This appears, I think, from the evidence in the present case, and is in accordance with the view expressed in the case of the "National Telephone Co. *v.* Baker" by Mr. Justice Kekewich, and with that of the Tennessee (U.S.A.) Court in the valuable and instructive judgment in the case of "Cumberland Telephone Co. *v.* United Electric Railway." Something, however, might perhaps have been said as to the conduct of defendants in allowing a larger proportion of the electric current to escape than is sanctioned by Government regulations, and it might have been contended that they could and should have materially reduced that percentage, and so probably the resulting disturbance, by the employment of boosters or the construction of intermediate generating stations. However, plaintiffs do not make any point of this; neither did their counsel rely in his argument on sec. 28, I think rightly, as on the whole it seems clear that the provision in clause (*f*) refers to injuries of quite a different kind, and to interference with sewers, drains, pipes, lamps, cables, or wires, of a direct or physical character, resulting from the construction, repairs, or maintenance of the tramlines. Plaintiffs, however, assert that defendants have carried on their business in such a way as to cause a nuisance; but they rely mainly, so far as defendants work under their Acts, on the special undertaking given in sec. 4, and, so far as concerns the other portion of their line, on their alleged duty at common law to prevent the electricity which they produce from injuring their neighbours or disturbing them in the lawful exercise of their business and enjoyment of their rights. So far as the question of nuisance is concerned, it was pointed out in the Tennessee case that "nothing authorised by competent authority can be treated as a nuisance *per se*," apart from some special feature in time, place, or manner in which the work is done or the business carried on, and various cases, both English and American, are cited in support of that proposition. The main question seems to be with regard to the scope of sec. 4. As to the small portion of defendants' system which does not come within any of the Acts, not only was this point not raised on the pleadings, but the evidence, I think, is insufficient to enable the Court to decide to what extent, if any, the electric current escaping from this small section alone would have caused inconvenience to plaintiffs. All that is clear is that the extent of the entire system and the volume of the traffic was a very material element in the production of the disturbance of which they complain. I may here add that the *obiter dicta* of Mr. Justice Kekewich in the case cited above, based on the decision in "Fletcher *v.* Rylands," really only assists the plaintiffs so far as this small section is concerned. The decision in that case was on the ground that the defendants were protected by their provisional order from liability for nuisance. Similarly Baron Pollock, in his work on "Torts," in his interesting discussion of the former case, and of the tendency in more recent decisions to narrow its scope, points out that in any case there is an exception to its application in favour of persons acting in the exercise of powers specially conferred by law. He cites a case where the owners of a canal constructed under the authority of an Act of Parliament were held not bound at their peril to keep the water from escaping into a mine worked under the canal ("Pollock on Torts," 2nd ed., pp. 425-430; "Dunn *v.* Birmingham Canal Co."). I come now to the effect of defendants'

* The action, "National Telephone Co. (Ltd.) and Another *v.* Graff Baker (Leeds Corporation)," was fully reported in *The Electrician* for Dec. 16 and 23, 1892, and Jan. 20 and 27 and Feb. 10 (Judgment), 1893.

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special undertaking, which appears to have been obtained primarily in the interest and on behalf of the City Council, to make good the damage "in the event of any electric leak taking place, and any damage being thereby caused at any time by electrolysis or otherwise." Plaintiffs contend that this is a case of an electric leak, causing them damage, not by electrolysis, but "otherwise" within the meaning of the section. Now, it is clear that this discharge from the rails as a conductor into the earth as another conductor, and thence into the sea, might in a popular and general sense be described as "leakage." But I feel great doubt as to whether it can be held to fall within the description of "an electric leak." The use of the concrete word "a leak" seems to me much stronger. A leak, so to speak, is a thing, while leakage is a process. Moreover, the section says, "in the event of an electric leak taking place." The use of the phrase "in the event" seems to imply that the thing may or may not take place; perhaps one might even go so far as to say that it implies that in the normal course it would not take place. But the use of the rails for the return current, with the consent of the Council, was expressly contemplated by the same section; the use of uninsulated rails for that purpose necessarily involves the escape of some portion of the current, and the phrase "in the event" seems therefore scarcely applicable to such a state of things. It means not a regular process, but an accidental and exceptional occurrence, which might be traced to its source in the manner and by the tests provided, and then remedied in due course. Even, however, if I am wrong on this point, and have construed too narrowly the meaning of "an electric leak," I am further of opinion that the words "or otherwise" read in connection with the context ought not to be construed as covering damage, not of a physical or tangible nature, not caused to any structure or material, not resulting from any lesion, corrosion, or fusion, and having no analogy or relation to the damage caused by electrolysis. It is contended that electrolysis is a thing *sui generis*, and that therefore, in order to give any effect to the words "or otherwise," they ought to have assigned to them the widest possible meaning. In that case the insertion of the four words "by electrolysis or otherwise" must be regarded as entirely superfluous, and the intention of the Legislature would have been equally well and much more clearly conveyed had they been entirely omitted. I think there is evidence that damage of a nature more or less analogous to electrolysis might reasonably have been apprehended when the Act was passed, and that the words "or otherwise" might therefore well have been inserted *ex abundanti cautela*. The damage in this case appears to me to be of a wholly different nature, too remote, and, if I may so put it, too impalpable in its character, to be covered by these words. There is not much use, with regard to the principle of construction of general words following particular words, in referring to the details of previously decided cases, as each case depends so much on its own details. I quite accept the general principle laid down in the recent case of "Anderson *v.* Anderson," in accordance with which in that case—as in the still more recent case of "Richmond Hill SS. Co. *v.* Trinity House"—a wide meaning, including live-stock, was given to the words "other goods" in the construction of a deed and of an Act of Parliament respectively. As Lord Esher put in, "general words are to be taken in their larger sense, unless you can find that in the particular case the true construction of the instrument requires you to conclude that they are intended to be used in a sense limited to things *ejusdem generis* with those which have been specifically mentioned before." It may perhaps be suggested that the wider the general words, the more probable it is that such construction will have to be applied. These very words "or otherwise" had, it is true, a very wide meaning given them in the construction of a section of the Patents Act in the case of "Skinner *v.* Shaw," but that was on a consideration of the whole section, and of the state of the existing law, and therefore on grounds that do not appear to assist plaintiffs in the present case. There have also been various cases on the construction of the prima facie comprehensive words "or other person whatsoever" in the Sunday Trading Act of Charles II, and the most recent decision I notice, pronounced a few weeks ago by a Divisional Court, is that these words do not include a barber, whose occupation, it may be observed, was similarly held not to be "trading" within the meaning of Ordinance 1 of 1838 by a decision of the High Court pronounced in 1889 in accordance, as it happened, with the contention of the present Attorney-General, who was then counsel for the appellant "Marks *v.* The Queen." Holding as I do, on these grounds, that there is no special provision in the statute enabling plaintiffs to recover, and that in the absence of such provision defendants are protected in the legitimate exercise of their business by their Parliamentary powers, there only remains the question as to the portion of the line between Woodstock and Mowbray, as to which I have already observed that there is not sufficient to show that, taken by itself, it would cause plaintiffs any material damage. Moreover, even with regard to this, in the absence of negligence, defendants could be held responsible only on a very rigid application of the reasons given in the House of Lords for their decision in "Rylands *v.* Fletcher." On that case Sir F. Pollock observes, *loco citato*, that "no case has been found, not being closely similar in its facts or within some previously recognised category, in which the unqualified rule of liability without proof of negligence has been enforced." No such rule appears ever to have been adopted in either the Scotch or the American courts, and I can find nothing to show that it is in accordance with the principles of our system of jurisprudence to hold that a person exercising a lawful calling in a lawful way, even when it involves the control of elements or the use of methods potentially hazardous, is liable for any resulting damage if he is able to show that he took all due precautions, and that the damage occurred without any negligence, or culpa, on his part. Many of the cases were examined, and the proper application of the general principle, *sic utere tuo ut alienum non laedas*, considered in the High Court case of "Reed *v.* De Beers Co.," in which the judgment was confirmed on appeal by the Supreme Court. It was there held that as there was no proof of any wrongful act committed by the defendants to the prejudice of the plaintiff, or of any omission of a legal duty which they owed to the plaintiff, the case was one of damnum sine injuria. In the present case I think on similar grounds we must arrive at a similar conclusion. I wish to add only a very few words on the question of damages, as we were informed that, whatever our decision, the case would probably go farther. There was a great deal of evidence on this part of the case, but it was not fully argued. I take it, however, that the general principle in a case like the present is that the plaintiff should take all reasonable steps to minimise the damages which he seeks to recover from the defendant. Now, I am satisfied from the evidence, and from a passage in Mr. A. P. Trotter's Paper, that in the state of electrical science in 1896, when this question arose, plaintiffs ought to have been able to find and to apply within a reasonable time an effective and certain remedy for these disturbances by laying a twin-core cable as described. I am inclined to think that a length of five miles would have been ample to secure them against any appreciable disturbance; and even had it subsequently proved insufficient, I suppose it could afterwards have been lengthened or a longer one substituted at the expense, if they were liable, of defendants. I may also point out that if this had been done between August, 1896, and the middle of 1897, there would only have been an aggregate period of about three weeks during which plaintiffs' line was interrupted, and the amount of interim damage or inconvenience which plaintiffs would have sustained would therefore apparently have been very small.

Judgment was then entered for defendants, with costs.

In the Supreme Court at Capetown, on March 20, an application was made by the Eastern and South African Telegraph Co. for leave to appeal to Her Majesty in Privy Council against the above decision.

The application was granted.

With regard to the costs of the main action, the Court, on the application of Mr. Innes, Q.C., decided that the costs should be paid on the respondents giving security. It was ordered that this order should form part of the judgment.

There was a further application, the Tramway Co. being the applicants and the Telegraph Co. the respondents. The Tramway Co. now asked for an order authorising the payment of the expenses, including the qualifying expenses of two witnesses called on behalf of defendants. These two witnesses were Mr. F. Jacob and Prof. A. Jamieson. It appeared that some time previous to the last August term of the Supreme Court these gentlemen were subpœnaed as witnesses, it having been agreed by the parties that the case should come on for trial that term. Subsequently plaintiffs found they would be unable to proceed to trial that term, and a cable message was sent to stop the witnesses from coming, but arrived too late, the witnesses having sailed the same day. The two witnesses had returned to England, Mr. Jacob coming out again and giving evidence at the hearing of the case, but the evidence of Prof. Jamieson had been taken on commission in London, he being unable to come out again. For the applicants it was contended that the evidence of these witnesses was necessary, there being no electrical engineer of sufficient standing at Capetown to give the evidence required. For the respondents it was urged that the evidence could have been taken on commission, as was actually done later on in the case of Prof. Jamieson. In any case it was said that these witnesses should not have been brought out here in August until it was certain that the case would come on for trial that term.

The CHIEF JUSTICE said: As to the qualifying expenses of the two witnesses, Mr. Jacob and Prof. Jamieson, the Court is of opinion that they should not be allowed. Mr. Jacob himself stated it was not necessary for the purpose of giving his evidence to come out to the Cape, and he made no experiments There was no necessity for him coming out to qualify himself as a witness, and therefore that part of the application will be refused. As to Prof. Jamieson's expenses, we think they were unnecessary, and that he might well have been examined, as he ultimately was, on commission, and there was no necessity for his coming out to the Cape on the first occasion. As to Mr. Jacob, the Court found that he was a very material and necessary witness, and that it was advisable that he should come out and give his evidence personally. We think it fair that the travelling expenses of Mr. Jacob to the Cape on the occasion of his first visit, in August, 1899, be allowed. No order will be made as to the costs of the application.

Attorney-General v. London County Council.

In the Chancery Division on Friday Mr. Justice Cozens-Hardy delivered his reserved judgment in this case, an information by the Attorney-General at the instance of a number of companies and others interested as omnibus proprietors in the omnibus traffic of London and as ratepapers in the administration and application of the county fund, was heard. The object of the proceedings was to contest the legality of the action of the London County Council in starting and running a service of omnibuses through certain streets in London in competition with the complainers.

Mr. ASQUITH, Q.C., who opened the case when the evidence and arguments were originally before the Court, said defendants were lawfully possessed of certain systems of tramway lines on the south side of the Thames. The termini of those systems were—so far as material to the case—Blackfriars, Waterloo, and Westminster Bridges. Defendants had started omnibuses running from these termini. The omnibuses plied in exactly the same way as the ordinary omnibuses, with the same solicitation to wayfarers. The County Council charged ½d. as a fare, and the result was that the fares of the companies had to be correspondingly reduced. It would not be suggested that a municipal authority, with the powers conferred by the County Council's Local Government Act of 1888, had any right to carry on business at the expense of the ratepayers in competition with a certain body. The question would be whether or not certain legislation had widened and amplified the powers of a local authority so as to justify the action the Council had taken. Under the Tramways Act of

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1870 it was only the undertaking and powers of tramways companies as such that local authorities had a right to purchase. The Council could not justify under that Act the working of a separate omnibus system, and if they had such a right it must be conferred on them by special legislation. This, he contended, the London County Council had not got.

Mr. HALDANE, Q.C., for the Council, said the only change made by the Council since they took over the tramways was that they had run their omnibuses from Westminster to Waterloo in a continuous round. The plaintiffs had challenged the right of the Council to do what the old tramway company used to do—to run the omnibuses in connection with their three termini. Was it *ultra vires* on the part of the Council to take over and continue the practice which the old tramway company had adopted in running these omnibuses? It was convenient, profitable, and useful to do it, and the omnibuses were for the purpose of feeding the trams. Unless it could be shown that the Council were taking money out of the public till or were causing some injury to the ratepayers, the Attorney-General must not interfere.

Mr. BAKER, manager of the Council's tramways, stated that 75 per cent. of the passengers using the omnibuses rode in connection with the tramways. The running of the 'buses from Westminster to Waterloo was a material advantage to the tramway system, and had resulted in a great increase in the number of passengers carried by the Council. He admitted that some of the passengers who got into the 'buses at Charing-cross got out at Waterloo Station.

His LORDSHIP, in delivering judgment, said that it had been argued that the Court ought not to apply the doctrine of *ultra vires* to a public body such as the London County Council, but it seemed to him that there was no foundation for that contention. The Council was a body created by statute, and to every such statutory creation the language used by Lord Blackburn in the House of Lords case "Attorney-General *v.* Great Eastern Railway Co." applied: "Where there is an Act of Parliament creating a corporation for a particular purpose, and giving it powers for that particular purpose, what it does not expressly or impliedly authorise is to be taken to be prohibited." The same principle was applied to the School Board for London in "Reg. *v.* Reed," and he thought it must be applicable to the Council in their character of owners of tramways. The jurisdiction of the Court to restrain the application of public funds to unauthorised purposes, apart from the doctrine of *ultra vires*, was too well established to admit of dispute, and it had not been challenged before him. It had also been urged that the Court ought to give a more liberal construction to the powers conferred upon a public body for the public benefit than it was in the habit of giving to similar powers claimed by trading companies. He was not satisfied that that distinction was well founded. Tramways were made by virtue of special Acts or provisional orders, and Parliament had, when the promoters were not the local authority, given to the local authority a power of compulsory purchase of "the tramway and all lands, buildings, works, materials, and plant of the promoters suitable to and used by them for the purposes of their undertaking within the district." That power could only be exercised on notice at the expiration of certain periods of years and upon terms of payment which had been the subject of litigation, but which were not material for the present case. The Council were the local authority for that purpose. The local authority had in general no power to work any tramways they might purchase. Before the London County Tramway Act, 1896 (extracts from which were quoted by his lordship) the Council had no power to work tramways which they might purchase, and both before and after that Act they could only purchase tramway undertakings. For example, they could not purchase the whole of the undertaking of the limited company which owned in 1896 the tramways mentioned in the schedule to the Council's Act of 1896, and whose objects extended beyond the owning and working of tramways. From the beginning of 1899 the Council had worked the purchased tramways, and the Council ran omnibuses from the south side of Blackfriars-bridge, where one tramway ends, across the bridge to Farringdon-street, and *vice versa*. They also run omnibuses from the south side of Waterloo-bridge, where a second tramway ends, across Waterloo-bridge, along the Strand, down Whitehall, and across Westminster-bridge to the place where a third tramway ends, and *vice versa*. Halfpenny fares were charged for each omnibus journey or part of a journey. The question was whether it was competent for the Council to run those omnibuses. It was admitted that moneys raised by or on the security of rates had been applied for the purchase and working of the omnibuses. It seemed that the Council could only justify their action by reference to sec. 2 of their Act of 1896. The course adopted by the Council in this respect is that which was followed by the limited company, the former owners of the tramways, except that the limited company did not run omnibuses along the Strand, but only ran omnibuses across each of the three bridges and back. The tramways which alone the Council were empowered to purchase have certain definite limits at the southern and northern ends. Within those termini the Council may "work" the tramways and convey passengers in tramcars. There are many things fairly incidental to this which they may do, and indeed must do. Anything not falling within that definition is outside their powers. It seems to me that the London County Council are really carrying on a separate and distinct business as omnibus proprietors. They do not, and they cannot lawfully, convey in their omnibuses only passengers from and to their tramways. By the Act of 1843 for regulating hackney and stage carriages in and near London they are bound to take any passenger who desires a ride and is willing to pay a halfpenny, provided there is a vacant seat. The running of omnibuses in the streets of London is certainly not expressly authorised by the Act of 1896, and in my opinion it is not impliedly authorised. I must therefore make a declaration in the terms of the claim, but I will give liberty to apply. I do not propose to grant an injunction unless the plaintiffs insist upon it.

Judgment accordingly, with costs.

The Attorney-General v. The National Telephone Co. (Ltd.).

This case was in the list for hearing before Justices Bigham and Channell on Friday last. Upon being called on, the Attorney-General stated that it would not be necessary to trouble their lordships with the case that day. The information was brought to restrain the breaking up of the streets by the Telephone Co. without the licence of the Postmaster-General. The matter was to a certain extent involved by the fact of the consent of the London County Council being necessary, and there were certain proceedings pending between the Council and the Telephone Co. Sir Edward Clarke (for defendants) and he had agreed that the hearing should stand over for three months, defendants undertaking in the meantime not to break up the surface of any street in the county of London without obtaining the authority of the Postmaster-General, and the consent of the London County Council. The costs to be costs in the information, and a judge's order if necessary.

Sir EDWARD CLARKE, in concurring, said there were very important questions to be argued, which would take a great deal of time; but no admission or concession on the part of the defendants was made, except that they agreed to the undertaking mentioned.

Turner and Sons v. Brinsmead.

Mr. Justice Mathew on Friday last disposed of this action. The previous proceedings were fully reported in *The Electrician* for Jan. 12 and 25, and Feb. 9 last.

Mr. Justice MATHEW, in delivering his reserved judgment, suggested that the parties should come to terms. Counsel then held a consultation with the learned judge in his private room, and in the result Mr. Jelf announced that the parties had come to what he regarded as a fair termination of this disastrous litigation. The record would be withdrawn, plaintiffs would pay £100 towards defendant's costs, and plaintiffs would take back their lift, with the exception of £99 worth of the work, which defendant would keep without payment.

Portsmouth Corporation Tramways.

In the Divisional Court (Mr. Justice Ridley and Mr. Justice Darling), on Tuesday, Mr. Balfour Browne, Q.C., moved *ex parte* for a rule *nisi* directed to the Portsmouth Street Tramways and the Provincial Tramways Co., calling upon them to show cause why they should not give up possession of their undertakings to the Portsmouth Corporation. Counsel said the companies had, besides the tramways which the Corporation were seeking to purchase, established a business as omnibus, cab, &c., proprietors, and they insisted upon the Corporation purchasing those as well as the tramways. The Corporation declined, saying they had no power to purchase anything beyond the tramways. The companies were not authorised by statute to carry on any other business than that of a tramway company, but by their articles of association they were empowered to carry on the other businesses.

Their lordships granted the application, and a rule *nisi* was accordingly made.

Crystal Electric Lamp Co. v. Hirst.

At the Croydon County Court last week, before Judge Lushington, an action was brought to recover £42. 3s. 1d., the price of electric lamps supplied to defendant. The defence was that the lamps were supplied subject to return if they were not found suitable for the purpose for which they were required, and that they were not suitable. Mr. D. Scarr, plaintiffs' traveller, proved the sale of the lamps. Defendant admitted that some of the lamps were still in use. He complained to Mr. Scarr about the lamps. He heard Mr. Harrison say that he tested the 75 lamps returned, and only found 15 of them defective. He himself had no means of testing the actual candle-power of lamps. He suggested that the lamps were fitted with filaments for a voltage other than 200, as ordered. He did not say it was a custom in the trade to guarantee lamps, but it was done in this case. His honour said he had no doubt whatever that defendant was liable. He would take off £2, and give judgment for plaintiffs for £40.

Alexander v. Automatic Telephone Co.

In the Court of Appeal on Monday the Master of the Rolls and Lords Justices Rigby and Vaughan Williams delivered their reserved judgment in this appeal of the plaintiffs from a judgment of Mr. Justice Cozens-Hardy. The action, which was fully reported in our issues of May 12 and 19, was practically against three of the directors of the company, who as signatories to the memorandum of association had taken between them some thousands of shares with the object (as they contended) of ensuring the success of the company. Other shareholders who had subscribed for shares had paid application and allotment money to the extent of 3s. a share, and a further 2s. in respect of two calls which had been made subsequently. Defendants had paid the 2s. as calls, but nothing in respect of application and allotment, and plaintiffs contended that they were entitled to a declaration calling on defendants to pay the 3s. on each share, on the ground that defendants had no legal right to differentiate between the two classes of shares.

The Master of the Rolls reviewed the case at length, and said that the appeal should be allowed, and that the judgment appealed from should be reversed. The three defendants, Margowski, Cohen and Sworn, were guilty of a breach of duty as directors in not paying to the company in respect of the shares allotted to them on July 5, 1897, 3s. per share, the amount which they obtained from the other members of the company in respect of shares allotted to them, and the plaintiffs would have liberty to apply for an order for payment if necessary. The three defendants would have to pay the costs of the appeal and also the costs of the action, except such costs as had been occasioned by the charges of fraud, which would have to be borne by plaintiffs. Lords Justices Rigby and Vaughan Williams concurred.

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PARLIAMENTARY INTELLIGENCE.

MUNICIPAL TRADING.

In the House of Commons last week Mr. ANSTRUTHER moved: "That a select committee of five members be appointed to join with a committee of the House of Lords to consider and report as to the principles which should govern powers given by bills and provisional orders to municipal and other local authorities for industrial enterprise within or without the area of their jurisdiction."

Mr. BROADHURST was not aware that any of the municipal bodies were in favour of the appointment of this committee. It might be that the people who had induced the Government to take this action were promoters of private companies, who were opposed to the works now being carried on by the various municipal authorities of the country. He therefore protested against the appointment of the committee. He wanted to know why the corporations were to be "carpeted" before a committee in the appointment of which they had had no voice?

Mr. GALLOWAY (on behalf of the Corporation of Manchester) said they accepted this committee with reluctance, as they believed it to be unnecessary. They had no desire whatever to shirk a full and thorough inquiry into the whole subject.

The PRESIDENT OF THE BOARD OF TRADE said this was of course no attack upon corporations. The Board of Trade required some direction to enable them to deal effectively with the frequent applications that were being made to them by corporations.

Mr. BURNS asked why the Government had suddenly taken up a committee that last year they would have nothing to do with. The Government then brought in a bill for the nationalisation of telephone matters, and the motion was brought forward to shelve that bill. That did not succeed: now this Select Committee was introduced in this fashion. What was the object of this committee? What was the necessity for it? Was it to have a roving, a fishing commission, which was to last over four or five years? This was evidently to be a hanging committee for municipal enterprises—they were all to be hung with their faces to the wall. The proposal was made to pander to a gang of company promoters who met at the Society of Arts three months ago.

Mr. JEFFREYS said schemes had been started to provide electric tramways outside borough boundaries, and how could they tell where this movement would end? The guidance of the House was needed on the subject, and if the committee was appointed he thought some conclusion would be arrived at which would be to the interest of the corporations as well as tend to the saving of money. It was important the House should lay down definite rules as to whether or not corporations should, for example, be allowed to construct electric tramways outside their boundaries.

Mr. HALDANE said the actual author of this committee held that the embarking upon industrial enterprise by corporations should be discouraged and prohibited by the Legislature. What guidance was the Board of Trade likely to get from such a committee as now proposed? He urged that the House should insist upon the question of municipal trading being left to its own consideration, and not to the tender mercy of any committee.

Mr. BALFOUR said that some of the speakers upon the motion appeared to think that the appointment of such a committee as now proposed meant the passing of a prima facie condemnation upon municipal trading. The Government did not desire to prejudice the question, or even to lay down any principles for the guidance of the committee. They did not say whether it was right or wrong for a Corporation, in addition to providing proper highways, police protection, gas and water, to launch into the illimitable field of commercial enterprise. His own personal opinion was that in many cases these commercial undertakings might properly be entered into by municipalities. But what the Government asked for was not a judgment upon the abstract question, but some general guidance to both Houses of Parliament as to the method in which they were to deal from time to time with the innumerable practical problems that came before them in connection with private bill legislation. The House was, neither compelled to accept the report of the committee in general nor in any particular instance give application to it. They might even reverse it. If in the end they agreed to differ, even then their action would be incomparably more profitable to the community, to the great Corporations, and to the work of private enterprise than was the random dealing with great interests which at present prevailed.

Mr. DILLON contended that the proposal for a committee was made in the interests of syndicates, companies, and private enterprise, as against municipal enterprise. The growth of municipal enterprise had been accompanied by progress and by immense savings to the ratepayers of the country. If they had had order and guidance in this matter 20 years ago there would have been no progress at all. The appointment of a joint committee would be a retrograde step. There was no evidence that the ratepayers desired an investigation.

Mr. J. SAMUEL said he understood this proposal was not to apply to matters which for half a century had been recognised by that House as fair objects of municipal enterprise. If this committee reported to the House that no Corporation should have the power to go beyond its own boundaries the power which many Corporations now had to purchase tramways which connected with their suburbs might be nullified. No hard and fast rule could be laid down.

The debate was then adjourned for a week. Upon its resumption on Thursday last,

Sir A. ROLLIT said that at the annual meeting of the Association of Municipal Corporations in London on the 7th inst. a resolution declaring that the Corporations were opposed to any attempt to fix a hard and fast rule between what Corporations might and might not undertake was passed unanimously, as was also a resolution by the council of the Association that there was no valid reason for the appointment of a committee, and that there were the strongest objections to it. He asked the Government to reconsider their determination to appoint the committee. This motion sprang entirely from the Municipal Trading Committee, and was not an administrative question, but a direct attack upon municipal institutions. No ratepayer had made a protest to the House for protection against municipal trading. The municipalities, members and ratepayers, were able to take care of themselves. They were the best judges of their own interests. They had already obtained sufficient statutory protection, for one thing, in the difficulty of getting a bill passed through Parliament, which was a great deterrent to municipalities attempting to extend their operations. The check upon municipal activity and progress, if such were needed, was that gentlemen should go upon the Councils and take their part in municipal work. No specific instances of unwarranted trading on the part of municipalities had been given in support of the appointment of this committee. Practically no powers had been asked for by municipalities except those incidental and necessary to the wise and prudent exercise of the powers already conferred by law. He admitted that here and there aspirations had been shown for higher powers among municipalities, but these were exceptional. The circular in support of the present motion which had been issued by the Municipal Trading Committee set forth instances of undertakings by municipalities—and these included telephones. Why, it was but a year ago that Parliament conferred powers for the municipalisation of the telephone. The next subject on the list was the supply of electricity. But Manchester was supplying this need on a splendid scale, cheaply and well, inside and outside the borough. Then followed the control of markets, gas, and the manufacture of residual products. One chief point in this matter was that a Corporation should not do its own work of construction. There might be cases in which it was wise to employ a contractor, but there might be other cases in which it was best for the municipal authority to do its own work. It was a question of local conditions and variation of prices. He did not advocate a rigid rule, but he did say that there were many cases in which it was prudent and economical, and therefore, right, for municipalities to do their own work. A further charge related to municipal fire insurance—the establishment of a fund to provide against accident by fire. Why should not the ratepayers' money be safeguarded? As to the acquisition of patent rights, why should a municipality be denied the right claimed by private individuals and by the Government? Some rights claimed by municipalities he did not altogether approve. One London borough had applied for power to manufacture and sell paving and paving materials. The manufacture might conceivably be wise, but the sale raised a serious question Then there was the acquiring and working of lifts at Hastings. Lifts of the kind referred to were roads or ways, and were distinctly work for municipalities. The question of cold storage had also been mentioned, and that was becoming an essential industry. Ratepayers had a right to possess cold storage if they wanted it. The municipalities had been the pioneers of Parliament in these matters. And these municipal efforts had been successful financially. A Parliamentary return recently granted showed that upon a net capital, including borrowed money, of 88 and odd millions sterling there had been an average annual net profit of £3,600,000, or over 4 per cent.—not an excessive return, but one which showed fair regard for the interests of consumers, and therefore of the industry of the boroughs in which the works had been carried on. But profit was not the only consideration. Consider the attachment of the people to their own work in their own municipality. He hoped that, if the proposed committee were appointed, care would be taken that there were those upon it who knew the subjects practically from personal acquaintance, and who would be able to put before the committee information which was absolutely essential in dealing with them.

Sir S. HOARE said applications to Parliament by municipalities had enormously increased of late years, and much greater demands were made on committees. The difficulties of committees were not met by the standing orders of the House, and this was notably so in relation to the acquisition of tramways by municipalities. Upon this and upon the financial arrangements incident upon powers for electric traction the utmost care and caution were required by committees, and yet he showed how in two days the decisions of committees in relation to borrowing powers for such undertakings varied between periods for repayment of 30 and 40 years. Much uncertainty existed as to the duration of electrical plant, and it was not fair to leave committees without indication of the lines upon which they should work so that uniformity of decision might be arrived at.

Mr. STEADMAN said the purpose of this motion was to clip the wings of the London County Council. What was the difference between a company and a municipality? The company worked for a profit on behalf of its shareholders, and the municipality worked in the interest of the ratepayers, the profit going towards the reduction of rates. Yet in London the people were debarred from taking steps towards this desirable end. The popularity of the Colonial Secretary in Birmingham was due to the work he had carried out there as a member of the Corporation on behalf of the community. He was not in favour of municipalities establishing municipal workshops and becoming competitors with the private employer, because they would not improve the condition of the workman. But he was in favour of monopolies like gas, water, and tramways being worked on behalf of the municipality and in the interest of the community as a whole. His counsel to the Government was to let sleeping dogs lie.

Lord BALCARRES hoped the result of the work of the proposed committee would be that a principle would be laid down on which municipal enterprise might be regulated in the future. He was in favour of municipalities supplying water, gas, and electric light, but there were some undertakings which were not civic or communal, such as the supply of electric power, and which they should not have the right to supply. This matter ought to be entrusted to a perfectly impartial body, and he moved to amend the motion by providing that the committee should be nominated by the Committee of Selection.

This amendment was agreed to.

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Sir H. CAMPBELL-BANNERMAN said some of the previous speakers seemed to think the municipalities had gone beyond their functions in embarking on trading enterprises. He suspected that those who held this view were influenced by the action of the London County Council and other municipalities employing their own workmen instead of outside contractors. But the proposed committee would have no power to inquire into that question at all, which was purely a matter of administrative discretion. One hon. member had spoken of the difficulty of fixing the precise number of years for the repayment of a loan where electric work was concerned. He believed it was a fact that that uncertainty was part of the necessity of the case when they were dealing with a new and experimental enterprise. Each particular case must be judged on its merits, according to the circumstances of the locality. If this was to be a great new departure, and if the enterprises of the municipalities throughout the country were to be regulated by a formal tribunal according to some fixed principles, was this the particular period of Parliament at which the work should be undertaken? Would it not be much better to relegate it, if it was to be done at all, to a new Parliament?

The vote was then taken, and the resolution for the appointment of the committee was carried by 141 to 67; majority 74.

ALL-BRITISH CABLE.

In the House of Commons, on Friday, Sir C. DILKE asked the Chancellor of the Exchequer if he would state on what grounds the offer to lay an all-British cable from England to Capetown by Gibraltar and Sierra Leone for a subsidy of £20,000 a year, to connect with the Capetown-Australia cable, to be laid without subsidy, had been refused by the Government, with the result that the cable was now being taken by a route passing through two Portuguese possessions; whether the cable company which made the offer was required by the Government to lay, maintain, and work a strategic spur cable between Ascension and Sierra Leone at an estimated cost of £150,000, in consideration only of the Treasury finding it unnecessary to oppose the grant of landing rights in Cornwall at a spot where other cables of the same company were already landed with Board of Trade permission; and, if the facts were as stated, what precedent there was for refusing landing rights in the United Kingdom to British cable companies.

The CHANCELLOR of the EXCHEQUER: I cannot give a full answer to the first question (which does not, I consider, state the position quite accurately) without going into the history of negotiations, extending over several years and involving other questions besides this, between the Government of the United Kingdom, the Cape of Good Hope, and Australia and the cable company; but I may say that one reason for refusing the subsidy of £20,000 per annum was that another company had applied for landing rights for a cable to be laid by the all-British route without a subsidy. I think there is now ground for supposing that an all-British communication with the Cape will be obtained in another way. The statement in the second question is correct. So far as I know, no steps have hitherto been taken by any Government in this country to obtain any return from telegraph companies seeking landing rights; but the Cape Government have recently obtained substantial concessions as the condition of landing rights for this new cable, and it seemed to me that the grant of new landing rights in this country was a valuable concession for which it was my duty in the public interest to try and obtain in this and other instances some return in such a form as the circumstances might indicate to be most desirable.

THE PACIFIC CABLE COMMITTEE.

Mr. CHAMBERLAIN informed Mr. Hogan that this committee had made considerable progress, and was now considering the terms of a report. The report would deal chiefly with the offer made by the Eastern Extension Telegraph Co. to the Australasian Governments.

ABERDEEN CORPORATION TRAMWAY BILL.

A Select Committee of the House of Commons, presided over by Mr. Jeffreys, last week considered this bill, which seeks power to authorise the doubling of several sections of the tramway system and to make a number of extensions. The Great North of Scotland and Caledonian Railway Companies, as well as a number of traders, opposed.

Mr. JOHN YOUNG, manager of the Glasgow Corporation tramways, said he had inspected the tramway system in Aberdeen, and approved of all the extensions proposed. They were all within the city boundaries, and without them he did not think the Corporation could give the citizens the service to which they were now entitled. The proposed tramways, with their characteristic house-to-house traffic, served quite a different purpose from railways, and if there was competition at all, it was over a small area. His experience was that where tramways spread the population the railways came in and reaped the benefit. There had been an instance of this in Glasgow. In 1894, when extensions of tramways were being completed, it was alleged that the cheap fares proposed would mean keen competition with the suburban railway. The result was that in a very short time after the complaint was made the railway company lowered their own fares and gave a better service, and they had paid a dividend ever since. He understood that no objection had been taken to the proposal to place rosettes on buildings in connection with the electric service. They had power in Glasgow to put up rosettes, and no complaint had ever been made.

Other evidence having been given, the chairman announced that the committee had agreed to strike out the proposed line at the Upper Quay, as well as a short connection. The preamble so far as the rest of the bill was concerned was passed.

EAST END OF LONDON ELECTRICAL ORDERS.

On Friday, Sir Courtenay Boyle heard the appeal of the County of London and Brush Provincial Electric Light Co. against the three provisional orders of the local authorities of Mile End Old Town, Limehouse, and St. George's-in-the-East, who are applying for power to supply electric current in their respective districts for which the County of London Co. obtained powers in 1897. The points raised were whether the Board of Trade would allow these local authorities to compete against a company which had already obtained powers but had not exercised them or would compel the local authorities to buy up the existing company.

Mr. BALFOUR BROWNE, Q.C., for the company, said there were applications being made to Parliament on the part of three local authorities in the East end of London to establish electricity supply works and to supply electric current in their various districts. The County of London Co. obtained their 1897 order with the consent of these local authorities, who were now applying for leave to compete with the company. By their order the company were bound to lay distributing mains within two years of the date of the order, and the company certainly would have done so but for the difficulties and delays that had been put in its way by these authorities and the London County Council. Last year the company promoted a bill in Parliament to get power to break up the streets and roads in intervening districts, and that bill was opposed, and ultimately rejected by a committee of Parliament. The company then made an agreement with the Regent's Canal Co., on payment of £300 per annum, to lay mains from their generating station, and they were now in a position to commence work. If the Board of Trade gave the power to these local authorities it would not do away with the power of the company, and the question was whether there was room for two competing authorities in the same district. If they took the analogy of local authorities desiring to supply gas or water, it was settled policy that they should not do so unless they bought out the existing companies; and in this case he asked that the same rule should be applied to an electric company, which had expended money and acquired rights, or in the alternative to allow the company to go on with their works without the competition of the local authorities.

It was contended by the learned counsel for the three local authorities—by Mr. Hertslet for the London County Council and by Mr. Turner for the Whitechapel Board of Works—that the company had done nothing under their order, and that the local authorities should be allowed to proceed, especially as Whitechapel (which had already obtained an electric lighting order) would be joined to the three other authorities next November as one body under the London Government Act.

Sir COURTNAY BOYLE reserved his decision, observing that should the preambles be proved, then the provisions of the Whitechapel order should be applied to the other three orders so that when the London Government Act came into force the borough should have identical provisions throughout its area.

LONDON COUNTY COUNCIL'S HIGH PRESSURE REGULATIONS.

The City of London Electric Lighting Co. recently applied to the London County Council for sanction to an alteration in its standard pressure of supply under the Southwark electric lighting order from 100 to 200 volts, and the Highways committee of the Council, before whom the matter came for consideration, have recommended that the Council's consent should be given to the company's proposals, and this recommendation has been approved. Having in view, however (the committee reports), the complaints arising with regard to the alteration of the standard pressure of the Westminster Electric Supply Corporation's supply (approved by the Council on August 1 last), the Highways committee considered, and the Council approved, that the conditions of that consent should be made more stringent. The following conditions were recommended by the committee and have been sanctioned by the Council:—

(1) That when an installation in any consumer's premises is to be changed to the higher pressure, the undertakers shall themselves carry out, or bear the cost of, any alterations which may be necessary in the wiring or the fittings of such premises, and shall at their own cost execute any repairs and make good any damage or injury to such premises which may be rendered necessary, or caused by, the carrying out of such alterations. Provided that if any dispute arise between the undertakers and any consumer as to what alterations or repairs may be necessary or what damage or injury to such premises has been caused, such dispute shall be decided by an arbitrator to be agreed on between the undertakers and the consumer or, failing agreement, to be appointed by the Board of Trade on the application of either party after notice to the other, and the expenses of arbitration shall be borne and paid as the arbitrator may direct.

(2) That in the case of special fittings, and for lamps of small candle-power, the new lamps shall be arranged in series where so desired by the consumer.

(3) That all the consumer's lamps in use and in stock shall be replaced by the undertakers free of charge with new lamps suitable for the higher pressure.

(4) That when any such supply has been changed to the higher pressure, the consumers shall be informed, in writing, by the undertakers that all the necessary alterations have been made and that the installation is in a satisfactory condition.

(5) That when any such supply is to be changed to the higher pressure, the undertakers shall offer to the consumer to communicate with the fire insurance companies concerned, and shall take all reasonable precautions to prevent the policies being affected; and, if any increase shall be made

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in the premium charged upon such policy, in consequence of the hange to the higher pressure, the consumer shall be entitled to deduct the amount of any such increase from the payment to the undertakers for electric supply.

(6) That the undertakers shall make good, at their own expense, any defects which may develop in any installation within twelve months of the date when the pressure is changed or the alteration completed (whichever may be the later date), where such defect can reasonably be attributed to the increase of pressure. Provided that if any dispute shall arise between the undertakers and any consumer as to such defects as aforesaid, such dispute shall be decided by an arbitrator to be agreed on between the undertakers and the consumer or, failing agreement, to be appointed by the Board of Trade on the application of either party after notice to the other, and the expenses of arbitration shall be borne and paid as the arbitrator may direct.

(7) That if the supply be given by a three-wire system, then, subject to the approval of the Board of Trade, the middle wire shall be earthed as that Board may direct.

(8) That when the supply is changed to the higher pressure on any consumer's premises, a reduction of not less than 15 per cent. shall be made in the price charged for supply at the time at which the change is so made.

(9) That no increase shall be made in the price charged for supply to consumers who, under the powers conferred by the Board of Trade regulations, refuse to consent to the change in the pressure.

(10) That in all cases where three wires are brought into any premises with any pressure above 220 volts between the outer wires, either one outer wire shall be removed, or the two sides shall be separated by a reasonable distance, the middle wire being split and proper fuses placed upon it, thus making two pairs of undertakers' terminals at least 6ft. apart.

(11) That the undertakers, when the supply is given by an alternating system, shall, whenever called upon by a consumer, provide upon the premises of such consumer a two-to-one transformer.

(12) That a print of the foregoing terms and conditions shall forthwith be sent by the undertakers to all their consumers.

TRADE NOTES AND NOTICES.

[Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.]

TENDERS INVITED.

The *Dundee* Town Council invite tenders for the supply and erection of a traction switchboard and equipments. Further particulars are set out in an advertisement, and specifications can be obtained from the city electrical engineer (Mr. Walter H. Tittensor), Dudhope-crescent road. Tenders must be lodged with the town clerk (Sir Thomas Thornton, LL.D.), City Chambers, Dundee, by 25th inst.

The *Sunderland* Corporation invite tenders for two additional switchboard panels, with instruments, &c. Specifications can be obtained from the borough electrical engineer (Mr. J. F. C. Snell), Dunning-street, and tenders (addressed chairman of Lighting committee, Town Hall, Sunderland) must be delivered at the offices of the town clerk (Mr. Fras. M. Bowey) by noon, 27th inst. An advertisement contains further particulars.

The *Plymouth* Corporation invite tenders for overhead line construction, &c. Further particulars are set out in an advertisement and specifications, &c., can be obtained from the borough electrical engineer (Mr. John H. Rider), Prince Rock, Plymouth. Tenders by May 2.

The *Southampton* Corporation invite tenders for a 300 kw. continuous-current generator. Specifications, &c., can be obtained at the offices of the town clerk (Mr. R. R. Linthorne), and can be inspected at (but not obtained from) the offices of the consulting engineers (Messrs. Kincaid, Waller and Manville), 29, George-street, Westminster. Tenders must be sent to Mr. Linthorne by May 1. An advertisement contains some further particulars.

The *Wimbledon* District Council invite tenders for wiring their new isolation hospital. Specifications and forms of tender can be obtained from the resident electrical engineer (Mr. F. Barnes Spencer), Durnford-road, Wimbledon, and tenders addressed to the clerk (Mr. R. H. S. Butterworth), Council offices, Broadway, Wimbledon, must be in by noon of 24th inst. See advertisement.

The *Brighton* Corporation invite tenders for the supply of incandescent lamps for 12 months from July 1 next. Specifications and forms of tender may be obtained at the offices of the town clerk (Mr. Francis J. Tillstone), Town Hall, Brighton. Tenders must be left at Mr. Tillstone's office before 10 a.m. of June 11. See advertisement.

The *Brighton* Corporation also invite tenders for the supply of electricity meters for one year from June 1, 1900. Specifications, &c., may be obtained at the offices of the town clerk (Mr. Francis J. Tillstone), and tenders must be in by 23rd inst. See advertisement.

Tenders are invited for wiring the nurses' homes (about 100 lights) at the workhouse, Brownlow-hill, *Liverpool*. Tenders to vestry clerk to Select Vestry (Mr. H. J. Hagger), Parish Offices, Brownlow Hill, Liverpool, by 25th inst. See advertisement.

The *Ilford* District Council invite tenders for erecting a chimney shaft and electricity station buildings. Tenders to clerk by 23rd inst.

The *Belfast* Electric committee invite tenders for 12 months' supply of electric motors. Tenders to town clerk by 19th inst.

The *Bermondsey* (London) Vestry require tenders for the erection of a chimney shaft at their electricity station. Tenders to vestry clerk by 4th May.

The *Glasgow* Corporation invite tenders for telephone cables (including drawing into conduits and jointing) and telephone instruments (wall and table). Tenders by April 18.

The *Dunmanway* (Cork) District Council invite tenders for electric lighting, to be in by May 3.

The *Barking* District Council invite tenders for the construction of an electric railway, with bonding, &c. Tenders by May 7.

The *Dublin* Electric Lighting committee invite tenders for electric lighting plant. Tenders by 4 p.m. April 26.

The *Newcastle-upon-Tyne* Tramways committee invite tenders for steel and iron work for the car sheds at Byker. Tenders by 21st inst.

The *Birkenhead* Corporation invite tenders for tramway plant. Tenders by 23rd inst.

Tenders are invited until the 30th inst. by the municipal authorities of *Villa del Rio* (Cordoba), Spain, for the concession for the electric lighting for 20 years. Tenders to el Secretario del Ayuntamiento.

TENDERS RECEIVED AND ACCEPTED.

The following tenders have been received by the Fulham (London) Vestry for the supply of 100 5-ampere, 100 10-ampere, and 50 20-ampere meters. No tender has yet been accepted :—

British Thomson-Houston Co. (Thomson)	£1,277	10	0
British Westinghouse Co. (Shallenger) part round	900	0	0
Do. do. do. square	1,300	0	0
Electrical Co. (Hümmel)	1,250	0	0
General Electric Co. (Aron)	1,280	0	0
Johnson and Phillips (Hümmel)	1,250	0	0
Venner and Co. (Hookham), part round	861	2	6
Do. do. square	1,071	2	6
Witting Bros. (Hümmel)	1,062	10	0

The Committee of Visitors of the Lancashire County Asylum, Rainhill, have received the tenders set out below for the supply and erection of electric lighting plant. The consulting engineer is Mr. Thomas L. Miller, Liverpool :—

Contract No. 1 (three Lancashire boilers and superheaters and one economiser).

A. Anderton (*accepted*)	£2,735	J. Musgrave and Sons	£3,124
†International Power Co.	4,300	J. Thompson	3,050
Claud Hamilton	3,437	British Insulated Wire Co.	2,987
G. H. Woods and Co.	3,350	E. Danks and Co.	2,965
Yates and Thom	3,334	Tetlow Bros.	2,845
P. Dewhirst	3,320	Clayton, Sons and Co.	2,821
Tinkers Ltd.	3,210	*Lowdon Bros.	2,550

* Incomplete. † Not to specification.

Contract No. 2 (three 175 b.h.p. steam dynamos, with booster, switchboard, feed pumps, piping, tanks, cranes, and all accessories

Lowdon Bros. (*accepted*) £6,740 (Revell engine), £7,211 (Browett engine), £7,260. 7s. (Belliss engine).

The following also tendered :—

Bow, McLachlan and Co.	Crompton and Co.
T. Scott Anderson.	Electric Construction Co.
R. Dewhirst.	W. B. Haigh and Co.
G. H. Woods and Co.	P. R. Jackson and Co.
P. Dewhirst.	Read, Holliday and Co.
Thames Iron Works Co.	Geo. Hill and Co.
Phœnix Dynamo Co.	Clarke, Chapman and Co.
Lea and Warren.	International Power Co.
Dennison, Berlyn, Sillem and Co.	Mather and Platt.
Claud Hamilton.	Brush Co.
Frank Suter and Co.	R. W. Blackwell and Co.
Lancashire Dynamo Co.	J. Musgrave and Sons.
Johnson and Phillips.	Walsall Electrical Co.
Clayton Engineering Co.	Warrington Electricity Co.
Thomas Parker (Ltd.).	Benj. Goodfellow.
British Insulated Wire Co.	

Contract No. 3 (storage battery of 1,200 ampere-hours capacity and accessories).

			10 years' maintenance.	Cost and maintenance capitalised.
Chloride Electrical Storage Synd (*accepted*)	£1,730	0	£104 5 yrs. / 120 "	£2,850 0
Electrical Power Storage Co.	1,985	0	193 0	3,915 0
Hart Accumulator Co.	1,844	0	181 0	3,654 0
Drake and Gorham (Chloride)	2,211	0	134 0	3,556 0
Marquand Accumulator Co.	1,869	18	140 5	3,272 8
Ashmore, Benson, Pease and Co.	1,299	0	195 0	3,219 0
Tudor Accumulator Co.	1,861	0	108 0	2,941 0
P. Dewhirst (Chloride)	1,730	0	120 0	2,930 0
British Insul'd Wire Co. (Chloride)	1,816	13	110 0	2,916 0
Rooper and Robins (Epstein)	1,681	14	75 0	2,431 14
G. H. Woods and Co. (Pritchett)	1,482	0	85 0	2,332 0

Incomplete tenders were received from the D.P. Battery Co., Drake and Gorham, Lea and Warren, T. Scott Anderson, Lowdon Bros. and Claud Hamilton.

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Contract No. 4 (feeder mains—solid system).

*St. Helens Cable Co. (*accepted*)	£2,336	5	10	G. H. Woods and Co.	2,529	14	6
Lowdon Bros.	2,940	3	4	W. T. Glover and Co.	2,467	10	10
Geo. Hill and Co.	2,923	5	0	P. Dewhirst	2,456	2	6
Lea and Warren	2,883	7	0	Callender Co.	2,442	5	0
Pratt and Keith	2,828	15	0	Brit. Insulated Wire Co.	2,407	4	2
Drake and Gorham	2,742	5	0	Rooper and Robins	2,184	15	10
W. T. Henley's Co.	2,603	5	2	T. Scott Anderson	1,597	11	0
Claud Hamilton	2,586	6	8				

* Ten years' free maintenance.

Contract No. 5 (wiring of buildings).

Lowdon Bros. (*accepted*)	£3,460	0		Walsall Electrical Co.	£5,065	0	
Gilchrist and Co.	7,600	0		T. Scott Anderson	4,860	0	
Warrington and District Electric Co.	6,493	0		Claud Hamilton	4,794	0	
Alliance Electrical Co.	6,210	9		Parr and McLachlan	4,760	0	
Rochdale Electric Co.	6,193	0		Rooper and Robins	4,626	13	
Frank Suter and Co.	6,158	0		Lea and Warren	4,257	15	
Albert Dickenson	6,115	0		Drake and Gorham	4,149	0	
Sharples, Taffs and Co.	6,068	10		G. H. Woods and Co.	4,055	0	
Eckersley and Co.	6,045	10		Donnison, Berlyn, Sillem and Co.	3,927	0	
Geo. Hill and Co.	5,850	0		P. C. Middleton and Co.	3,735	0	
J. Lomax Kendall & Co.	5,820	0		G. Lummis, Paterson & Co.	3,707	19	
Pratt and Keith	5,747	10		J. Dewhirst	3,646	0	
British Ins. Wire Co.	5,514	1		Campbell and Isherwood	3,665	0	
Norman Hirst	5,500	0		P. Dewhirst	3,559	4	
National Elec. Wiring Co.	5,452	10		J. Bakewell	2,896	10	
Ensor, Brentnall and Co.	5,239	0					

The Shoreditch (London) Vestry have referred the following tenders for the supply of transformers to the Lighting committee for consideration :—

Siemens Bros. and Co.	£6,645
Electrical Construction Co.	9,046

For cable in connection with the annual contracts the Vestry have accepted the tenders of the St. Helens Cable Co. and Messrs. W. T. Glover and Co.

The Bridges committee reported to the London Council, at their meeting on Tuesday, that trouble had arisen in connection with the cables feeding the lamps in the open approaches to the Blackwall Tunnel owing to defects in the manufacture of the cables. The firm who supplied them had been called upon to bear the expense of making them good, and a sufficient sum had been retained under the award by the Council to meet the cost. As the firm of makers was in liquidation, the committee did not think it desirable that they should do the work, and had therefore obtained the following tenders :—

British Insulated Wire Co.	£553	17	4
St. Helens Cable Co.	790	0	0
Tyler and Duncan	808	0	0

Owing to an error, the British Insulated Wire Co.'s tender had been increased to £624. As it was still by far the lowest, the committee recommended that it be accepted. Agreed.

The Devonport Electric Lighting committee have received the following tenders for the supply of temporary electric traction plant :—

Babcock and Wilcox (boiler)	£558
Browett, Lindley and Co. (engine)	950
Electric Construction Co (generator)	900

The Leeds Tramways committee have accepted the tender of the Electric Construction Co. for an additional steam dynamo for the tramway generating station at £10,000, the plant to be delivered in ten months. The committee have the option of ordering two more steam dynamos at the same price.

The Southend Town Council have accepted the tender of the Brush Co. for the supply of 10 car bodies to carry 43 passengers at £235 each, two to carry 67 passengers at £315 each, and two to carry 20 passengers at £198 each.

The tender of Messrs. Spoor and Co. has been accepted for the electric lighting of New Brancepeth. There will be 24 lamps at an annual cost of £5. 10s. per lamp. Messrs. Scott and Mountain tendered at £6. 10s. per lamp.

The Barrow-in-Furness Council have accepted the tender of Messrs. Babcock and Wilcox for additional boilers, &c., for the electricity works at £4,540.

The Islington (London) Vestry have accepted the following tenders for the supply of electrical stores during the ensuing year : Edison and Swan Co., Sloan Electrical Co, and Hands Ltd.

The tender of Messrs. W. Macfarlane and Co. has been accepted by the Bury St. Edmunds Corporation for the supply of 20 single and six double electric lamp pillars at £87. 5s.

APPOINTMENTS VACANT AND FILLED.

The Ayr Police Commissioners invite applications for the position of mains superintendent. An advertisement contains further particulars, and applications must reach the burgh electrical engineer (Mr. Arthur J. Fuller) by 23rd inst.

The Peterborough Corporation require an engineer-in-charge for their electricity works. An advertisement contains further particulars, and applications must be sent to the city engineer (Mr. John C. Gill) by 26th inst.

The Carlisle Corporation require a mains foreman for their electricity works. Applications to the city electrical engineer (Mr. Charles D. Burnet). See advertisement.

The Cardiff Corporation require a mains superintendent. Applications to town clerk by 15th inst.

The Cambridge Electric Supply Co. require a mains superintendent. Applications to secretary before 20th inst.

A second assistant lecturer in the physics and electrical engineering department of the Blackburn Municipal Technical School is required for next session. Applications to the secretary (Mr. A. W. King) by 28th inst. See advertisement.

The Sheffield Electric Light committee have appointed Mr. S. Edgar Fedden, of Greenock, electrical engineer to the Corporation electric light undertaking. Out of 23 applicants the sub-committee had selected five, who appeared before the committee. These were Messrs. S. Edgar Fedden (Greenock), Percy W. Snelus (Brussels), F. B. Aspinall (City of London Co.), Alfred Lucas (Sheffield district manager to B.T.-H. Co.), and J. A. Jeckell (South Shields). Mr. Fedden is a member of the Institute of Shipbuilders and Engineers (Scotland) and of the Association of Municipal Engineers. In 1893-4 Mr. Fedden was mechanical engineer in Nevada (U.S.A.), from 1893 to 1894 was engaged in the expert department of the Thomson-Houston Co. (U.S.A.), from 1894 to 1898 chief assistant engineer at the Edinburgh electric light works, and since 1898 has been chief engineer at Greenock. The salary attaching to the new appointment is £500 per annum.

Mr. K. O. Hale has been appointed draughtsman in the Bristol city electrical engineer's office at a salary of £200, rising by annual increments to £260 per annum.

BUSINESS NOTICES.

The head offices and works of Messrs. Werner, Pfleiderer and Perkins, Ltd., engineers and masticating and incorporating machine makers, are now at Regent's-square, Gray's Inn-road, W.C. The showrooms are at 117, Queen Victoria-street, E.C., and branches at Manchester and Bristol.

Messrs. Charles Joyner and Co, of Birmingham, have appointed Messrs. Fry and Co, Farringdon-avenue, London, E.C., their sole representatives for London and the South Coast.

BANKRUPTCIES, LIQUIDATIONS, &c.

The liquidator (Mr. E. Wilding) of Poole and White (Ltd.), electrical supplies dealers, has been released.

A meeting of the London and Provincial Traction Co., Ltd. (in voluntary liquidation), will be held at 2, Copthall-buildings, London, E.C., on May 21, to receive an account of the winding-up.

F. B. de F. Paynter, electrical engineer, lately carrying on business at 64 and 65, Chancery-lane, W.C., was publicly examined last week. Debtor ascribed his position to living beyond his income, to law costs, &c. The accounts show total liabilities £3,616 (unsecured £2,009), assets £1,433. Examination was adjourned to May 18.

Tom Arthur Flather, electrical engineer, trading as Flather and Son, Speedwell-street, Woodhouse Carr, and 406, Meanwood-road, Leeds, has executed a deed of assignment. Mr. R. M. Burgess, 38, Albion-street, Leeds, is trustee. Liabilities £1,836. 1s. 10d., assets £1,510. 9s. 4d. The principal trade creditors are :—

Midland Electric Wire Co.	£78	B. Gawthorpe	£24
W. Procter	58	M. B. Broadbent and Co.	22
R. Smith	44	Cuttriss, Wallis and Co.	19
W. T. Glover and Co.	42	W. Bywater	14
Cutting Bros.	36	S. Rentell and Co.	13
H. Sharrock and Co.	28	Cox Walkers	12
W. Hibbert	27		

Albert Edward Oakley, electrical engineer, 569, Green-lanes, London, N., has executed a deed of assignment. Liabilities £244. 10s. 11d., assets £132. 17s. Mr. P. Mason, 64, Gresham-street, E.C., is trustee. The creditors include :—

G. Braulik	£29	International Electric Co.	£17
Millard Bros.	21	Atlas Carbon and Battery Co	12

Plant for Sale.—Messrs. Albright and Wilson (Ltd.), Oldbury, near Birmingham, have a Willans-Crompton steam dynamo for sale. See advertisement.

Messrs. A. Verey & Co., Dover, advertise some electrical instruments, arc lamps, wire, switches, &c., for sale.

Land for Sale.—Mr. Peter Newton, 4, Albert-street, Derby, has for sale about 20 acres of freehold land, conveniently situated and suitable for the erection of electrical or general engineering works. See advertisement.

Electrical Exhibition.—An interesting exhibition of electrical apparatus and fittings was opened at the Public Offices, Barking (Essex), on Friday last, and remained open until Wednesday. Among the exhibitors were the Edison and Swan Co., Mr. H. J. Dowsing

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(Dowsing Radiant Heat Co), Messrs. E. Goossens, Pope and Co., the Western Electric Co., the Sunbeam Lamp Co., and the General Electric Co. At the opening ceremony Mr. S. E. Britton, the resident electrical engineer, announced that the exhibition had been arranged in connection with the Council's electricity supply undertaking, with the object of showing the townspeople the uses to which electricity could be applied, more especially in regard to heating and cooking, private lighting, and for driving ventilating fans and small machinery. The exhibition was opened by Mr. J. N. Reeson, J.P., chairman of the Council, who announced that up to the present £20,000 had been spent on the Council's electric lighting scheme; and he called upon those interested in the improvement of the district to take full advantage of the facilities which the Council offered for inaugurating the use of electric current for various domestic purposes. He complimented Mr. Britton on the fine show which had been made with the extensive collection of apparatus and fittings at his command, most of which had been courteously lent by the exhibitors. Mr. Ald. Glenny, in proposing a vote of thanks to Mr. Reeson, stated that he had been informed that one owner of house property in the town had arranged to have electricity supplied to over 600 houses.

Electric Lighting Sundries.—A useful sheet of additions to the catalogue issued by Messrs. Davies, Kent and Stewart, manufacturers of electrical accessories, &c., 17, Berners-street, London, W., is to hand. The text and illustrations refer chiefly to high voltage supplies.

Exhibits for Paris Exhibition.—Messrs. S. Smith and Son, of 9, Strand, London, have prepared a large number of carefully-selected exhibits of their high-class, non-magnetisable chronometers, clocks, and watches for the Paris Exhibition. The collection is valued at £15,000, and includes a number of watches which have passed the severe Kew Observatory tests. The whole of these watches are throughout of English manufacture, and it is claimed for them that they represent the very highest class of workmanship possible. The display is a unique one in many respects. We learn from Messrs. S. Smith and Son that a very large number of their make of non-magnetisable watches have been supplied to members of the electrical profession in all parts of the world.

Exports of Electrical Apparatus and Material.—**The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from April 4 to April 10, with the ports of destination :—**

Africa—Cape Town, £2,466 (including £2,412 telegraph material); Durban, £534. *Australasia*—Adelaide, £795 (including £152 telegraph material); Auckland, £70; Melbourne, £1,699 (including £1,605 telegraph material); Sydney, £2,375 (including £170 telegraph material); Wellington, £407. *Belgium*—Brussels, £12; Ostend, £167. *Channel Islands*—£19. *China*—Shanghai, £27. *Germany*—Hamburg, £400 (telegraph material). *Gibraltar*—£17. *Holland*—Amsterdam, £185; Rotterdam, £200 (telegraph material). *Hong Kong*—£20 (telegraph stores). *India*—Calcutta, £1,136. *Japan*—Kobe, £1,173; Nagasaki, £20,000 (telegraph cable) Yokohama, £2,321. *Mauritius*—£20. *Portugal*—Lisbon, £25. *Straits Settlements*—Singapore, £386 (including £179 (telegraph material). Total £34,454, against £19,357 for 12 days last year (March 31 to April 11).

MUNICIPAL, FOREIGN, AND GENERAL NOTES.

Arbroath.—The Council are recommended to appoint a consulting engineer to report upon the advisability of carrying out the terms of the electric lighting provisional order, and two names (Mr. W. C. C. Hawtayne, of London, and Mr. Buchan, of Edinburgh) have been submitted.

Barking (Essex).—At present private consumers of electric current are charged 6d. and 2d. per unit. It is proposed in future to charge one figure—4½d.

Birmingham.—The Public Works committee recommend the Corporation to consent to the adoption of the overhead trolley system on the Bristol-road tramway route.

Bradford.—The total receipts from the Bolton electric tramway for the twelve months ended March amounted to £6,072. 1s. 7d., or 11·2d. per car mile. On the Horton section the total was £13,611. 18s. 6d., equal to 12·56d. per car mile.

Brighton.—In a special report to the Council the Lighting committee stated they had received letters from Mr. Arthur Wright, engineer and manager of the electricity department, suggesting the appointment of Mr. C. Joyce as acting manager during Mr. Fowler's absence at the front, and an alteration in the terms of his own engagement. Mr. Wright stated that, while being very willing to continue to take full responsibility under the committee for the proper carrying on of the electric lighting undertaking, he now felt that it was hardly necessary, or even possible, for him to continue to be nominally responsible for all the ordinary routine work, as the heads of the different departments were perfectly able, with the help of the acting manager, to carry out this everyday work. On all important commercial questions and in cases of serious difficulties he would of course prefer to be consulted. He therefore proposed that the terms of his appointment be re-drawn, so that he should in future be the consulting manager and engineer, whose duty it would be to superintend the design of new extensions, advise the committee on commercial and technical developments, and arrange, through the acting manager, the organisation of the staff for the proper carrying on of the supply business. Should he at any time have to be absent from England, he would undertake to appoint a fully qualified electrical and civil engineer to act for him in case of emergency. As an earnest of his desire to continue to superintend and be mainly responsible for the carrying on of the Brighton electric lighting, with which he had been connected for the last 19 years, he was willing to enter into an agreement, should the Council desire it, to act as consultant for a minimum period of five years at an annual fee equivalent to his present salary, and subject to the Corporation being able to determine such an agreement by three months' notice if thought desirable. Under this new arrangement he would be willing to pay his travelling expenses, and thought the result of his wider experience in other towns would be of material service to Brighton. As he had at present no intention of moving his residence from Brighton, and certainly not his chief interest in its electrical welfare, he felt the only real effect of his proposal on the Corporation's electricity undertaking would be to develop a greater sense of self-reliance and responsibility in the acting manager and other members of the staff, without in any way endangering the continued success of the electricity works. The committee adopted Mr. Wright's suggestions, and recommended that he be retained as consulting engineer at his present salary (£600 per annum), he to enter into an agreement to remain in the service of the Corporation for five years, the Corporation to be at liberty to terminate the engagement on three months' notice. The committee also recommended that Mr. Joyce should be appointed acting manager *pro tem.* The chairman of the committee (Councillor Briant) paid a tribute to the abilities of Mr. Wright, who had, he said, become essential to Brighton. The report was, however, rejected by 21 votes to 19.

Bristol.—The Corporation on Tuesday decided to submit the proposals of the city electrical engineer (Mr. H. Faraday Proctor) for the extension of the electricity undertaking to Sir Wm. Preece, K.C.B., for report.

Bury (Lancs.).—The Council have decided to approach the Bury, Oldham and Rochdale Tramways Co. with a view to purchasing their undertaking, and a sub-committee has been appointed to enter into negotiations with outside authorities, in order to obtain running powers in those districts. The proposal to adopt the overhead trolley system has been referred back.

Cardiff.—A special meeting of the Electrical committee was held on Tuesday, and a communication read from Messrs. S. Z. de Ferranti (Ltd), suggesting that while they were engaged in carrying out the alterations ordered by the Court to the engine which they were building for the Corporation they should work out a more recent design, which at small cost would double the efficiency of the engine. The chairman stated that he had convened the meeting for determining what action should be taken with reference to certain matters brought by the engineer (Mr. N. Appelbee) to his attention, and on which he had asked Councillor Hallett as an expert to report. The chairman and deputy-chairman (Councillor Hallett) having testified to the improvement wrought at the works recently by Mr. Appelbee, the deputy-chairman said he had visited the works to examine for himself certain parts of the Ferranti engine which were considered by their engineer to have deteriorated while yet they had received only ordinary wear and tear. He found that certain parts of a beautiful mechanism were made of case-hardened steel, the surface of which had crumbled by the tapping bound to go on, and he suggested that an arrangement should be made with Messrs. Ferranti, now that the engine was opened up, to replace these parts with some sort of white metal which would wear better. He held no brief for Messrs. Ferranti, but he felt bound to say that when completed the engine would be without equal in the country. In reply to questions Councillor Hallett said further that if he were advising a private firm instead of a Corporation in which he was interested his fee for professional technical advice would be £200! It was economy to have this work carried out at the present time. After a sharp discussion lasting over an hour, it was proposed by Councillor Morgan that Mr. H. R. J. Burstall (Messrs. Burstall and Monkhouse) be asked to immediately inspect the engine and to advise the Corporation thereon. Councillor Fox, however, moved: "That, pending the expiration of one month from April 5, for which period the engine had been placed at the disposal of the builders for the purpose of carrying out the alterations agreed upon and ordered by the Court in the recent action 'Cardiff Corporation *v.* Ferranti,' it be an instruction to the electrical engineer not to run the 300 kw. steam alternator or otherwise use it for town purposes, nor afterwards until approved by Mr. Burstall and certified by him to be in an efficient and satisfactory condition." This resolution was carried by the casting vote of the chairman.

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The Tramways committee report that, having made the fullest inquiries into the question of generating electric energy for tramway traction, and a number of the committee having visited the electric tramway undertakings at Liverpool, Glasgow, Bradford, and Hull, they are of opinion that in the interests of the electric tramway undertaking of Cardiff, and in order to ensure its success, it is desirable that the tramway generating station should be separate and distinct from the electric lighting undertaking.

Chorleywood (Herts).—The Parish Council have been requested by the ratepayers to consider the question of adopting electric lighting.

Colchester.—The equivalent of about 5,000 8 c.p. lamps is at present connected, and there are applications in hand for about 800 more. At the last meeting an extension of the mains was authorised.

Coventry.—An inquiry was held last week into the application of the Corporation to borrow £821 for purchasing additional land for extending the electricity station. No opposition.

Ealing.—There is at present an equivalent of 32,586 8 c.p. lamps connected for private lighting, and in addition 75 arcs and 364 incandescent lamps for street lighting.

East Molesey.—The Council have instructed the surveyor to obtain estimates of the relative costs of electric and gas lighting. Oil is the present illuminant.

Farnworth (Bolton).—There was no opposition at the inquiry held last week into the application of the Council to borrow £22,000 for establishing works for supplying electric current for lighting and traction.

Hornsey (Middlesex).—On Monday the Council discussed a report presented by the Electricity committee on the proposed establishment of electricity supply for this district. The Council's provisional order was granted on July 1, 1898, and Mr. Robert Hammond, in a report to the Council dated Feb. 27 last (now presented), points out that by January next supply under this order must be given. Mr. Hammond further points out that Parliament is now disposed to act more strictly in the revocation of provisional orders which have not been put into effect, unless it is shown that works under the order are about to be started. For the Council to allow their order to lapse and a company to step in would, Mr. Hammond urges, be unwise, as the Board of Trade would give little consideration to the Council's opposition to a company applying for an order under these circumstances. If, therefore, the Council do not propose to work the order themselves, he recommends that arrangements be made with a company to supply electrical energy as tenants under the Council, or to transfer the order to a company on equitable terms. Mr. Hammond would favour the latter course. He is of opinion that the cost of supplying current for lighting, public and private, will be covered by the profits of the undertaking. On the question of comparative cost of lighting by gas and electricity, Mr. Hammond considers that electric lighting at 6d. per unit equals gas at 3s. per 1,000ft. (the price is 3s. and 3s. 1d. per 1,000 in Hornsey), 5d. per unit is equal to gas at 2s. 6d. per 1,000, and so on. The improvements in lamps and other apparatus in connection with electricity supply tend to still further lessen the cost of electric lighting. Mr. Hammond's report outlines a scheme for the compulsory area under the order. As far back as November, 1897, in a preliminary report to the Council he recommended the high-pressure alternating system of supply; but he now considers the low-pressure system would be best suited for Hornsey, and would be more economical under the new conditions. The cost of laying mains is estimated at £6,104, with a further £3,750 for extensions. 6,000 equivalent 8 c.p. lamps would be required, but 15,000 should be provided for; and the generating plant for this output is estimated to cost £20,250. These estimates do not include the cost of site. Mr. Hammond estimates that 45 arc lamps would be required for public lighting, costing, with connections, &c., £2,250; and that meters, fuse-boxes, and house connections would cost a further £3,050. With £3,096 for contingencies, engineer's fees, &c., the total would come to £38,500, or £3,500 in excess of the preliminary estimate in 1897, mainly owing to the increase in cost of material. An alternative scheme for 21,000 lamps alight at one time (from 30,000 and 40,000 lamps on consumers' premises) Mr. Hammond estimates would involve an expenditure, including public lighting, of £73,500. Taking the maximum charge for current at 7d. per unit for the first 100 hours per quarter and 2d. per unit after (averaging about 5d. per unit), Mr. Hammond estimates that the financial results would be an income of £6,119 for the first-mentioned scheme and of £11,512 for the larger undertaking. The estimate of annual working costs is put at £3,329 and £5,990 respectively. Adding £2,630 and £4,226 for interest and sinking fund, there would be a net profit, after public lighting had been effected, of £160 and £1,764 respectively. The Council instructed the committee to consider the matter and report at once.

A number of companies have offered to take over the Hornsey order. The British Insulated Wire Co. offer to supply current for a number of years, with power to the Council to purchase at 10 years at a valuation. A company would be formed with £50,000 capital, and a maximum charge of 4½d. per unit to private consumers and 2d. for public lamps would be made, the Council providing the public lamps and columns. The proposal of Edmundson's Electricity Corporation suggests a charge of 2½d. per unit for public lamps and a maximum charge of 7d. per unit for the first, 4d. for the second, and 2d. for the remaining hours' supply for private lighting. The North Metropolitan Co.'s offer provides for the Wright system of charging, the Council to pay a sum for goodwill if purchase is ultimately made.

Hull.—The Holderness-road electric tramway route (about two miles) was officially inspected on Tuesday. Objection was taken that insufficient space had been left between the lines and the kerbstones in several places, but the inspector passed the line and sanctioned its opening for traffic.

Leamington.—The 1887 agreement between the Council and the Midland Electric Light and Power Co. has been cancelled and the period of company's provisional order has been fixed at 37 years.

Light Railways.—The Rhyl Council have sanctioned the proposed extension of the Rhyl and Prestatyn light railway, but electric current is to be taken from the proposed municipal electricity station.

The Southend Town Council have decided to apply for powers to construct five additional light (electric) railway routes.

London County Council.—At Tuesday's meeting the Hampstead Vestry were granted a loan of £38,134 for building work and for £52,606 for 42 years for electric lighting, and £218 for 15 years in respect of street lighting works. The original application of the Vestry was for £97,178—£40,915 for building works and £55,461 for engineering works.

The Fire Brigade committee, reporting on the acquisition of premises at Streatham for a station, pointed out that it would be costly to connect the station with fire alarm and telephone apparatus, and, pending the erection of a temporary station, the chief officer suggested that a trial should be made of the Marconi system of wireless telegraphy. He had been in communication with the Wireless Telegraph and Signal Co., who had agreed to instal and maintain the necessary instruments for a period of two years at an annual cost of £50. As this experiment would be less costly than the usual arrangement, the committee recommended its adoption, and this was agreed to.

Longton.—The Fenton District Council, who wish to obtain electric current for public lighting from Longton, intimate that the minimum number of units required would be 30,000 per annum, and the maximum 100,000. The matter has been referred to a sub-committee.

St. Helens.—The new Haydock electric tramway route was officially inspected on Thursday last by Col. York and Mr. A. P. Trotter, and is now open for traffic.

Salford.—Mr. A. P. Trotter held an inquiry on Thursday last into the application of the Corporation to borrow £227,392, balance of amount required for the reconstruction and electrical equipment of the local tramways. The town clerk (Mr. L. C. Evans) explained that the working of the tramway system was leased to the Manchester Carriage and Tramways Co. The Corporation would enter into possession of the lines in 1901, and then work them on their own account. The Corporation were authorised to reconstruct the tramways, construct additional lines, and equip them electrically, and the inquiry had special reference to that part of their powers. Under their 1899 Act the Corporation were authorised to borrow £250,000 for the construction of tramways. The amount of the present application was made up as follows: Poles, spans, wires, &c., £42,892, tramcars £95,315, land and buildings £83,380, legal and professional expenses £5,805. The Corporation had entered into an agreement with the District Council of Swinton had Pendlebury to work their tramways for 21 years and had also an agreement with the Eccles Corporation to work their tramways for 35 years. It was desirable that the tramway equipment of the borough should be laid down by April 29, 1901, and desired the Board of Trade to give the present application early consideration because they were now negotiating with the authorities of the Swinton and Pendlebury district and with the Corporation of Eccles as to the reconstruction of their lines. It was essential that this should be done, so that when the lease of the Manchester Carriage and Tramways Co. expired the tram service might continue without any block or hindrance. Mr. E. Hutton, tramways engineer to the Salford Corporation, gave technical details, and Mr. Evans added that certain contracts in connection with the work were already let, and others were being prepared. Arrangements would probably be made to light the streets along the tram route by electricity. Mr. S. V. Clirehugh, consulting electrical engineer (Messrs. Lacey, Clirehugh and Sillar) also gave evidence. There was no opposition.

In our last issue we briefly referred to the resignation of the chairman of the Electric Lighting committee (Councillor A. Haworth) and to the appointment of a special committee for the purpose of investigating certain alleged irregularities in connection

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with the electric lighting department. Councillor Haworth explained at the last sitting that about three weeks ago he was informed that there was a grave irregularity taking place in regard to one of their contracts, and a letter was shown to him from a firm of ironfounders in Staffordshire. He then asked Mr. Turner, the electrical engineer, if he had taken out a patent, and he said he certainly had about 12 months ago. At the committee meeting he asked Mr. Turner if he had supplied a firm in Staffordshire with a list of names of firms who tendered for a certain contract, and Mr. Turner said he had done so. He then suggested that they write to the various firms asking what they had added for royalty for the patent of Mr. Turner, which would have to be obtained through the Staffordshire firm, and one firm wrote that if royalty had not to be paid they could reduce their tender by £251. 5s., and another firm that if they were allowed to go into the open market the total reduction would be £1,300. Mr. Turner was asked certain questions and then requested to retire, and it was decided to send the matter to the General Purposes committee. At a subsequent meeting that resolution was rescinded, and he felt that he could not with self-respect retain his membership of the committee. He had lost confidence in their engineer, and it had been painful for him to take the action he had done. The patent was taken out on Nov. 22, and on Nov. 29 their plans and estimates were in the hands of the Local Government Board. It looked to him that the patent had been rushed into the Patent Office as soon as Mr. Turner knew their plans were settled. He moved that the electrical engineer, Mr. Turner, be forthwith requested to send in his resignation. Councillor Bates seconded this. Councillor Jones said he felt that an injustice was being done. He believed Mr. Turner to be innocent. They went to Staffordshire, and the answer to every question asked of the firm referred to exonerated Mr. Turner up to the hilt. Ald. Phillips said they had to consider the dignity of the Council, and they had to do justice. They had heard a grave statement from the chairman of the committee, and a defence by Councillor Jones, which, to his mind, entirely avoided the point at issue. The question was whether Mr. Turner was faithfully discharging his duties or not. He thought the best course was to appoint a special committee to thoroughly investigate the whole matter. He moved that such a committee be appointed. Ald. Mandley seconded, and after further discussion the amendment was carried and the special committee duly appointed.

Sheffield.—Mr. A. P. Trotter inspected the electrical equipment of the Ecclesall-road tramway route on Friday last.

Sleaford.—Some time ago the Council obtained a report from Mr. E. Bremner Smith, in which the cost of an electric lighting scheme was put at £5,717. Mr. C. S. Vesey Brown, of Lincoln, who was recently invited to advise upon the proposal, put the least possible expenditure at £10,759. After considering both reports the Council have authorised the Electric Lighting committee to instruct Mr. Smith to submit plans and particulars of his scheme.

Southport.—In the *Southport Guardian* of Wednesday appears an article on "Electric Traction," by Mr. R. H. Scotter, C.E., dealing with the developments of this industry in Germany and the importance of the application of electric traction to the Cheshire lines extension. On the subject of the developments in Germany Mr. Scotter states that at least 50 per cent. of the electric lines owe their existence to the very substantial assistance given by the German banks. This was not the case, however, in England, where an engineer, if he is competent to form original projects, must first give the result of his brainwork away to all and sundry while casting about for capital. The system of bankers' help in Germany protected to a certain extent original ideas until these have been a certain time in working and are an assured success or failure. Mr. Scotter instanced one small railway system running out of Munich (which exactly corresponds to the Cheshire Lines extension). This Munich line was a non-paying concern until its conversion to electric traction. Some three years ago he had pointed out to the Cheshire Lines committee how, by rearranging their connections and adopting electric traction, a much shorter and more direct route from Liverpool to Southport could be accomplished, but to advocate new methods for existing railways where old methods had failed was (said Mr. Scotter) as difficult as preaching a new faith. He had formulated a scheme for converting the Southport and Cheshire Lines extension into an electric railway for passenger service only, leaving the line to be worked by steam as it now is for long-distance and goods traffic. This scheme would not be costly, and when it was remembered that the Liverpool electric trams run close to the Aintree station on the Cheshire Lines Railway, a mode of intercommunication at once suggested itself. The use of electricity as the motive power would immensely cheapen both the cost of construction and the working expenses of the line, so that such a system would easily earn a reasonable dividend.

Stockton.—On the advice of Mr. C. S. Vesey Brown the Council have decided to erect 36 arc lamps for public lighting instead of 27, as originally proposed.

Swansea.—A trial trip took place on the Cwmbwrla electric tramway route last week. It is not expected that the cars will be running till next month, when all sections will be opened at once. It is intended to run 21 small cars and 15 large ones ultimately.

Swinton and Pendelbury.—The terms of the Salford Corporation for constructing and operating certain proposed new tramway lines are considered unacceptable by the District Council, and the result of the South Lancashire Tramways Co.'s bill is awaited.

Underground Cable from London to Birmingham.—The *Daily News* states that on Tuesday the last length of the underground telegraph cable between London and Birmingham, which the Post Office has been laying since January, 1897, was completed. 120 miles of underground cable connect the capital of the Midlands with the metropolis of the empire.

Wigan.—After inspecting various electric tramway systems in this country, a Tramways sub-committee reports :—

Our observations lead us to the conclusion that a good line, kept in good order, with single truck carriages will give satisfaction, and that we cannot find sufficient advantage in the adoption of bogie cars to warrant the extra expenditure in running cost. We therefore recommend the adoption of a single truck car with a body similar to the one recently adopted by Liverpool.

Wolverhampton.—The British Electric Traction Co. have offered to work the whole of the tramways within and without the borough so as to keep up the connection between the outlying portions of the Bilston, Willenhall and Sedgley districts, and pay the Corporation 6 per cent. interest on £30,000—rather more than the price (£26,750) paid by the Corporation for their newly acquired undertaking. The subject has been referred to the Tramway committee.

COMPANIES' MEETINGS AND REPORTS.

Willans and Robinson (Ltd.).

The ordinary general meeting was held at the Cannon-street Hotel, London, on Wednesday, under the presidency of Mr. MARK ROBINSON, M.Inst.C.E.

The SECRETARY (Mr. C. S. Essex) having read the notice calling the meeting,

The CHAIRMAN said: I do not think I need say much about the accounts. It will scarcely be questioned that the half-year's results are satisfactory, and we hope there will be as little disposition to challenge the increased distribution which we propose to base upon them. We do not feel that the present prosperity has endured quite long enough to justify us in paying a 12 per cent. dividend; we prefer to call the addition of 2 per cent. a bonus—which is meant to suggest something perhaps a little less assured than the dividend we are accustomed to. The difficulty of getting our new capital into profitable work has been and is a very real one, and we may congratulate ourselves that the instalments on the last issue have been spread over so long a period. The delays by the contractors for the extension of works at Rugby have been bad enough, but at Queen's Ferry, the site of the new boiler works, we have been most unfortunate. Months were occupied in coming to an agreement. At last everything was signed and ready to be exchanged, when suddenly one of the judges was found to have given a judgment respecting certain leasehold property, in no way concerning us, which we are informed incidentally invalidates our lease, and with it a large proportion of all the leases in England. This judgment stands for the present, and our lease has now to be taken to the Court of Appeal. It is said that a decision will soon be reached, but if not, and we should be threatened with long delay, we may have give to up Queen's Ferry entirely. We hope no great delay need be anticipated if the change be forced upon us. Notwithstanding these delays, it will be wise to issue the remaining shares before long, though we propose to spread the payment over as long a time as is reasonable—say a year. The price of issue is a subject upon which expression of opinion by the shareholders can scarcely fail to be helpful, but, broadly speaking, we hold to the view, expressed on previous occasions, that it is not well to fix the price at the very highest obtainable (perhaps not without some chance of a failure): it is better to issue at a moderate price, and to let the profit be divided between the company as a body, in the form of premiums, and the shareholders as individuals in the form of added value to their holdings or of profit upon re-sale. Turning from the boiler works and their finance to the boiler which is to be made in them, the shareholders will doubtless be interested to hear that the Admiralty trials of the Niclausse boilers in H.M.S. "Seagul," have at length been brought to an end—three years after the boilers were made and delivered to the Admiralty. Compared with the boilers which are to be made at Queen's Ferry, those of the "Seagull" may almost be described as of obsolete pattern, and this largely takes from the comparative interest and value of the economical results obtained. The Admiralty figures on this subject, whatever they are, are not published, but it is no secret that the Niclausse boiler, in respect of practical convenience and reliability, passed its tests with flying colours. There is said to have been a complete absence of hitches of all kinds. A number of trials were made, each consisting, or intended to consist, of 1,000 miles under steam, in all sorts of weather and sea, and the remarkable statement is made that during the last, or full power trial, after some 9,000 miles steaming spread over many months, during which time the tubes were never cleaned internally, a sudden order was given to shut off and empty one of the boilers, to remove two of its tubes, to put in two others in their place, to get up steam again, and to report

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when ready for giving steam to the engines; and that the time which elapsed from the order to empty the boiler to the time when it was reported to have steam up again to working pressure was 48 minutes only, of which five minutes were occupied in removing and replacing the tubes. This wonderful record (which surpasses, though not by very much, what we used to do with the first experimental boiler) gives striking testimony to the ease with which the boiler can be overhauled and repaired, and, we think, to the accuracy of our judgment in taking it up and in preparing to manufacture it on the largest scale. This will ultimately necessitate the issue of still further capital—I mean beyond the 20,000 shares to be issued this year. We have satisfied ourselves that we must be more than mere boiler makers and must be tube makers, and that we should be prepared to make much of the other material for ourselves. The production of even a part of our own materials will be justified by the complete control it will give us over the processes of manufacture, which will then be carried on to suit our requirements alone, and not those of other people, either as regards quality or time for delivery.

Turning to the accounts, you will see that we continue to add largely to reserve out of the ordinary profit—viz., at the rate of £7,000 per annum—besides £4,000 per annum carried to debenture sinking fund. But the amount shown in the balance-sheet to the credit of reserve (before the present recommendations are acted upon), viz., £28,646, is much below its real amount, for there is a further sum of £29,656, the premiums on the last issue, which, after some deductions not yet carried out, is destined to swell the reserve. Taking into account the premiums upon the forthcoming issue of shares, there can be little doubt that we ought soon to see a reserve equal to our whole debenture debt, apart from the separate provision which is being made for the redemption of the debentures. The large amount of cash in hand on Dec. 31, about £64,500, is partly due to the fact that it included premiums on shares awaiting investment, nearly £30,000; partly to the natural slowness in payments, consequent upon the delays over the extension works. £48,000 was on deposit, and of this £20,000 was shortly afterwards invested in consols. Debtors stand for a larger sum than before, but no effort is spared to keep this amount as small as possible. Large balances outstanding on important municipal contracts still unfinished are the principal reasons. These debts are valued very rigidly.

The company this year sends a large engine to the Paris Exhibition, coupled to a dynamo made by Messrs. Siemens Bros. and Co. We are nominally suppliers of the whole, but the dynamo is shown at no cost to us, and we shall of course see that its makers have the credit which is due to them. The engine and dynamo will, we understand, form the largest and most important electric generating plant in the whole Exhibition—that is, largest in horse-power and electrical output, not of course in space occupied. It will be employed in actual work, for which steam will be found and a small payment made to us, but not enough, I fear, to seriously reduce the cost of the exhibit. The engine will have an indicated H.P. of 3,000 as the "emergency" load; the continuous load is meant to be 2,400 H.P., and the most economical load about 2,000 H.P. This engine, which we could scarcely erect in our present erecting shop, lofty as it is, is a good example of the success of boldness in standardising patterns. We put in hand one engine as though we expected to make a dozen, and though the electrical trade, fast as it grows, has not yet reached the point of ordering such engines as this by the dozen, it probably will do so some day, for already two others are on order for the Corporation of a great city, and the highly elaborate patterns and the costly special tools intended to ensure interchangeable work in all the engines of this size have already paid for themselves. The Paris engine, which is so far unsold, is not likely to be long without a purchaser. I now move that the report and accounts be adopted.

Mr. MARRIOTT (shareholder) seconded the motion, and expressed great satisfaction with the report and accounts.

A discussion followed, in which several shareholders took part, and general satisfaction was expressed with the report and accounts.

The CHAIRMAN, in answer to questions, said that the new shares would not be allotted on the same terms as on the last occasion, because in the interval they had risen two or three points in market value. He thought that the gentleman who had suggested that the issue should be at two-thirds of the market price approached most nearly to what would be a fair premium. Additional capital had been issued hitherto gradually with the extension of the company's business, and the increase had been justified by the steady advance in the dividends from 5 per cent. at the beginning and 8 per cent. shortly afterwards to 12 per cent., the return on the present occasion with the bonus.

The motion was unanimously adopted, and the retiring directors and auditors were afterwards re-elected.

A vote of thanks to the chairman and directors brought the meeting to a close.

Brockie-Pell Arc Lamp (Ltd.).

The fourth annual general meeting of this company was held at the new premises, 60, Worship-street, Finsbury, London, E.C., on Monday, under the presidency of the Right Hon. Lord SUFFIELD.

The SECRETARY (Mr. W. J. G. FitzGibbon) having read the notice convening the meeting,

The CHAIRMAN said: When I last addressed the shareholders I expressed a hope that when we next met I should be able to present to you a better balance-sheet than on the previous occasion, and that hope, I am pleased to say, has been fulfilled. I trust that the accounts submitted to you to-day will be followed at no distant date by accounts which will warrant our paying a dividend to the shareholders. The business has shown a steady rate of increase throughout the year. We have not only new and important contracts for lighting, but have carried out satisfactorily those contracts we had in hand. Our lamp has fully maintained its reputation, the works are fully occupied and will be so on existing orders for some time to come. The plant, tools, apparatus, and other items have been maintained at the fullest efficiency, and a fair sum for depreciation has been allowed for. The high price of materials has affected us in common with other manufacturers. The directors have reduced their fees by three-fourths, and every effort has been made to reduce expenditure, but with a business such as ours the technical staff expenses are necessarily heavy. These expenses will, however, not increase in the same ratio as the company's trade increases. In our new premises we shall be able to do at least three times the business we could carry out in our former premises, as well as being able to keep a stock of the goods we manufacture. The new premises as a property are also well worth having, as we could re-let them at any time, should such a step be necessary, at a good premium. I should like, before concluding, to say that the great improvement in the position of the company is principally due to Mr. Shrimpton and our secretary, Mr. FitzGibbon. Mr. Shrimpton has devoted not only a great deal of time but a great deal of ability to the interests of the company. We have had a pretty hard time of it, but have, I believe, turned the corner. I now move the adoption of the report and accounts.

The VICE-CHAIRMAN (Sir F. D. Dixon-Hartland, Bart., M.P.) seconded the motion, and said he agreed with Lord Suffield that the company had now turned the corner. Whereas 12 months ago a debit balance of over £1,500 on the year's trading was brought forward, there was now a profit of £1,250. He could honestly say he thought the work they had in hand now was even more than they could do, and he thought the business would go on increasing. They now had premises where such an increase could be dealt with. He thoroughly endorsed the chairman's remarks concerning Mr. Shrimpton.

Dr. FEGAN asked if the £1,000 mortgage to the bank appeared in the balance-sheet now for the first time. With regard to the 5 per cent. depreciation on the plant and machinery, &c., he thought this should be 10 per cent. The report did not state the number of lamps which had been turned out during the year, but probably this was intended to be a trade secret. He regarded the amount of £6,803. 19s. 7d. in the profit and loss account as very satisfactory. He would like to know how the directors proposed to deal with the large debit item of about £6,000 on the working for the past two years, as he thought the item was one that should be disposed of, so that the shareholders might get the advantage of any profits earned in the future. He could himself bear independent testimony to Mr. Shrimpton's ability. He was undoubtedly the right man for the management of the company from a commercial standpoint, and he hoped the technical part of the business was equally well provided for. According to their contract with Mr. Brockie, their late manager, who was now consulting engineer to the company, he understood they were to have a half share of a very important invention of his, of an electric lathe, and in any other inventions which he might bring out. He thought the shareholders should know exactly the position of this matter.

No other questions being asked,

The VICE-CHAIRMAN said: The £1,000 mortgage to the bank appears in the balance-sheet for the first time this year, and represents so much more capital borrowed for the purposes of the business. With respect to the allowance for depreciation, the shareholders must remember that not only were items amounting to £750 wiped off, but £798 was represented in addition to the 5 per cent. The whole of their machinery was new and was in the best possible condition.

Mr. SHRIMPTON, in answering the technical questions, said he would first say that they had let their old premises at a bonus of £300, which would be something towards their moving expenses. In their new works they had put in electric motors in place of oil engines. They had debited the accounts for the year with the full expense of maintaining the machinery in first-class condition, and the auditor considered that the depreciation shown in the report was a fair figure to take. He agreed that the patents should be written down as soon as possible. With regard to advertising, there was considerable competition in connection with arc lamp supply, and they must endeavour to make new friends as well as to retain old ones. They had had no occasion to consult with Mr. Brockie, who was, however, available at the directors' call if they required him. Mr. Worsley, the manager of the works, had had many years' experience in the manufacture of arc lamps, and altogether their technical department was in a healthy and sound condition. With regard to the electric lathe, that had been left out of the accounts because they were not certain whether it was an asset at all. If it was asset, they had it still. Their foreign patents were also left out, in order that nothing but the most substantial figures should be included in the balance-sheet. The electric lathe might be a clever invention but they had no time to occupy themselves with it at present, nor the capital to develop it. With regard to the number of lamps supplied, they had competitors in trade, or there were many things the directors would like to tell the shareholders; but this information was at the disposal of any shareholder requiring the information privately.

The resolution was then put to the meeting and carried.

The Hon. R. Brougham was re-elected a director, and the auditors having been re-elected,

The VICE-CHAIRMAN said: Before the meeting concludes I should like to say a few words with reference to the capital of the company. An enlarged business requires an enlarged capital. We cannot carry on the largely increased business we shall now do—bringing, we hope, a large amount of profit to the shareholders—without capital to work with. It was astonishing how the work had been done in the past year with the small capital at command. There are two ways of getting this increased capital—by the issue of debentures or by the reconstitution of the company. The disadvantage of issuing debentures is that they will be a permanent charge: if, however, we reconstitute the company, we shall have the right of taking out of the balance-sheet the debits made in the first two years of our works, amounting to £5,647. 12s. 6d. We can

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also write down our patents. I therefore make the following suggestions for the shareholders' consideration. There are 80,000 shares in the company, and if we give two shares in the reconstituted company for three shares now held by the proprietors, we shall reduce the capital by one-third. Then, if we bring out the new shares at 15s. paid instead of three shares fully paid, the company would have ample capital to do its work and to pay a dividend which would make the two shares worth a good deal more than the present three shares. There would remain upon the two shares with 15s. paid a liability of 10s. upon which the directors propose to call up 2s. This would furnish them with funds to go on with, and in addition bankers will always advance on a call which can be made, as they will not do if the whole of the capital of the company is paid up. He invited the opinions of the shareholders on his proposal.

Dr. FEGAN said that personally he should prefer to see a reconstruction of the company, with an issue of shares with 18s. paid and carrying a liability of 2s.

The VICE-CHAIRMAN said the directors would call a few of the largest shareholders together and see what could be done in the matter, and then hold an extraordinary meeting.

Mr. SHRIMPTON said the urgency for more capital was that they had a piece of business in hand that was extremely valuable, involving nearly 1,000 lamps. If the necessary funds were not provided by the shareholders they would have to go to someone else and borrow them.

A cordial vote of thanks to the chairman, directors, and staff was then carried unanimously, and the proceedings terminated.

Westminster Electric Supply Corporation (Ltd.).

An extraordinary meeting of this corporation was held on Wednesday to consider the following resolution: "That the capital of the corporation be increased from £399,500 to £550,000 by the creation of 30,100 ordinary shares of £5 each, and that the board of directors be authorised to issue 20,100 of the shares at £10 per share."

Lord SUFFIELD presided, and moved the resolution. He said that the matter had been fully considered by the board and, by five to two of the directors, the plan proposed was judged to be the only sound financial method of raising the required capital. This opinion was supported by eminent legal and financial authorities. He deeply regretted that the views of the majority of the board were opposed by two directors, who had put before the shareholders a proposal which undoubtedly, on the face of it, was more attractive, but careful consideration would show that, if adopted, it would, in the course of the next few months have such a prejudicial effect on dividends as to enormously depreciate the value of the shares to the investor. As Chairman of the company he thought it his duty to warn them of the perilous course on which they would be entering should they assent to the proposal put forward by a minority of the board.

Mr. E. BOULNOIS, M.P. seconded the resolution. He said that, although not specifically stated, it was intended to issue the new shares *pro rata* among the existing shareholders. By issuing them at £10 each—the market price being £15—the shareholders would get the handsome bonus of £5 per share, while another £5 in the shape of premium would go into the coffers of the company, and of course on that money no dividend would have to be paid. On the other hand, the minority proposal was that the whole £10 should go into the shareholders' pockets. He held that the recommendation of the majority of the board was financially sound, and would be for the best interests of the company in the long run.

Mr. R. D. WALLACE, Q.C., proposed the following amendment:—"That the capital of the corporation be increased from £399,500 to £550,000 by the creation of 30,100 shares of £5 each, and that such shares be issued at par to the shareholders *pro rata* according to their holdings in the company." He said he believed the company had a still greater future before it, and he did not adopt the view of the other directors that the amount earned available for dividends was likely to decrease. If they went on issuing shares at a premium the rate of dividend paid would be to some extent fictitious, not being paid on the whole capital, and it might be of such an amount as would attract the attention of the Board of Trade.

Mr. WHITE seconded the amendment, which was supported by Mr. Browne-Martin (a director).

Mr. HAYES FISHER, M.P., contended that from the investors' point of view the proposal of the majority of the board was the better of the two.

Lord AMPTHILL supported the resolution, but, after some discussion, the amendment was, on a show of hands, carried by 27 votes to 20, and was also carried as a substantive motion. The chairman thereupon demanded a poll, which he ordered to be taken on the 11th prox.

Mr. WALLACE protested against the delay in taking the poll, and mentioned that he held a majority of votes.

The CHAIRMAN said the majority of the board had decided, for certain reasons, that the poll should not take place at once.

The proceedings then terminated.

ANGLO-ARGENTINE TRAMWAYS CO. (LTD.)—At Tuesday's meeting the chairman (Mr. H. Doughty Browne) said that under the arrangement made with the Argentine Electric Traction Co. the latter company guaranteed the ordinary share capital of the Anglo-Argentine Co. a minimum dividend of 4 per cent. for a period not exceeding five years, but if the profits exceeded this 4 per cent. that amount could be divided among the shareholders. He congratulated them on the fact that the negotiations for an electrical concession had been brought to a satisfactory conclusion. The new concession was for 99 years, and in many ways it was favourable to the company, while it was untrammelled by the onerous conditions which it was suggested they should undertake when the question of conversion to electricity was first mooted.

BABCOCK AND WILCOX (LTD.)—Mr. J. Dewrance presided at the meeting of this company on Tuesday, and stated that the growth of the business had been very satisfactory. The profit during the year amounted to £106,585, which with the balance forward came to £115,918. After deducting interim dividends there was a balance of £90,918, from which the directors recommended a dividend at the rate of 6 per cent. per annum on the preference shares and a dividend of 20s. per share on the ordinary shares for the half-year to Dec. 31. They proposed to place £50,000 to reserve, which would leave £15 918 to be carried forward. An extraordinary general meeting was then held, to consider resolutions for winding up the company voluntarily, its reconstruction, and the appointment of Messrs. Rosenthal and Simpson as liquidators. The chairman stated that the principal reason in submitting to the shareholders, at this particular time, the reconstruction scheme was owing to the enormous expansion in the business. With the increase in assets, it was necessary that the board should make due provision for the future. The company's works, which had been extended by the increase in the plant throughout the year, were still fully occupied, and it was thought desirable that they should be further largely extended. The assets now exceeded the share capital, and it was proposed to adjust more closely their proportion by issuing new ordinary shares to the present holders. Both preference and ordinary shares were £10 each, and it was proposed that they should be split into £1 shares, holders of the preference shares receiving ten £1 shares for each £10 share at present held, and holders of the ordinary shares receiving 20 £1 shares for each £10 share now held. The 90,000 ordinary shares in the new company were to be offered for subscription to both classes of shareholders at a premium of 50 per cent., or £1. 10s. per share. The resolutions were unanimously adopted.

GUILDFORD ELECTRICITY SUPPLY CO. (LTD.)—The annual meeting of this company was recently held at Guildford. In moving the adoption of the report, which appeared in our issue of March 23, the chairman (Dr. F. R. Russell) stated that their receipts were £500 better than those of 1898, while their expenses had only increased by £283, this increase being almost entirely accounted for by the cost of coal. The amount of current sold was 56,724 units, against 29,127 in 1893, and the cost of production had gone down proportionately, being 3·76d. per unit, compared with 5·24d. More capital was wanted to provide a much larger storage battery for the night load. The deficit of £222 had been wiped out. With regard to the purchase of their undertaking by the Corporation of Guildford, if the directors got an offer which they thought it would be for the benefit of the shareholders to accept, the latter would be called together to consider the matter.

SAN PAULO GAS CO. (LTD.)—At the meeting the chairman (Mr. D. M. Fox) stated that the directors had a number of difficulties to contend with during 1899, owing to changes made in the laws regulating electric lighting at San Paulo. The question of electric lighting had caused the board great anxiety during the year. Having an offer to light the new railway station at San Paulo by electricity, it was decided that the occasion was favourable for the company to start an electrical department. The business was approached with the greatest caution, and it was not until they were assured by their legal adviser that the company had the right to supply electric current, and that the president of the Municipal Chamber was favourable to their doing so, that the directors entertained the idea. Within six months of entering into a contract for the supply of the necessary plant, and when the same was nearly ready for shipment, the Chamber passed a law for regulating the supply of the electric current in the city, the conditions of which were so onerous that the company had no alternative but to cancel the contract and throw up the business. The directors had paid £2,200 to rid the company of all liability under the contract, and he thought that they had acted wisely in cutting the loss.

THAMES IRON WORKS SHIPBUILDING AND ENGINEERING CO. (LTD.)—The first annual meeting of this company was held on Wednesday, Mr. Arnold F. Hills presiding. The chairman, in reviewing the business of the past year, said that every department had been full of work, and the company had contracts in hand that would occupy about two years. Their electrical engineering department was a small one as yet. They began it mainly in connection with their own yard lighting and the lighting of their shops five or six years ago: but it had gone on, and a considerable amount of work had been done in it in the last 12 months. The profit made was between £3,000 and £4,000. In his opinion there was more room for development in the electrical department than in any other branch of engineering. Engineers had at last seen the possibility of the effective utilisation of the electric current for traction, for light and similar uses, and he ventured to think that the electrical engineering department of the company would become no less important than their other engineering departments. The directors' report was carried unanimously.

WINCHESTER ELECTRIC LIGHT CO. (LTD.)—The annual meeting was held on Tuesday. The directors' report stated that the equivalent of 10,000 8 c.p. lamps were connected to the mains at the end of last year, and further applications continued to be received. The accounts showed a net profit of £323. 12s. 2d., of which it was proposed to apply £202. 6s. 6d. in payment of a dividend of 2½ per cent. for the year, and to write off the balance (£121. 5s. 8d.) in reduction of the preliminary expenses (£197. 17s. 4d.) The chairman (Mr. T. F. Kirbey) said this was really the first annual meeting of the company since the works were opened, because they only took over the undertaking from the contractors on July 1 last. They were well satisfied with the progress made, and he predicted a still larger increase in customers, to meet which they had added another steam dynamo. The report was adopted, and Mr. F. E. Gripper, the retiring director, was re-elected.

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CITY NOTES.

MEMORANDA.—Bank rate 4 per cent. (since Jan. 25, 1900). Price of silver 27⅜d. per oz. (April 11). Consols (2¾ per cent.) 100 15/16—101 1/16 for money, 101 3/16—101 5/16 for account; 2½ per cent. 97¾—98¼ (April 11). Stock Exchange Settling Day: Consols, May 4; Stocks and Shares Continuation Days, April 25 and May 14; Ticket Days, April 26 and May 15; Pay Day, April 27; Mining Share Carry-over Days, April 24 and May 11.

EDISON AND SWAN UNITED ELECTRIC LIGHT CO. (LTD.)—Applications have been invited this week for the subscription at par for £100,000 5 per cent. second debenture stock in this company. The directors state that the rapid extension of the company's business necessitates the employment of further capital, and that the funds received from this issue will be devoted to such extension. The stock is subject to redemption at £110 per cent. at six months' notice by the company. A statement of the company's assets from the balance-sheet of June 30 last shows a balance available as security for the entire £300,000 5 per cent. second debenture stock (of which the present £100,000 is the first issue) of £352,692, in addition to the amount to be received from the stock to be issued. The profits of the company during the past five completed years ended June 30 last show a steady increase in dividend from 5 per cent. to 6 per cent. on the paid-up share capital, the annual profits increasing from £25,876 in 1894-95 to £32,213 in 1898-99. The list closed yesterday (Thursday).

INDO-EUROPEAN TELEGRAPH CO. (LTD.)—The directors, after adding £25,000 to reserve, and subject to final audit, recommend the payment of a dividend for the six months ended Dec. 31 of 17s. 6d. per share, making, with interim dividend, 6 per cent., and a bonus of 20s. per share, both free of tax, making 10 per cent. for the year, payable May 1.

ISLE OF MAN.—The *Manchester Guardian* Douglas correspondent reports that, "following the audit made of the Isle of Man Electric Tramway Co.'s accounts by Messrs. Aldred, of Manchester, the auditors appointed by the shareholders in March last year (Messrs. Turquand, Youngs and Co.)" have been engaged for weeks on a special audit of the accounts for some of the directors. I have authentic information that the liabilities discovered by Messrs. Turquand, Youngs and Co. already amount to about £200,000, and that reconstruction or liquidation of the company will be imperative. In the event of reconstruction few of the ordinary shareholders have the qualification for directors. A remarkable provision in the articles of the company is that the directors in transacting board business have a vote for each share they hold. A large proportion of the tramway shares are held in England."

MUNICIPAL LOAN.—The Epsom District Council invite applications for £16,100, in 322 registered nominal debentures of £50 each, required for electric lighting purposes. Applications to the London and County Bank, 21, Lombard-street, E.C., or Epsom, before 19th inst.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	1900	£	£		£	£
*Birmingham Tramways.	Apl. 7	4,280	– 225	14	55,514	+ 2,205
‡Blackpool Corporation...	,, 5	126	– 458	1	126	– 458
Blackpool and Fleetwood	,, 7	206	– 396	14	2,278	– 845
†Bradford Corporation...	,, 8	541	+ 190	1	541	...
Brisbane Trams	Feb. 21	1,797	+ 533	21	43,324	+13,233
*Bristol Trams & Carriage	Apl. 6	2,738	– 850	14	36,084	+ 120
*Buenos Ayres & Belgrano	Mar. 11	2,227	– 224	10	23,464	+ 5,211
City & South London Ry.	Apl. 8	1,380	+ 404	14	17,319	+ 2,104
Dover Corporation	,, 7	160	– 104	1	160	– 104
Dublin United	,, 6	5,090	+ 1,688	14	41,785	} +5681
Dublin Southern Dist....	,, 6	1,753	+ 719	14	9,415	
*Glasgow Corporation ...	,, 7	8,986	+ 193	...	...	...
*Liverpool Corporation...	Mar. 31	7,122	+ 667	13	86,628	+10,618
Liverpool Overhead Rly.	Apl. 8	1,317	– 357	14	19,454	+ 755
*Sheffield Tramways	,, 8	1,922	+ 551	14	25,527	+ 7,724
*South Staffs. Trams.....	,, 6	679	– 246	14	8,505	– 84

* Partly electrical. † 9 days. ‡ 5 days.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	NAME.	Previous Week's Price, April 4.		Price Tuesday, April 10.		Rate per Cent. Yield'd.	Dividend Due.	Business Done During Six Days Ending April 10.	
			TELEGRAPHS.					£ s. d.		Highest	Lowest
£110,900	100	4%	*African Direct Telegraph 4% Mort. Deb. (red.)	100	104	100	104	3 17 4	January and July	...	...
25,000	10	...	Amazon Telegraph	3	4	3	4	...	June and December	...	...
£125,000	100	5%	Do. 5 per Cent. Debentures	85	90	85	90	5 11 1	...	...	...
£875,520	Stock	28/6	Anglo-American	65	68	65	68	5 8 7	Feb., May, Aug., Nov.	...	...
£3,062,240	Stock	30/0	Do. Preferred	117	118	116¼	117½	5 3 0	,, ,,	117½	116¾
£3,062,240	Stock	27/0	Do. Deferred	15	15½	14¾	15	9 0 0	...	15 5/16	14¾
$10,000,000	$100	$1¼	Commercial Cable Capital Stock	165	175	165	175	4 11 5	Jan., Apr., July, Oct.	...	...
£1,563,078	Stock	4%	* Do. 4 per Cent. Debenture Stock	103	105	102	104	3 17 0	,, ,,	103½	...
16,000	10	8/0	Cuba Submarine Ordinary	9	10	9	10	8 0 0	February and August	...	...
6,000	10	10/0	Do. Preference 10 per Cent.	19	20	19	20	5 0 0	,, ,,	...	...
12,931	5	2/0	Direct Spanish Ordinary	4	5	4	5	4 0 0	April and October	...	...
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference	9	10	9	10	5 0 0	,, ,,	...	...
£30,000	50	4½%	Do. 4½ per Cent. Debentures	101¾	105¾	101¾	105¾	4 5 9	January and July	...	...
60,710	20	3/0	Direct United States Cable	11½	12	11½	12	5 16 8	Jan., Apr., July, Oct.	11¾	11¾
£120,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red.)	103	103	100	103	4 8 0	June and December	...	...
£4,000,000	Stock	5%	Eastern Ordinary	152	157	152	157	4 10 0	Jan., Apr., July, Oct.	156	153
£1,795,000	Stock	3½%	Do. 3½ per Cent. Preference Stock	98	101	98	101	3 9 3	,, ,,	100⅜	99⅛
£1,432,268	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.)	115	120	115	120	3 7 8	May and November	116⅜	116
250,000	10	2/6	Eastern Extension	16	16½	16	16½	4 4 10	Jan., Apr., July, Oct.	16 1/16	16⅛
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	115	120	115	120	3 6 8	February and August	...	...
£6,700	100	5%	* Do. 5% (Austin. Gov. Sub.) Deb., 1900 (reg.)	100	103	100	103	4 17 1	January and July	...	...
£26,600	100	5%	Do. (Bearer)	100	103	100	103	4 17 1	,, ,,	...	...
£200,000	100	4%	*Eastern and S. African 4% Mort. Deb., 1909	100	103	100	103	3 18 5	February and August	100⅛	...
£200,000	25	4%	Do. 4 per Cent. Mauritius Sub. Debs. (red.)	101¾	104¾	101¾	104¾	3 16 10	May and November	...	...
180,227	10	1/0	Globe Telegraph and Trust	11⅛	12	11⅛	12	4 7 6	Jan., Apr., July, Oct.	11⅜	11⅛
180,042	10	3/0	Do. 6 per Cent. Preference	15⅝	16	15⅝	16	3 15 0	,, ,,	15⅞	...
150,000	10	5/0	Great Northern of Copenhagen	32	34	33	35	3 11 5	January and July	...	...
£96,300	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb. (red.)	100	103	100	103	4 8 0	...	...	...
17,000	25	12/6	Indo-European	54	58	54	58	4 6 2	May and November	...	...
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904	105	108	105	108	5 11 7	March and September	..	...
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.)	102	105	102	105	3 16 9	June and December	...	...
11,839	8	4/0	Reuter's	7	8	7	8	5 0 0	April and October	...	...
3,381	£100 Cert.	6%	Submarine Cables Trust	126	131	126	131	4 13 5	,, ,,	...	...
15,609	10	...	West African Telegraph	2½	3½	2½	3½	4 9 3	December and July	...	...
£200,000	100	5%	* Do. 5 per Cent. Debentures (red.)	97	100	97	100	5 0 4	March and September	99⅛	99
20,008	2½	...	West Coast of America	¼	1	¼	1	...	...	...	...
£150,000	100	4%	* Do. 4 per Cent. Debentures	100	104	100	103	3 15 7	January and July	...	...
88,321	10	6d.	West India and Panama	¾	1⅛	¾	1⅛	...	May and November	1	...
34,563	10	6/0	Do. 6 per Cent. 1st Preference	9½	9¾	9½	9¾	6 3 1	,, ,,	9 7/8	9½
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	7	8	7	8	7 10 0	,, ,,	...	...
£80,000	100	5%	* Do. 5 per Cent. Debentures	104	107	104	107	4 13 6	January and July	...	...
£389,731	Stock	4%	Western & Brazilian 4 per Cent. Debenture Stock	100	104	100	104	3 16 11	June and December	...	...
207,930	10	3/0	Western Telegraph (late Brazilian Submarine)	14¾	15½	14¼	15	4 13 4	Mar., June, Oct., Dec.	14⅜	...
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1900)	106	109	106	109	4 11 9	June and December	...	...
			TELEPHONES.								
44,000	£5	3/0	Chili Telephone (fully paid)	2	3	2	3	6 13 4	August	...	...
324,850	10s.	0/1½	Consolidated Telephone Const. & Manufacturing	⅛	¼	⅛	¼	4 15 3	July	...	...
72,680	1	2½%	Monte Video Telephone Ordinary	⅜	½	⅜	½	5 0 0	November	...	...
86,492	1	1 0	Do. 5 per Cent. Preference	¾	1	¾	1	5 0 0	,,	...	...
490,000	5	3/0	National	5	5½	5	5½	5 14 3	February and August	5 7/8	5½
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Preference	14	15	14	15	4 0 0	,, ,,	14½	...
15,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference	14	15	14	15	4 0 0	,, ,,	...	...
250,000	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref.	5¼	5½	5¼	5½	4 10 11	,, ,,	...	...
2,000,000	Stock	3½%	* Do. Debenture Stock 3½ per Cent. (red.)	97	100	97	100	3 10 0	June and December	97½	97½
171,504	1	0/4	Oriental	¾	1	¾	1	5 0 0	April and October	...	...
58,000	5	2/6	United River Plate	4¾	5¼	4¾	5¼	7 2 10	July	...	...
16,629	5	1/4	Do. 5% Cumulative Preference	4¾	5¼	4¾	5¼	4 15 3	June and December	...	...
£179,947	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	103	106	103	106	4 14 4	,, ,,	...	...

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, April 4.	Price Tuesday, April 10.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Six Days Ending April 10. Highest	Lowest
			ELECTRICITY SUPPLY COMPANIES.			£ s. d.			
100,000	1	...	Bl'ckh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.)	⅞ ⅞	⅞ ⅞	...	...	...	...
6,000	10	10 0	Bournemouth and Poole Elec. Supply Ord.	11⅛ 12⅛	11¼ 12¼	3 11 3	...	...	...
6,000	10	4/6	Do. 4½ per Cent. Cumulative Pref.	10 11	10 11	4 1 10	...	...	...
19,661	5	3/6	Brompton & Kensington Electricity Supply Ord.	7 8	7 8	3 15 0	...	...	...
12,000	5	3/6	Do. 7 per Cent. Preference	8½ 9½	8½ 9½	3 13 8	March and September	...	...
20,000	5	...	Calcutta Elec. Supply Ordinary (fully paid)	7 7½	7 7½	...	...	...	...
50,000	5	5/0	Charing Cross & Strand Electricity Supply Corp.	9½ 10⅛	9½ 10⅛	4 5 9	February and August	10¼	10⅛
20,000	5	2/3	Do. 4½ per Cent. Preference	5½ 6	5½ 6	3 15 0	,, ,,	...	...
34,000	5	3/6	Chelsea Electricity Supply Ordinary	7 8	6½ 7½	4 0 0	March	...	...
£150,000	Stock	4½%	* Do. 4½ per Cent. Debenture Stock (red.)	108 111	108 111	4 2 2	June and December	...	...
$1,200,000	$1,000	5%	Chicago Edison 1st Mort. 5% 30 yr. Gold Bonds (red.)	100 110	100 110	4 10 11	April and October	...	...
60,000	10	8/0	City of London Electric Lighting Ord.	10 11	10 11	3 12 9	February and August	10⅜	9⅞
40,000	10	6%	Do. 6 per Cent. Cumulative Pref.	12½ 13½	12 13	4 12 4	January and July	...	...
£400,000	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	122 127	122 127	3 18 9	June and December	...	...
40,000	10	8/0	County of London and Brush Prov. Ordinary	9½ 10⅛	9½ 10⅛	3 15 2	...	10¼	10⅛
20,000	10	6/0	Do. 6 per Cent. Cumulative Preference	12⅜ 13⅜	12⅜ 13⅜	4 8 11	March and September	13⅛	13
£200,000	Stock	4½%	Do. 4½% Deb. Stock Certs. (all pd.) (red.)	109 112	109 112	4 0 11	...	110½	...
15,000	5	10%	Kensington and Knightsbridge Ordinary	12½ 13⅝	12½ 13⅝	4 1 6	...	...	...
10,000	5	6%	Do. 6 per Cent. 1st Preference	7 7⅛	7 7⅛	4 0 0	January and July	...	...
110,000	3	...	London Electric Supply Ordinary	1⅜ 2⅛	1½ 2	...	...	1⅝	1½
48,050	5	3/0	Do. 6 per Cent. Preference	4⅜ 5	4½ 4⅝	6 6 4	...	...	...
£250,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures	100 102	100 102	3 19 3	Mar., June, Sept., Dec.	...	...
85,000	10	5/0	Metropolitan Elec. Supply Ord.	14 15	13½ 14½	3 9 0	April and October	14½	14
£220,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage	114 117	114 117	3 16 11	June and December	...	...
£125,000	Stock	2⅜	Do. 3½ per Cent. Mort. Deb. Stock (red.)	96 98	93 93	3 11 10	...	...	...
6,452	10	8/0	Notting Hill Electric Ordinary	15½ 16½	15⅜ 16½	4 4 10	March	...	...
10,000	5	5/0	Oxford Electric Ordinary	6½ 7	6⅜ 7	3 11 5	,,	...	...
300,000	1	8%	Rand Electric	⅜ ⅝	⅜ ⅝	10 13 4	...	...	...
£130,070	Stock	5%	River Plate El. Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb.	75 85	75 85	5 18 0	...	...	...
150,000	$100	$2	Royal Electric Company of Montreal Shares	170 190	170 190	4 5 1	...	...	...
£123,200	100	4½%	* Do. 4½ per Cent. 1st Mortgage Debentures	103 105	103 105	4 5 9	April and October	...	...
40,000	5	9/6	St. James's and Pall Mall Electric Ordinary	14½ 15½	14½ 15⅝	4 13 7	February and August	14⅛	...
20,000	5	3/6	Do. 7 per Cent. Preference	8⅝ 9½	8⅝ 9½	3 13 8	,, ,,	...	...
12,000	5	...	Smithfield Markets Electric Supply Ordinary	2¼ 2⅞	2¼ 2⅞	...	...	...	...
£50,000	Stock	...	Do. 4% Debentures	85 95	85 95	...	...	...	...
65,000	5	...	South London Electric Supply Ordinary (fully paid)	4 4½	4 4½	...	...	4½	...
79,900	5	8/0	Westminster Electric Supply Ordinary	14½ 15⅜	15 16	4 1 8	March and September	15⅜	15
			ELECTRIC MANUFACTURING, &c., COMPANIES.						
125,000	1	7½d.	Aron Electricity Meter 6 per Cent. Cum. Pref.	1/16 1/16	¾ ⅞	6 17 2	...	⅞	...
45,000	1	...	British Electric Works Co. Ordinary	⅝ 1	⅝ 1	...	...	17/16	17/16
50,000	1	...	Do. 5 per Cent. Cumulative Preference	⅝ 1	⅝ 1	...	...	...	...
£50,000	100	4½%	Do. First Mortgage Debentures	99 101	99 101	...	...	...	...
40,000	5	15/0	British Insulated Wire Ordinary	11 12	11 12	4 3 4	...	1⅜	...
27,500	5	3/0	Do. 6 per Cent. Preference	6 6½	6 6½	4 12 4	...	6⅜	...
100,000	5	...	British Westinghouse 6% Preference	4⅜ 5⅛	4⅜ 5⅛	...	...	...	...
90,000	2	1/2	Brush Electrical Engineering	1⅝ 2	1⅝ 2	4 0 0	September	...	...
90,000	2	1/2	Do. 6 per Cent. Pref. Non-Cum.	2⅛ 2⅜	2⅛ 2⅜	5 1 1	,,	2/16	2⅛
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Deb. Stock	103 113	103 113	3 19 8	February and August	114	...
£103,710	Stock	12/1	* Do. 2nd Debenture Stock (red.)	103 105	103 105	4 5 9	June and December	...	...
20,000	5	5/0	Callender's Cable Construction Ordinary	14½ 15½	14½ 15½	4 16 9	,, ,,	15/16	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5½ 6	5½ 6	4 3 4	...	...	...
£90,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb. (red.)	112 116	112 116	3 18 5	November and May	...	...
300,000	1	0/9⅜	Castner-Kellner Alkali Co. (fully paid)	1⅛ 1⅜	1⅛ 1⅜	5 14 5	...	1⅛	...
£150,000	Stock	7/1	Do. 4½ per Cent. First Mort. Deb. (red.)	...	99 102	4 8 3	...	...	...
60,000	1	0/7½	Chadburn's Ship Telegraph Ordinary	⅞ 1⅛	⅞ 1⅛	5 6 8	...	...	...
60,000	1	0/7½	Do. 6 per Cent. Cumulative Preference	⅞ 1⅛	⅞ 1⅛	5 6 8	...	...	...
32,098	3	1/9⅜	Crompton and Co. (Nos. 1 to 32,098)	3½ 4	3½ 4	4 10 9	January and July	3⅝	3⅛
£100,000	100	5%	* Do. 5 per Cent. First Mortgage Deb. (red.)	98 101	99 102	4 19 3	,, ,,	101⅛	...
60,000	1	0/7½	Davis and Timmins 6 per Cent. Cum. Pref.	⅝ 1⅛	⅝ 1⅛	5 6 8	...	...	...
99,261	5	1/9⅜	Edison and Swan United ("A" Shares) (£3 paid)	2 2⅛	2 2⅛	7 3 9	February and August	2⅛	2⅛
17,139	5	2/9⅜	Do. (£5 paid)	3½ 4⅛	3½ 4⅛	6 13 4	,, ,,	3⅝	3⅛
£344,023	Stock	4%	Do. 4 per Cent. Mortgage Deb. Stock (red.)	93 95	93 95	4 4 3	June and December	91⅛	...
26,100	5	5/11⅛	Edmundson's Electric Corporation Ord. (fully pd.)	4⅛ 5⅛	4⅛ 5⅛	5 14 3	Half-yearly	...	...
112,100	2	1/2⅛	Electric Construction Co. (Limited)	2⅜ 2⅝	2⅛ 2⅜	4 16 0	January and July	2⅝	...
25,000	2	2/9⅛	Do. 7 per Cent. Cumulative Preference	2⅛ 3⅛	2⅛ 3⅛	4 6 2	July	3	...
132,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	104 107	104 107	3 15 2	January and July	...	...
91,195	1	...	Elmore's Patent Copper Depositing	⅜ ⅝	⅜ ⅝	...	...	...	...
30,000	5	11 0	Henley's Telegraph Works Ordinary	13½ 14⅛	13½ 14⅛	3 15 10	February and August	...	...
30,000	5	1/3	Do. 4½ per Cent. Preference	5¼ 5⅝	5¼ 5⅝	3 18 3	,, ,,	...	...
£50,000	Stock	4½%	Do. 4½ per Cent. Mortgage Deb. Stock (red.)	110 114	110 114	3 18 11	,, ,,	...	...
50,000	10	10/0	India Rubber, Gutta Percha, &c., Works	21 22	21 22	4 11 10	,, ,,	21⅜	...
£300,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	100 103	100 103	3 17 6	March and September	...	...
37,350	12	24/0	Telegraph Construction and Maintenance	36 40	36 40	4 9 11	March and July	38⅛	36⅛
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909	102 105	102 105	3 16 2	...	...	...
20,000	5	3/0	Do. Manufacturing Ordinary	9½ 10⅛	9½ 10⅛	3 6 8	...	10⅞	10⅛
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5¼ 5⅜	5¼ 5⅜	4 6 11	...	...	...
30,000	5	5/0	Willans and Robinson Ordinary	12 13	12 13	3 9 3	April and October	10⅜	10⅛
30,000	5	3/0	Do. 6 per Cent. Cumulative Preference	7¼ 7¾	7¼ 7¾	3 17 5	,, ,,	...	...
£100,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Debentures	104 103	104 106	4 0 2	May and November	...	...
			ELECTRIC RAILWAYS, TRAMWAYS, &c.						
12,000	10	10/0	Blackpool and Fleetwood Tramways	17 18	17 18	4 8 11	...	...	...
£167,900	100	5%	Brisbane Tramway 5 per Cent. Debentures	104 106	104 106	4 14 4	...	...	...
50,000	10	8%	Bristol Tramways and Carriage Ordinary	22½ 23½	22½ 23½	3 3 10	February and August	...	...
25,000	10	4%	Do. Cumulative Preference (£5 paid)	8¼ 8⅝	8¼ 8⅝	...	...	...	...
£100,000	Stock	4%	Do. 4 per Cent. Debentures	117 118	117 118	3 8 5	...	...	...
12,000	10	...	British Columbia Electric Railway 5% Pref.	10¼ 10⅜	10 10½	...	...	...	...
30,000	10	9/0	British Electric Traction Ordinary (Nos. 1 to 30,000)	17 18	17 18	3 6 8	...	17 11/16	17½
£15,000	10	...	Do. (Nos. 60,001 to 75,000)	16½ 17⅜	16½ 17⅜	...	...	16¾	...
50,000	10	6/0	Do. 6% Cum. Pref. (Nos. 30,001 to 60,000)	12¾ 13¼	12¾ 13¼	4 11 7	...	13⅜	12⅝
£200,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures	124 127	124 127	3 18 9	...	...	...
40,000	5	1/9	Buenos Ayres & Belgrano 6% "A" Cum. Pref.	4⅝ 5⅛	4⅞ 5⅛	5 17 1	...	...	...
27,500	5	...	Do. "B"	4 4⅛	4 4⅛	...	...	4⅛	...
320,000	Stock	5%	Do. 5 per Cent. Debentures	105 108	105 108	4 12 7	...	...	...
213,553	10	3/0	Central London Ordinary	10¼ 10⅜	10¼ 10⅜	2 15 10	June and December	10⅜	...
£855,000	Stock	1½%	City and South London Railway Con. Ordinary	67 70	67 70	2 13 11	January and July	...	...
37,500	10	...	Do. (Nos. 22,501 to 60,000) (£5. 10s. paid)	6 7	6 7	...	...	...	...
£150,000	Stock	5%	Do. 5 per Cent. Perpetual Preference (1891)	140 145	140 145	3 9 0	January and July	...	...
x200,000	Stock	5%	Do. (1893)	132 137	132 137	3 13 0	...	...	...
£187,701	Stock	4%	Do. 4 per Cent. Perpetual Debenture	125 130	125 130	3 1 11	May and November	...	...
20,000	10	8½%	†Imperial Tramways Ordinary	22½ 23½	22½ 23½	3 6 8	March and September	...	...
10,000	10	6%	† Do. 6 per Cent. Preference	14¼ 15¼	14¼ 15¼	3 17 5	,, ,,	...	...
£100,000	Stock	4½%	† Do. 4½ per Cent. Debentures	113 115	114 115	3 17 11	January and July	...	...
30,000	10	1/3	Kidderminster & District E. L. & Tr'ct'n 5% Pref.	10 10⅜	9½ 10½	4 15 3	May and November	...	...
37,500	10	2½%	Liverpool Overhead Railway Ordinary	8¼ 8⅝	8¼ 8⅝	4 4 6	February and August	...	...
10,000	10	5%	Do. 5 per Cent. Preference	13¼ 13⅝	13¼ 13⅝	3 14 1	,, ,,	...	...
125,000	Stock	4%	Do. 4 per Cent. Debenture	105 107	105 107	3 15 4	January and July	...	...
24,000	5	...	New General Traction Ordinary	3¼ 4¼	3¼ 4¼	...	...	...	...
30,000	5	6/0	Do. 6 per Cent. Cumulative Preference	5 5⅛	5 5⅛	5 9 1	May	5¼	...
4,000	10	...	Oldham, Ashton and Hyde Elec. Tramway Ord.	16 18	16 18	...	February and August	...	...
4,000	10	5/0	Do. 5 per Cent. Preference	10⅜ 10⅞	10⅝ 10¾	4 13 0	,, ,,	...	...
13,334	10	...	Potteries Electric Traction Ordinary	11⅛ 12⅛	11⅛ 12⅛	...	...	...	...
20,000	10	5/0	Do. 5 per Cent. Cumulative Preference	10 11	10 11	4 10 11	...	10	...
£540,000	Stock	3%	Waterloo and City Ordinary	101 104	101 104	2 17 8	June and December	102¼	102

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption.
† The London Stock Exchange Committee refuses to quote these.

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THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,144. [No. 28, Vol. XLIV.] FRIDAY, APRIL 20, 1900. PRICE SIXPENCE (by post, 6½d.), Abroad, 8d., or 15 cents, or 2 Mk., or 10 fr.

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NOTES.

The Paris Exhibition of 1900 should be an event of some importance in the electrical world, if only one-half of the abundant promises of the display of new inventions and new designs are to be fulfilled. The opening of the exhibition on Saturday last, however, was not of much importance to the electrical profession, for it appears that the electrical sections of the exhibition are still in a very incomplete state. Although the electrically-driven moving platform was in operation, other portions of the electrical installation were not finished, and the exhibition has to be closed at dusk, for lack of electric light.

A telephone subscriber living on the Bedford estate, has received the following letter from the National Telephone Co.'s district manager, and as it is on a matter of public interest, has forwarded it to *The Times*:—

Dear Sir: I regret to inform you that the lessees on the Bedford estate, who for many years have granted the company wayleaves, are now being compelled by the estate authorities to give notice to the company terminating their agreements, with the only alternative of an absolutely prohibitory payment to the Bedford estate for wayleave rental. Under these circumstances the company, unless this arrangement can be modified, will have no option but to remove the whole of the wires, and I think it only right to call your attention to this at the earliest possible moment, so as to enable you to make whatever arrangements may be necessary.

I can assure you that it is with the greatest regret that the company will have to put you to this inconvenience, but, owing to the refusal of the London County Council to allow further underground work and the Bedford estate to allow overhead wires on reasonable terms, I see no prospect of being able to continue the service to you.

It is generally recognised that the National Telephone Co. is in a precarious condition as regards wayleaves in the Metropolis, and the opponents of the company have now all recognised that this weak point is the one at which to direct their attack in order to render it most effective. But the London County Council are not acting fairly towards their ratepayers, nor are the owners of the Bedford estate acting fairly towards their tenants, if they are depriving them of a telephone service before an alternative one is available. We published at the time the terms offered by the London County Council for underground wayleaves—viz., that the company should undertake to give a service at the same rates as their competitor the Post Office, and afford free use of their system by Post Office telephone subscribers, while the payment of 10 per cent. royalty to the Post Office must of course continue. It will be interesting to hear what are the terms which the Bedford estate authorities seek to impose, and whether the company is right in regarding them as "absolutely prohibitory."

There lies before us an advanced copy of the prospectus of the Johnson-Lundell Electric Traction Co., subscriptions for which are to be invited between Monday and Wednesday next week. In an article on another page we describe the technical aspects of this new financial venture, the authorised share capital of which is £300,000 in £5 shares. The vendors are to take 20,000 shares in part payment—16,000 of which temporarily rank for dividend only after 10 per cent. has been paid on the remaining shares: the balance of the purchase money being £100,000 in cash; so that no less than two-thirds of the total capital is to be paid to the vendors, the property acquired being patent rights alone. With a working capital of only £100,000 the company purposes to carry out the necessary operations for the development of its patents in Great Britain, the Continent of Europe, and all the British colonies except Canada. Although the company owns patents of a dynamo possessing valuable novel features, a considerable portion of the acquired property consists in the patent rights, for these countries, to a practically untried system of closed-conduit electric traction. Except for a short experimental line tried for a few months in New York, this system has not yet been worked anywhere; its commercial utility is therefore highly problematical. The main defect in the proposed flotation, in our opinion, is the small proportion of working capital.

Our esteemed contemporary, the *Journal of Gas Lighting*, ever has been solicitous for the welfare of electric supply consumers. Its latest anxiety is lest there should be any dis-

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crimination between them. Abhorrent of the least suspicion of "preferential charging," it lustily waves a danger flag over the remarks we made recently on Mr. WRIGHT'S maximum demand system. It recalls that it has itself often stigmatised the system as a "dodge." Not that aught but the most disinterested concern for the welfare of electricity consumers agitates the breast of our contemporary. "The gas industry," it declares, "would not, however, suffer harm from the cheapest possible electricity." From this lofty pedestal it warns all whom it may concern that "there are such things as injunctions, and the Board of Trade may wake up one fine morning and put a stop to all fancy methods for making one man pay more for his electricity than his neighbour and fellow,"—another reason, if true, why electric light men should dislike fine mornings. But the Board needs not to be digged in the ribs by our contemporary's flag-stick: it shows itself to be very wide awake already. Nor need any electrical engineer of the more timid sort be frightened by all this display into believing that he is trespassing where he will be prosecuted according to the law. The maximum demand system is not being used slyly in a corner, it has spread throughout the length and breadth of the land, and the Board of Trade knows all about it.

MEANWHILE inventors are busily engaged in devising new and improved "maximum demand" indicators, and the public is steadily appreciating the advantage of this system of charging. One such invention is described in an article this week, and is the result of much careful experimenting and thought on the part of its inventor, Mr. E. C. RIMINGTON. The action of this indicator is not directly electrical, but consists in utilising the pressure of the escaping gases evolved in the house meter, this latter being essentially, of course, electrolytic. As a consequence, absolutely no electrical energy is consumed by the demand indicator, a fact which gives it a tremendous advantage over other indicators. We wish Mr. RIMINGTON success with his ingenious invention.

Opening of a New Berlin Electric Tramway.—An electric tramway connecting the extreme north with the extreme south of Berlin was opened on Sunday last. The length of the line is 9·2 miles.

The Society of Chemical Industry.—The annual general meeting of the Society will be held in London in July next. In view of the projected visit of the New York section of the Society, efforts are being made to entertain suitably the visitors, and a provisional programme has already been formed.

Erratum.—In our editorial notes on the Barmen-Elberfeld single-rail overhead railway, in last week's issue, we inadvertently stated that this line had been built by Messrs. Siemens and Halske. This should have been the Continentale Gesellschaft für Elektrische Unternehmungen, in conjunction with Messrs. Schuckert and Co., of Nuremberg.

Cable Interruptions:—	Date of Interruption.
Latakia—Cyprus	June 21, 1899
Cayenne—Pinhieros	Oct. 11, 1899
Tangier—Tarifa	Jan. 3, 1900
Paramaribo—Cayenne	Feb. 16, 1900
Ceara—Maranham	Feb. 20, 1900
Para—Maranham	Mar. 2, 1900
Môle-St. Nicolas—Cap Haitien	Mar. 7, 1900
Trinidad—Demerara	Mar. 30, 1900
Manila—Iloilo	April 9, 1900

Australasian Cable Tariffs.—The Eastern Extension Australasia and China Telegraph Co. announce that an agreement has been concluded with the Governments of South Australia, Western Australia and Tasmania for the establishment of direct cable communication between South Africa, Perth and Adelaide, and for the reduction, on May 1, of the telegraphic charges between the contracting colonies and Great Britain to 4s. per word for ordinary messages and 1s. 4d. per word for Press telegrams. The existing tariffs will remain unchanged for telegrams exchanged with the other Australasian colonies.

Electric Motors for Power Purposes.—At a recent meeting of the American Society of Mechanical Engineers the question of what size of tool might advantageously have an individual electric motor was discussed. Prof. Jackson stated that all large tools or machines, requiring 5 H.P. to 7·5 H.P. and over, should have independent motors, while smaller tools or machines requiring less power should be grouped and driven from a motor-driven shaft. These groups should be arranged so that a motor of not less than 3 H.P. to 5 H.P. nor more than 10 H.P. to 15 H.P. is required. We think Prof. Jackson's rules are too sweeping. Practice is far from settled on these points.

Death by Lightning.—An unfortunate fatality occurred at St. Mary Cray, Kent, on Easter Monday, to a ship's officer named Davies. It appears, from the evidence adduced at the inquest, that the deceased attended a football match, during the course of which a thunderstorm arose, and the flagstaff of the grand stand was struck by lightning, killing Davies and dazing a few others in his neighbourhood. Subsequent examination revealed the fact that deceased was badly scorched about the body and down the right leg. Most of the money in his right-hand trousers pocket was melted, as also was his collar stud. Death was nearly instantaneous, Davies surviving but a few minutes after being struck.

International Electricity Congress at the Paris Exhibition.—A strong committee of French electricians has been formed to arrange the programme of the congress to be held in Paris from August 18th to 25th. The congress is to be divided in five sections, the programme for each of which is left in the hands of the small sub-committee given below:—I. Scientific Methods and Measurements, MM. Hospitalier, Janet and Pellat. II. Generation of Electric Energy, Transformers, Transmission and Distribution, Electric Lighting and Traction, MM. Hillairet, Meyer, Postel-Vinay and Violle. III. Electrochemistry and Electrometallurgy, Storage Batteries, Electric Furnaces, MM. Bouilhet, Moissan and Monnier. IV. Telegraphy, Telephony, &c., MM. Darcq, de Nerville, Sartiaux and Vivarez. V. Electrophysiology, MM. D'Arsonval, Gariel and de la Touanne. The final programme will be drawn up at the meeting of the Council of the Congress on April 28, before which date notice of intending contributions must be sent in to one of the members of the sectional committee named above.

A New Development in Electro-Metallurgy.—Swiss engineers, though so successful in the manufacture of various classes of machinery, labour under the disability that practically the whole of the iron employed, valued at over two million pounds annually, has to be imported from Germany and elsewhere. This is due, not so much to the absence of iron ores within their boundaries as to the want of coal wherewith to smelt it. Recent researches in electrometallurgy promise a means of overcoming the defect, and a scheme for the application of the electric furnace to the smelting of iron on the large scale is being developed by Herr Müller Landsmann in the Bernese Oberland, near Meiringen. A concession has been obtained from the State for the working of an outcrop of hæmatite. The vein has a thickness of 7ft., and is visible for a length of two miles along the mountain face. Thence the ore will be transported by an aerial ropeway to Innertkirchen below. The concession obtained for the water power available from the Aar in the immediate neighbourhood, amounting to 60,000 H.P. will be used to drive the machinery required, and to supply the power for the electric smelting furnaces.

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The Mechanism of the Coherer.—Herr Joh. Härdén publishes in the *Elektrotechnische Zeitschrift* of April 5th, an account of some experiments to ascertain the precise action that takes place when a coherer is under the influence of electric waves. His experiments, however, do not throw much light upon this interesting matter. He employed a coherer consisting merely of two steel points, and observed it through a microscope. When at a distance of 0·3mm., sparks passed between them while the neighbouring oscillator was in operation; but no current flowed through the battery and galvanometer circuit, which evidently remained interrupted by the coherer. It was not until the points were approached to within 0·006mm. of one another that a deflection (corresponding to 150 milliamperes) was obtained. With this distance between the points, as soon as the spark occurred, a dark bridge was seen to have formed across the gap. This could be clearly seen with a microscope magnifying 800 times and against a background of white paper. As soon as this bridge appeared the sparking ceased. The bridge remained and the deflection of the galvanometer continued practically constant, until the coherer was shaken.

Wireless Electrical Transmission.—As is well known, Mr. Nikola Tesla has been giving much attention and time lately to the problem of transmitting electric energy between distant points through the air. A patent was issued in the United States to that gentleman on March 20th, which relates to the production at one point of an electrical pressure of such character and magnitude as to cause thereby a current to traverse elevated strata of the air between the point of generation and a distant point at which the energy is to be received and utilised. As illustrated, the apparatus consists of a generator supplying current to the primary of a transformer: the secondary consists of many turns, and is connected at one side to the earth and at the other side to a terminal of large surface maintained by such means as a balloon at a high elevation. The receiver duplicates this apparatus, except that instead of a generator being in one circuit of the transformer, receiving devices such as lamps and motors take its place. The transformer consists of a coil of very large diameter wound in spiral form, either with or without magnetic core. The inventor claims that this furnishes a practical method or system of transmission of energy through natural media without the use of wires.

Consolidation of Bell Telephone Interests.—The annual meeting of the American Bell Telephone Co. was held in Boston last month, when the stockholders ratified the recommendation of the directors that the company be absorbed by the American Telephone and Telegraph Co. The latter company (known as the Long Distance Co.) owns the lines connecting almost all the large cities and towns in the United States lying east of Omaha and Kansas City. The shareholders of the Bell Co. will receive two shares of the stock of the Long Distance Co. for each one share of the stock of the Bell Co. The Bell Co. now owns substantially all the stock of the Long Distance Co. The chief advantage to be derived from this plan is the power to consolidate with or hold stock in connecting or subordinate companies, the statutes of Massachusetts limiting the Bell Co. in this respect. The annual report of the American Bell Telephone Co., which was read at the same meeting, shows net earnings applicable to dividends of $4,072,949, a decrease of $321,017 as compared with last year. These net earnings are equivalent to 15·8 per cent. on the $25,886,300 of stock outstanding as against 15 per cent. paid. These are not the entire earnings of the company, but only such earnings as accrue from the rentals of telephones and come in from the dividends paid by the subcompanies.

The Institution of Civil Engineers.—At the ordinary meeting on the 10th inst. two Papers were read. In the first of these, on "The Development of the Manufacture and Use of Rails in Great Britain," by Sir Isaac Lowthian Bell, the author traced the history of the development of wrought-iron and steel manufacture, with particular reference to its employment for rolling into rails. The loss of weight of iron and steel rails due to wear, and also the circumstances which influence the rapidity of the disappearance of carbon and phosphorus from the liquefied metal were referred to. The author also commented on the irregularity in the strength of rails produced from Bessemer steel. Tests of rails, by fracture under a falling weight, were given, and rails rolled from the upper, middle, and lower parts of the ingot were thus compared, and also by chemical analysis. An experimental investigation of the deflection of rails at various speeds of the train tended to prove that the deflection, and therefore the pressure on the rail, diminished as the speed increased. In the second Paper, on "The Wear of Steel Rails in Tunnels," by Mr. Thomas Andrews, F.R.S., the effects of the deteriorating influences peculiar to rails laid in tunnels were investigated. Among these were the increased corrosion of the surface of the rail, due to the action of moist chemical vapours, and the increased chemical action of the ballast on the foot of the rail. The author had made a careful examination of a rail which had been laid in a tunnel for seven years, and had carried main-line traffic during this time without fracture. The tunnel was about 1,000 yards in length, and was situated fairly near the sea coast. It lay in a direction nearly north and south. This fact was pointed out, as the author had observed indications that magnetisation exerted an influence tending to increase the corrosibility of steel in certain solutions. The results of this examination were given with reference to the mechanical, chemical and physical changes which the rail had undergone during its life in the tunnel. The rail, which originally weighed 84lb. per yard, lost weight at the rate of 2·81b. per yard per annum, and on the face the rail had worn down to the extent of §in. Chemical analysis showed that sulphur was present in considerable excess; the physical tests showed a very good result, the strength of the metal being normal, and an elongation of 27 per cent. being obtained. To obviate the excessive wear of rails in tunnels, he advocated the employment of a heavier section of rail, with a wider wearing surface. He also thought that, as a general rule, rails in tunnels should only be allowed to remain in the permanent way for one-half (or in some cases only one-third) of the time that is usually allowed for the ordinary use outside tunnels.

MEETINGS OF SCIENTIFIC AND ENGINEERING SOCIETIES, &c.

MONDAY, April 23rd.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Special Meeting, when Sir William H. Preece, F.R.S., will deliver the eighth "James Forrest" Lecture, the subject being "On the Relations between Electricity and Engineering." For the convenience of members and their friends the lecture will be repeated on the 24th inst., at 4 p.m.

TUESDAY, April 24th.

INSTITUTION OF CIVIL ENGINEERS.

4 p.m. Repetition of "James Forrest" Lecture by Sir William Preece.

THURSDAY, April 26th.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture I.: "A Century of Chemistry in the Royal Institution," by Prof. Dewar.

INSTITUTION OF MECHANICAL ENGINEERS.

8 p.m. Ordinary General Meeting at Storey's Gate, S.W. Paper to be read: "Road Locomotion," by Prof. H. S. Hele-Shaw, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary General Meeting. Paper to be read: "The Electric Transmission of Power," by Prof. George Forbes, F.R.S.

FRIDAY, April 27th.

PHYSICAL SOCIETY.

8 p.m. Ordinary Meeting in the Solar Physics Observatory, Exhibition-road, South Kensington. Agenda: (1) A Short Account of the Physical Problems now being investigated at the Solar Physics Observatory and their Astronomical Applications, by Sir Norman Lockyer, F.R.S.; (2) Weather permitting, the 36in., 10in., and 9in. telescopes will be used for the observation and photography of celestial objects and their spectra. The Apps-Spottiswood coil and 21ft. Rowland grating will also be in operation.

ROYAL INSTITUTION.

9 p.m. Evening Discourse by the Rt. Hon. Lord Kelvin, F.R.S., o "Nineteenth Century Clouds over the Dynamical Theory of He and Light."

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ELECTROMAGNETIC THEORY.—CXIV.*

BY OLIVER HEAVISIDE.

(*Continued from p. 774.*)

§ 460. An extension of the case represented by Fig. 10 may be arrived at in a different way. In Fig. 12 are shown two pure impulsive waves crossing one another. The magnetic force H is up through the paper in one wave and down in the other; both are equally intense. There is nothing abnormal. Remembering, however, that the waves move perpendicular to their planes at speed v, it follows that their line of intersection moves from left to right at speed u given given by $v = u \sin\theta$, where θ is the angle between D and the line of motion. Next, we may regard the line of intersection as consisting of two coincident equally and oppositely electrified lines, charged to linear density $\pm 2D$, if D is the strength of the impulsive waves. This is merely a truism, because they annul one another. What is not a

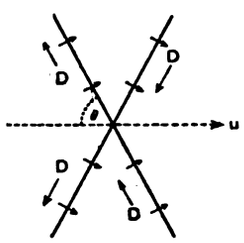

Fig. 12.

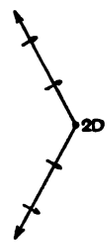

Fig. 13.

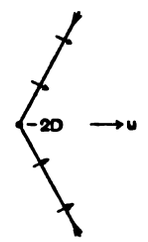

Fig. 14.

truism, however, but a striking fact, is that if we separate the two charges and the waves from one another, producing the two states shown in Figs. 13, 14, these states are separately possible.

Here it may be recognised that Fig. 13 shows the case before considered, Fig. 10, involving the generation of plane waves by an electrified line (or plane) moving at speed u, by force applied to the moving electrification acting from left to right. In Fig. 14, on the other hand, the waves advance towards one another, and are continuously destroyed at the moving electrified line. The force due to the stress tends to push the electrification along faster; so, to maintain the state steadily, an applied force pulling back the electrification is required. Without this applied force the tendency will be to make the two waves into one, since the force due to the stress will decrease. But this will not take place in any simple manner.

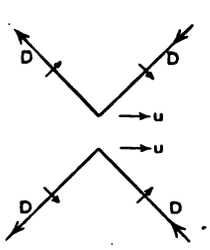

Fig. 15.

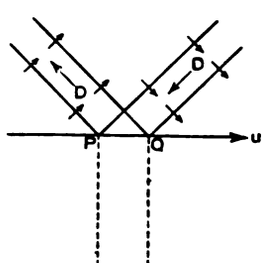

Fig. 16.

In Fig. 13 the charge may be negative, and in Fig. 14 it may be positive. Both E and H are then to be reversed, u remaining the same. The important distinction between Figs. 13 and 14 is merely that the former arrangement can arise from rest naturally, as before explained, whereas the latter needs some more artificial initial conditions.

Here is another way of splitting the crossed pure waves of Fig. 12:—In Fig. 15 there is no electrified line in either case. To interpret, consider the upper pair of waves, and expand to slab waves, as in Fig. 16. We see that there is no H in the overlapping region, and that the displacement is tangential therein. The tangential electric force is $2E\cos\theta$ from right to left. This is the measure of f, the curl of e on the surface PQ. That is, PQ must be a plane f source (say due to intrinsic electrisation), moving at speed u in its own plane. Similar remarks apply to the lower pair of waves in Fig. 15. But since one wave is in advance of PQ, neither of the cases in Fig. 15 can arise from rest in static condition.

§ 461. Closely connected with Fig. 16 is the case arising by turning D to B therein. No separate figure is needed. There is now no E in the overlapping region, and the induction is tangential, since it goes down one wave and up the other. The magnetic force at PQ is $2H\cos\theta$. There are two interpretations. First, PQ may be a portion of a stationary perfect electric conductor. Then the right wave is incident and the left wave reflected. Secondly, PQ may be a plane g source (curl of h, or intrinsic magnetisation), moving from left to

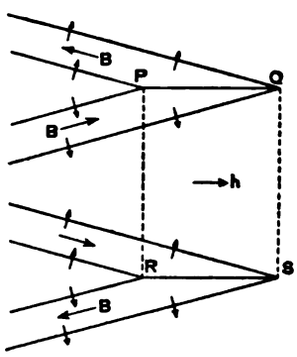

Fig. 17.

right at speed u. The dotted lines may represent the two sides of a slab magnetised parallel to u. Here, however, one wave is in advance of the moving slab, so some special initial state is required.

To substitute a state which could arise from rest naturally, have both waves behind the g source, as in Fig. 17. First of all, consider the top part only. The two waves have B normally continuous at PQ, which is right and proper. D is fully continuous there, but the tangential discontinuity in H at PQ is measured by $2H\cos\theta$. This is the measure of the surface density of the moving g source. There are many ways of developing this problem. The one shown in Fig. 17 concerns a magnetised slab moving in the direction of its magnetisation at speed u. The dotted lines show the forward and backward faces of the slab, magnetised from left to right, $h = 2H\cos\theta$. PQ and RS are its top and bottom sides, the seat of the g sources. They are equal but oppositely directed—viz, up through the paper on PQ and down on RS.

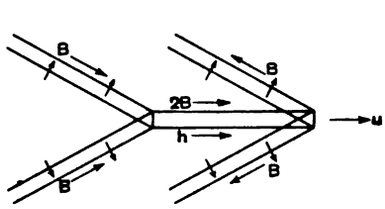

Fig. 18.

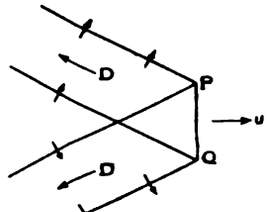

Fig. 19.

Such a magnetised slab, moved in the way indicated, will ultimately tend to have its induction distributed in the way shown—viz., in two pairs of pure electromagnetic waves, which are being continuously generated by the g sources through the agency of force (Newtonian) applied to the slab. The amount of this force has been given before equivalently, since it is determined by the speed and the density of energy (or the stress) and the depth of the wave. Double as much is wanted here, because there are two pairs of waves. The induction is shifted altogether out of a part of the magnet. That is nothing. More important are the reservations. The inductivity μ of the magnet must be the same as that of the ether. If different, the waves are not so simply calculated, though the general ideas are the same. And no allowance at

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all is made for any disturbance from rest of the ether itself due to the motion of the magnet. We do not know that such disturbance exists. And the magnet must be non-conducting.

At the speed $u=v$, Fig. 18 makes the longitudinal induction 2B be accompanied by terminal impulsive waves perpendicular to it. On the other hand, Fig. 17 apparently gives nothing when $u=v$. But take u a little greater than v, and it will be found that the overlapping of the waves in Fig. 17 leads to exactly the same result as Fig. 18, both inside and outside the magnet.

An interesting modification is got by decreasing the depth PR or QS till the magnetised slab becomes a plate moving in its own plane, and the waves in Fig. 17 overlap and cancel so much as to produce an apparently different case. The result is shown in Fig. 18. The plate, magnetised from left to right, moves from left to right. The induction total 2B is uniformly distributed along the magnet, but splits into two plane waves at the north and south poles.

We must not take one pair of waves by itself and ignore the rest of the arrangement, because the induction has no divergence in reality. But we may equivalently realise this process by turning B to D. We then obtain Fig. 19, wherein PQ is an electrified strip moving normally to its plane. This, of course, can be considered a development of the case of the transverse motion of a electrified line. There are, additionally, some interesting points to notice. Thus, there is no H in the overlapping region, where the displacement is normal to PQ. That is, there is no H all along PQ. Yet there is convection current there, of course. Also the current density is the curl of the magnetic force. There is, superficially, a contradiction.

The true current is $\dot{\mathbf{D}}+\mathbf{u}\,\mathrm{div}\,\mathbf{D}$, the sum of the displacement current and the convection current. This is zero along the strip PQ, because one term is the negative of the other.

If a is the breadth of the strip, the applied force is

$$\mathrm{F}=\tfrac{1}{2}a\frac{(2\mathrm{D}\cos\theta)^2}{c}$$

per unit depth perpendicular to the paper. Notice that this is finite at any speed, even up to $u=\infty$, when the two waves merge into one, containing no H. The tubes of displacement then simply grow longer at their ends upon PQ.

§ 462. In the previous, the moving source generates two plane waves, or else is accompanied by these without generation. But we may easily arrange matters so that only one terminated plane wave is generated. This brings us to a new class of problems—viz., concerning double sources with one wave, instead of two waves with one source.

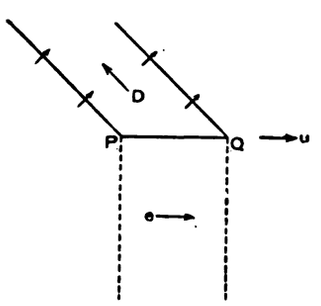

Fig. 20.

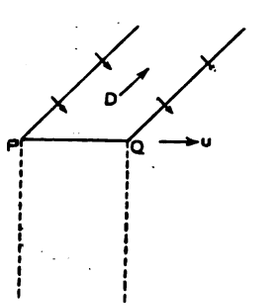

Fig. 21.

Consider Fig. 20 for example. There is supposed to be a single plane pure wave terminated at PQ, where it is continuously growing. What sources are required? The normal displacement is D sin θ. Therefore this is the surface density of electrification on PQ moving at speed u. But, in addition, the tangential electric force is E cos θ. This indicates the surface density of an f source. So PQ may be the end of a non-conducting slab (sides indicated by dotted lines) electrised to density ce, where $e=\mathrm{E}\cos\theta$; the direction of e being parallel to PQ. By itself this moving slab would produce a pair of waves. The electrification on PQ, however, by itself would also produce two waves; the same as f does above, but oppositely below. So the resultant effect is one wave only.

In Fig. 21 the electrification is the same, but the electrisation is reversed. Also, as the wave is being destroyed, and is an advance of PQ, a special initial state is required, whereas the case of Fig. 20 could arise naturally from rest, if no infinite resistance is met with in the transition from speed 0 to u.

If the waves are underneath PQ, there are similar interpretations.

If we change D to B, then e is changed to h, or the slab must be intrinsically magnetised. But then the electrification is changed to magnetification. So this imagined single wave is physically unreal.

When the slab is of finite depth let it be positively electrified on the top and also positively beneath, as in Fig. 22, besides being electrised in the direction of motion. There is no E or H inside the slab. By reducing the depth till the slab becomes a mere thin sheet the result is the same as Fig. 10, concerning the motion of a single sheet of electrification in its own plane. This is because the effect of e ultimately vanishes, and the two electrifications unite to make one. In fact, Fig. 22 shows how to separate the two waves in Fig. 10.

Although nearly all the above has been descriptive, yet the demonstrations of the various propositions have not been omitted. They all rest upon the simple properties of plane waves which were proved at the beginning, together with the general connections of E and D, H and B, e and h, &c., direct and crosswise. These are to be understood all along, in the way explained in Chap. II., Vol. I., especially the early part. When understood, the satisfaction of the proper conditions at the junctions becomes visible by inspection, and no repeated formal demonstrations are needed.

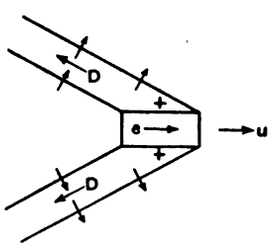

Fig. 22.

In electrostatics the lines of force are perpendicular to the equipotential surfaces. But if the charges be set in steady motion, the distribution of displacement is so changed as to reduce the angle between the lines of force and the new equipotential surfaces, the electric force being derived from the potential in an eolotropic manner. As the speed increases the angle between the lines of force and the surfaces decreases, until at the speed of light the lines lie in the surfaces. And after that? In all the above diverging plane waves the lines of force lie in the equipotential surfaces. But this requires some mathematics for its explanation.

(To be continued.)

THE RIMINGTON MAXIMUM DEMAND INDICATOR.

During a visit recently to Mr. E. C. Rimington's well-equipped testing laboratories in Queen Victoria-street, London, E.C., we had an opportunity of inspecting an entirely new form of maximum demand indicator perfected by him. This indicator is designed to work in conjunction with the Bastian electrolytic meter described in *The Electrician*, Vol. XLI., pages 104, 112 and 138; in fact, it is being placed on the market by the Bastian Meter Co., of Kentish Town.

In principle, the Rimington demand indicator is extremely simple, and it is satisfactory to learn that its working is accurate and reliable. Fig. 1 shows the general construction of the indicator, together with the mode of attaching it to the Bastian meter. The indicator consists of an U tube, A A', one limb of which is connected by a flexible tube to a glass tube K, sealed into the top of the electrolytic meter in such a way that the evolved gases are carried off through this tube. The other limb is provided at its upper end with a porous plug G, the purpose of which is to act as a damper upon too violent movement

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of the liquid contained in the lower part of the U tube. At the upper end of the limb A another porous plug, C, is connected in such a way that the evolved gases escape through this plug. Thus the rate at which these gases are evolved determines the pressure of the gas in this part of the tube, and this rate is, of course, proportional to the current passing through the meter. The effect of this pressure is to force the liquid down in the limb A and correspondingly to raise it in the limb A'. All the liquid raised above a certain point in the limb A' overflows into a vertical tube hanging at a point D, and this tube is provided with a by-pass, H, to allow of the free escape of air displaced by the liquid flowing into it. The maximum current passed through the Bastian meter therefore is indicated by the height of the liquid in the vertical tube just referred to, and may be read off against a scale placed beside that tube. Fig. 2 shows the demand indicator complete and as attached to the electrolytic meter.

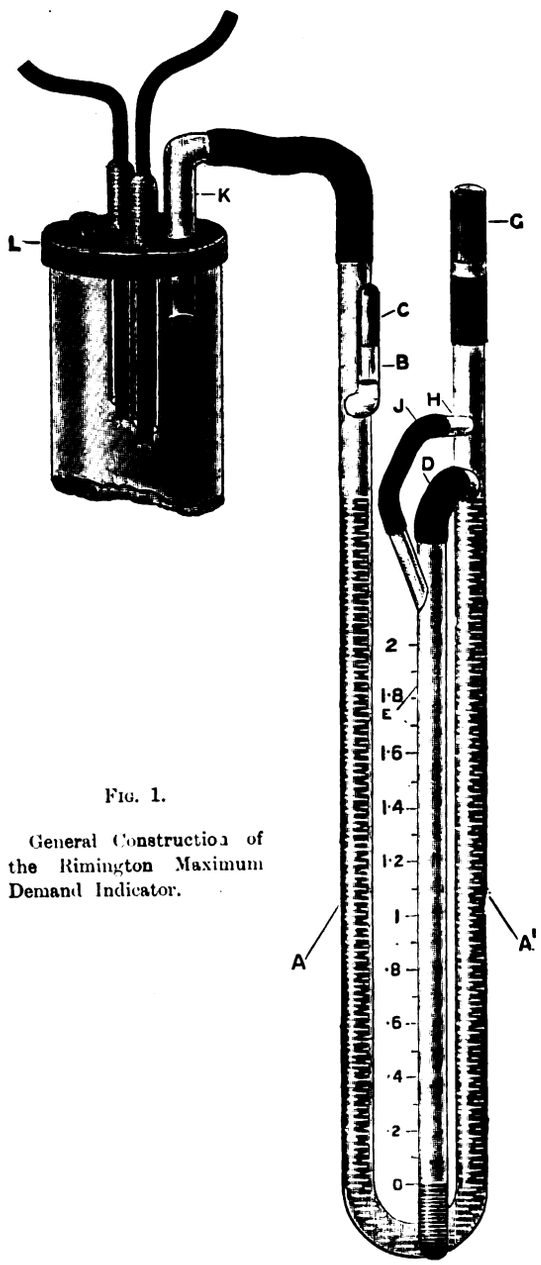

Fig. 1.

General Construction of the Rimington Maximum Demand Indicator.

Among the advantages of this simple form of demand indicator are its compactness and cheapness of construction, the readiness with which it can be set and the reading taken, the perfectly uniform scale, the fact that there is no temperature error in the working of the indicator, and last, but by no means least, the saving arising from there being no electrical energy consumed in the indicator. The plug G is also an advantage inasmuch as it can be graduated so as to provide any required amount of time lag in the working of the indicator. Thus, if it is desired to allow a longer interval before the maximum current is recorded, it is only necessary to increase the throttling due to this plug. We may add that the indicator is constructed in various forms to suit circuits of different voltage, and generally can be adapted to all the various systems of electrical supply.

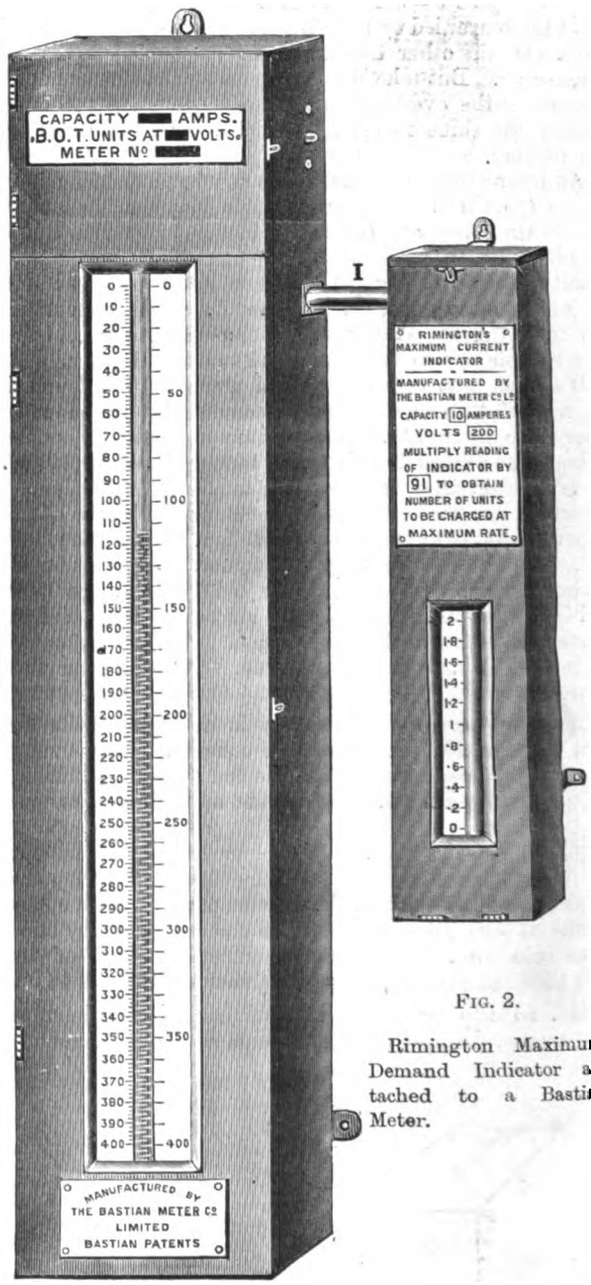
CAPACITY ■ AMPS.
B.O.T. UNITS AT ■ VOLTS.
METER Nº ■
I
RIMINGTON'S MAXIMUM CURRENT INDICATOR
MANUFACTURED BY THE BASTIAN METER Co LD
CAPACITY 10 AMPERES
VOLTS 200
MULTIPLY READING OF INDICATOR BY 91 TO OBTAIN NUMBER OF UNITS TO BE CHARGED AT MAXIMUM RATE
MANUFACTURED BY THE BASTIAN METER Co LIMITED BASTIAN PATENTS

Fig. 2.

Rimington Maximum Demand Indicator attached to a Bastian Meter.

JOHNSON-LUNDELL ELECTRIC TRACTION PLANT.

On Tuesday last, Messrs. L. W. Holmes and E. H. Johnson invited a party of engineers and press representatives to luncheon at the Hotel Cecil, and described the Johnson-Lundell electric traction plant which is shortly to be put on the market in this country. The system which the Johnson-Lundell Co. are introducing includes a generator of recent design, in which the armature reaction is compensated by a deviation from the usual shape of pole-pieces, a motor and controller claimed to possess considerable advantages over the present types, and a surface-knob distributing system. The dynamo, motor and controlling system are the invention of Mr. Robert Lundell, of New York, and the surface-knob system has been worked out by this gentleman in conjunction with Mr. E. H. Johnson.

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The Lundell generator has already been alluded to in our columns (see *The Electrician*, Dec. 22, 1899, p. 308). As is well known, the current through the armature of a dynamo causes a distortion in the field, this distortion varying with the current flowing through the armature. A glance through a file of *The Electrician* or the *Proceedings* of the Institution of Electrical Engineers will show that considerable attention has been devoted to this effect during the past 10 or 15 years, and that from time to time means have been tried—with varying degrees of success—to compensate this distortion in order to render the machine sparkless and to obviate moving the brushes as the load varies. Mr. Lundell, as

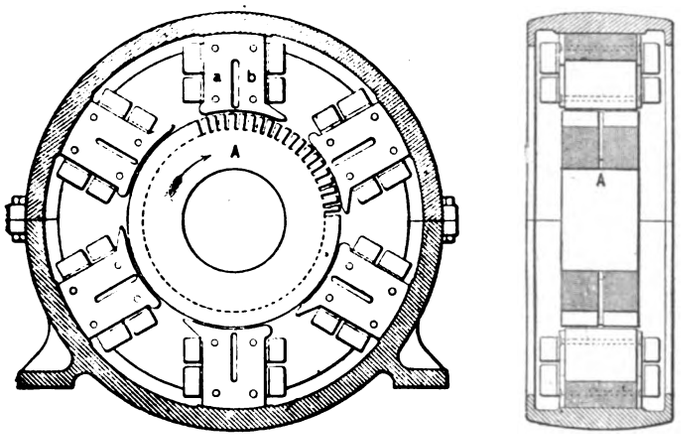

FIG. 1.—Cross Sections of Lundell Dynamo.

several of his predecessors have done, applies his remedy to the magnetic circuit, and retains the ordinary armature winding. The core of each of the field magnet poles is divided by an air-gap into two parts of practically equal cross-section, but while the side from which the armature coil approaches has only a slight polar extension, the other side is provided with the long wedge-shaped projection, seen in Figs. 1 and 2, which faces therefore a much greater surface of the armature core. So long as the magnetising current is only small, the magnetic lines of force are distributed equally over the two parts of the polar surface, and consequently the induction (*i.e.*, the number of lines per square inch) in the core itself is

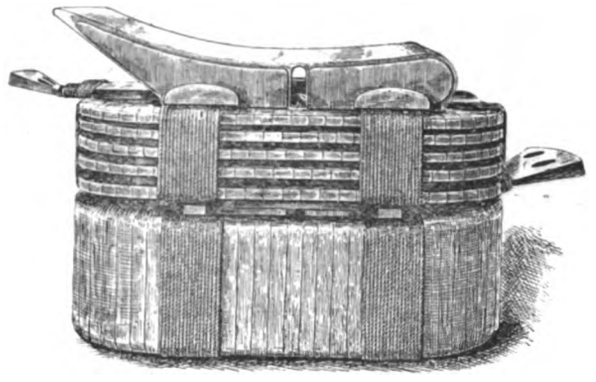

FIG. 2.—Pole-Piece of Lundell Dynamo.

much greater on the side to which the larger polar extension is attached. The dimensions of the coils are such that the side of the core with the projection is already saturated to about 16,500 lines per sq. cm., when the shunt coil only is energised and no current is flowing from the machine, and with this excitation the induction in the other part of the polar core is only about 10,500 lines per sq. cm. It follows therefore that as the armature current increases and tends to shift the magnetic field in the direction of rotation, the current through the series coils adds more to the magnetisation of the part of the core with the smaller pole-piece, as this part is not yet saturated. This tends to deflect the field in the contrary direction to that of the rotation of the armature, and the two deflecting influences therefore cancel one another.

The brushes are of carbon, and the brush-holders (illustrated in Fig. 4) present some new features which are apparent from the figure. The armature is of the now almost universal slotted core pattern, and needs no special description.

Figs. 5 and 6 are curves showing the results obtained from one of these generators, as evinced by tests made by the makers. The makers' figures for the rise of temperature in the various

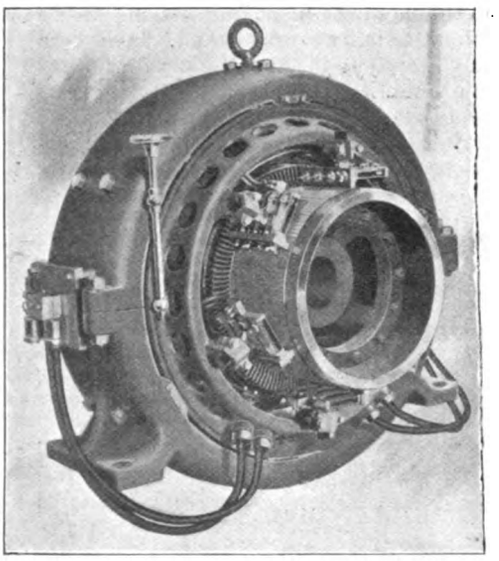

FIG. 3.—100 kw. Lundell Generator. 125 volts, 260 revs. per minute.

parts of the machine after 18 hours run at 800 amperes, which were as follows. The temperature of the atmosphere was 80° F.

Armature core	55° F.	Series Field	53° F.
Armature wire	51° F.	Shunt Field	47° F.
Commutator	53° F.	Between field coils	53° F.

Manufacture of the dynamo has already been commenced at Messrs. Holmes' works at Newcastle, but for the present, at any rate, the motors, controllers and surface-knob apparatus will be obtained from the American manufacturers, the Sprague Electric Co. We are unable to give detailed descriptions of these at present, but may refer to the leading features promised by the makers. The arrangement of motor and controller does away with added resistances in the armature circuit, even when going over from series to parallel, and permits a wide range of speed by varying the field strength alone. It is said that at slow speeds it will work practically as a shunt motor and at high speeds as a series motor. For braking, the

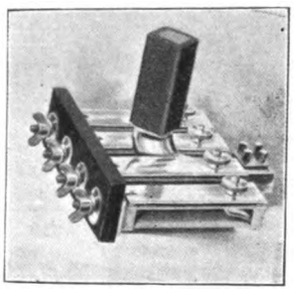

FIG. 4.—Brush Holder.

motor is not short-circuited, but remains connected to the mains, generating a higher E.M.F. than the line voltage.

The Johnson-Lundell surface-knob system has been modified since it was first patented, and now differs in some particulars from the sketch given of it in Dr. S. P. Thompson's recent British Association Paper (see *The Electrician*, Vol. XLI., p. 751). As the Diatto and Thompson-Walker systems, it is based on the fact of the iron skate below the car and the ironwork of the car itself improving a magnetic circuit, and thereby closing a switch. This switch is, however, not the main switch but only a relay which, with a voltage of 50 volts, closes in its turn the electromagnetic main circuit switch. It is proposed, in order to lessen the cost of the system to equip

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double-track systems with surface-knobs and feeders on the up-grades and level stretches only, having a small accumulator as reserve on the car to be employed for starting on slight down-grades. To deal with the difficulty of possible short-circuits by the skate-making connection between the studs and rails on crossings, the cut-out in circuit with each surface-knob connection will be bridged by a resistance, so that the blowing of a fuse will not necessarily interrupt the traffic on the line at the point in question.

Satisfactory tests, we understand, have been made with the system in New York, with flooded and frozen lines. We have before us expert opinions on the different plant, all of them favourable. The late Dr. John Hopkinson expressed his approval in 1896 of descriptions of

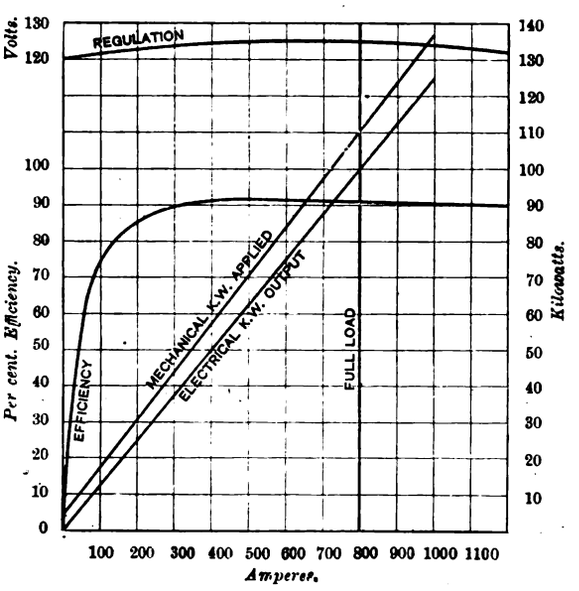

FIG. 5.—Tests of a 100-kw. Lundell E.T. Generator. (254 revs. per min., 125 volts.)

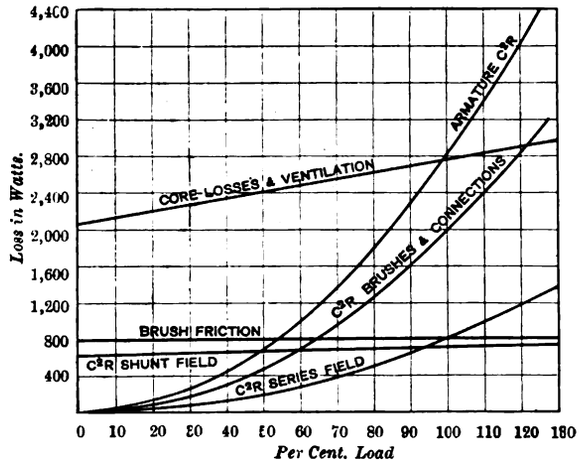

FIG. 6.—Losses in Watts of a 100 kw. Lundell E.T. Generator (254 revs. per min., 125 volts).

both the dynamo and the surface contact system. Mr. Parshall reports that he has had tests on the dynamo performed, which show that it has all the qualities claimed for it. Mr. E. Manville has done likewise for the motor and system of control. Lord Kelvin, Messrs. Preece and Cardew, and Messrs. Lacey, Clirehugh and Sillar have also commented favourably on the various parts of the system. At the luncheon, on Tuesday, Mr. Browett mentioned that a 100 kw. Lundell dynamo (450 revs. per min.), which was being tested at the works of Messrs. Browett, Lindley and Co., showed no sparking between no-load and 25 per cent. overload, without shifting the brushes, and that the direct-coupled Browett-Lindley-Lundell set, on its first trial run, gave a combined efficiency of 84 per cent.

THE ELECTRICAL EQUIPMENT OF SHIPS OF WAR.*

BY C. E. GROVE.

INTRODUCTORY.

This subject, already a great one, is rapidly growing, and the use of electricity on ships of war is yearly being extended in all the navies of the world. While therefore the bulk of the Paper records what has already been accomplished, regard has been paid throughout to certain imminent developments which in many departments overshadow present-day practice. The methods followed in the English navy have to so large an extent constituted a guide and pattern to the world, that the basis of the present Paper lies naturally in British Admiralty practice. In certain navies, however, important departures from British practice now exist, and tend to become more marked with the flux of time; some of these are

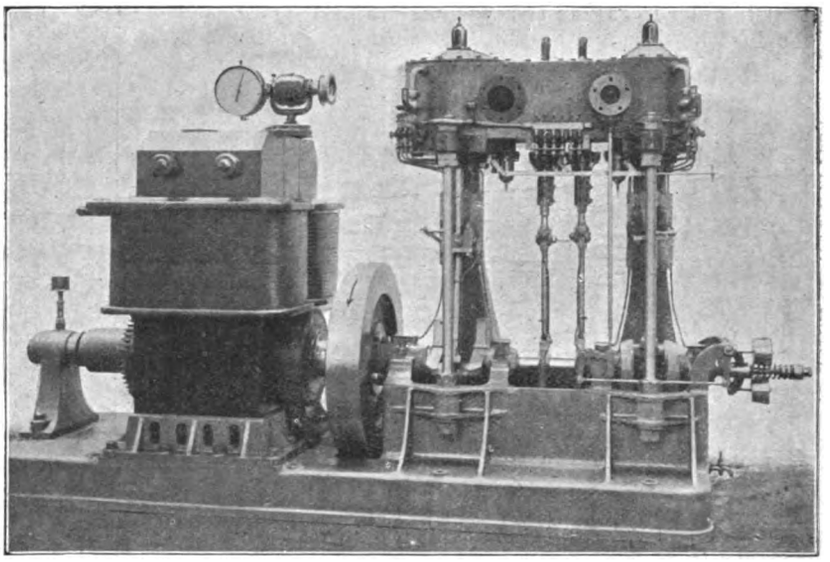

FIG. 1.—Admiralty Pattern Two-pole Steam Dynamo (Siemens Dynamo and Thornycroft Engine).

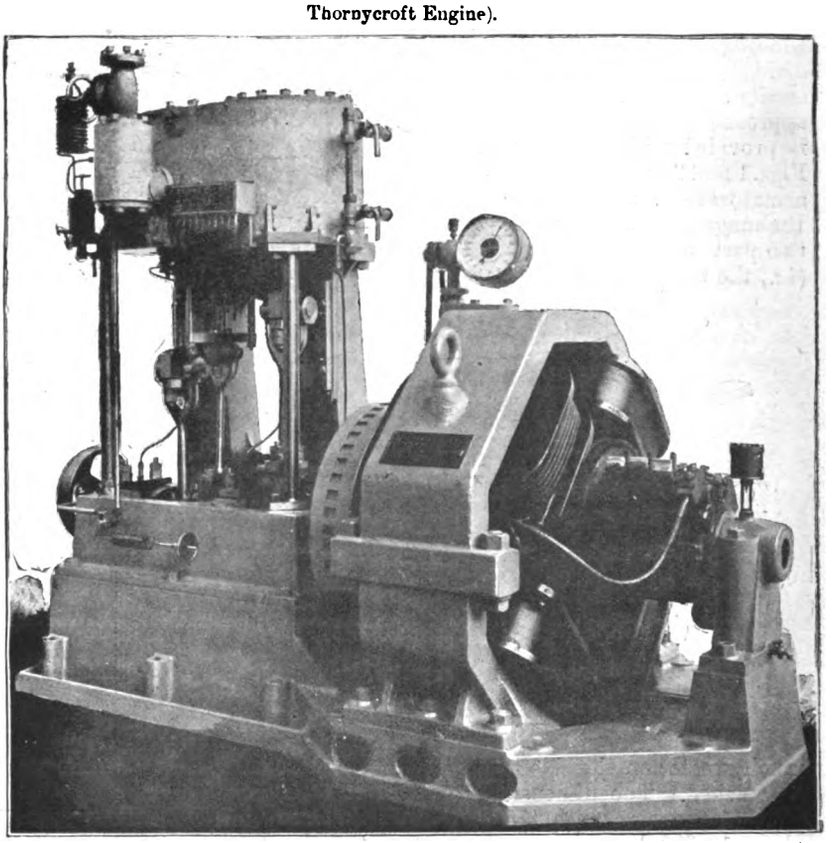

FIG. 4.—Modern Admiralty Multipolar Generator (W. H. Allen, Son and Co., Bedford).

* Paper read before the Institution of Electrical Engineers, April 5th.

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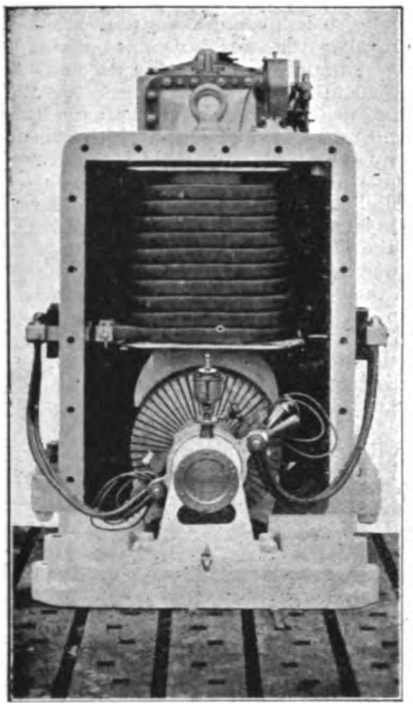
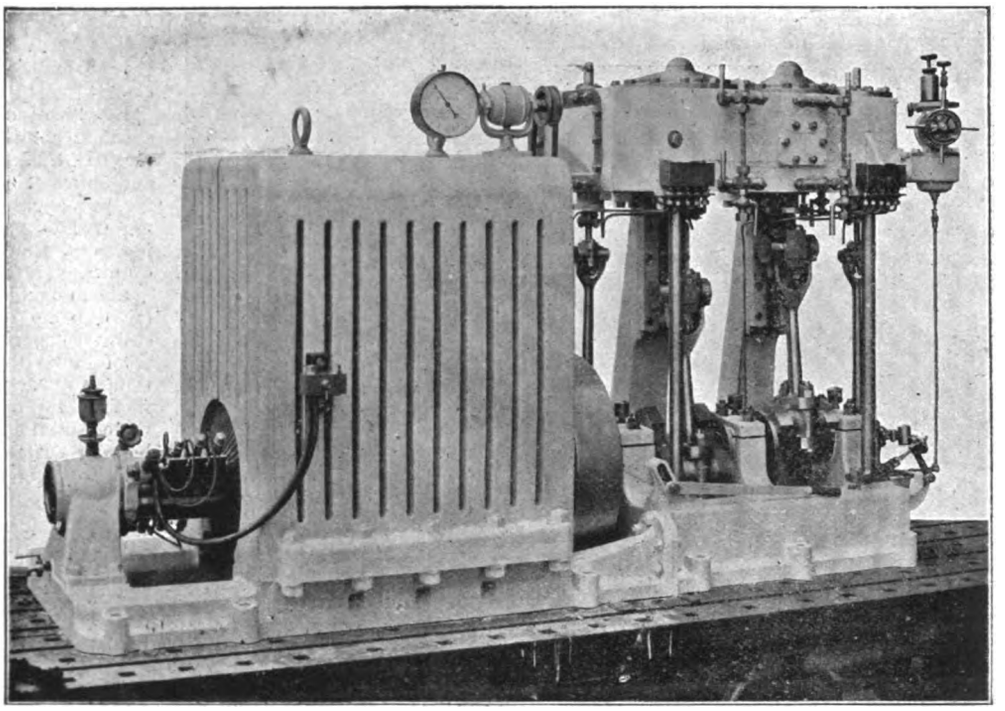
referred to hereafter. The author's intention has been entirely to avoid administrative and tactical questions, and to treat the subject solely from the point of view of an independent electrical engineer. In British warships, and in ships built in this country for foreign Governments, the constructive work falls into three main divisions,

PART I.—GENERAL EQUIPMENT.

Dynamos.—The first important step in the use of electricity on board ships of war dates from the introduction of the dynamo. In 1876 a Wilde alternate-current magneto machine, belt-driven, was installed in H.M.S. "Minotaur," to work a searchlight projector.





FIGS. 2 and 3.—"Ironclad" Dynamo (Thames Iron Works.)

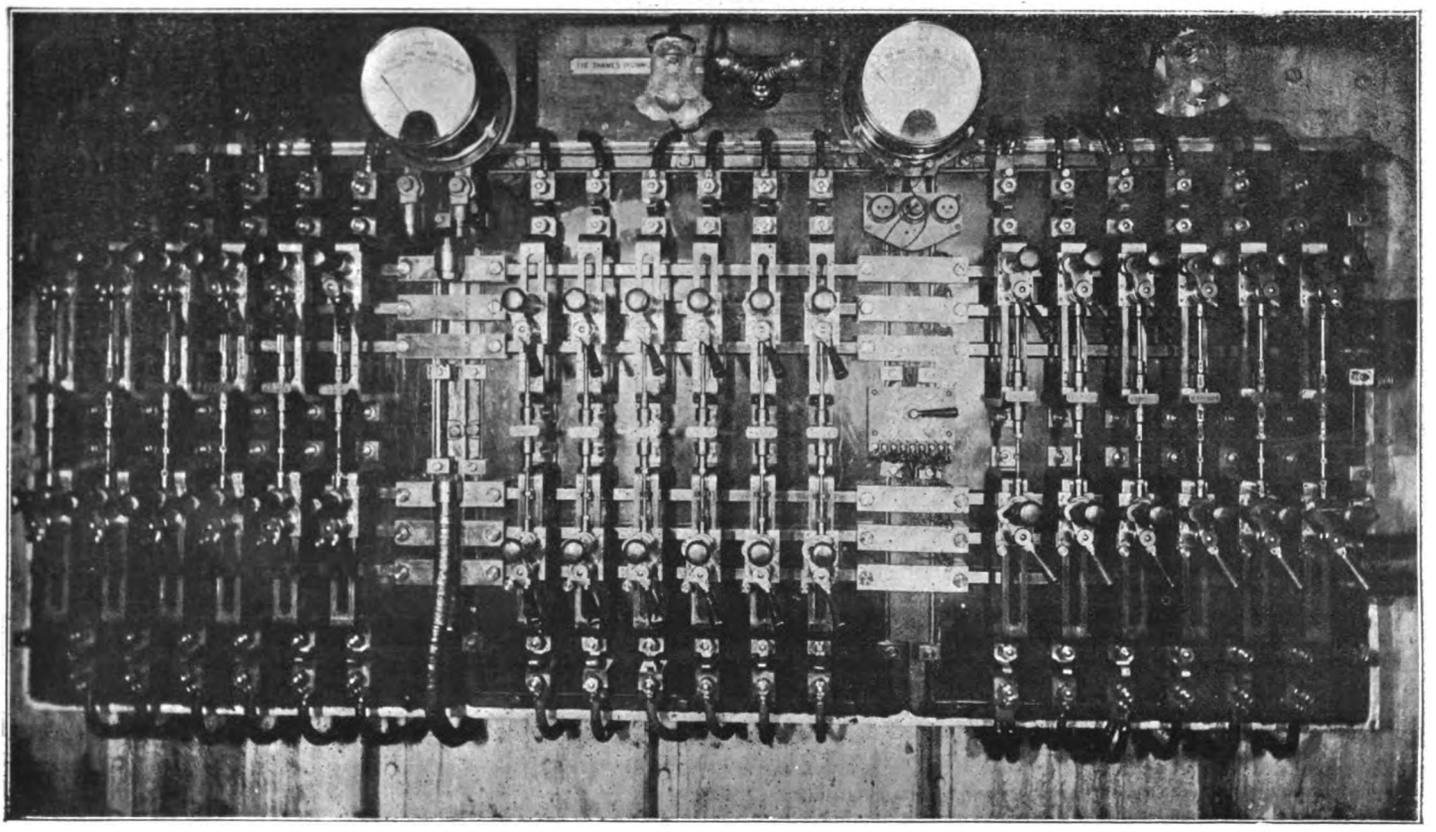


FIG. 7.—Admiralty Pattern Switchboards, as fitted in H.I.J.M.S. "Shikishima."

dealt with respectively by the shipbuilders, the engineers, and the ordnance contractors; and part of the electrical work falls into each division. In the present Paper this distinction is ignored and the electrical equipment treated as a unity.

This machine gave place to the continuous-current Gramme dynamo so soon as the latter had assumed practical form; and this again was superseded in due course by the two-pole, drum-wound, direct-coupled compound steam dynamo, which until about 189-

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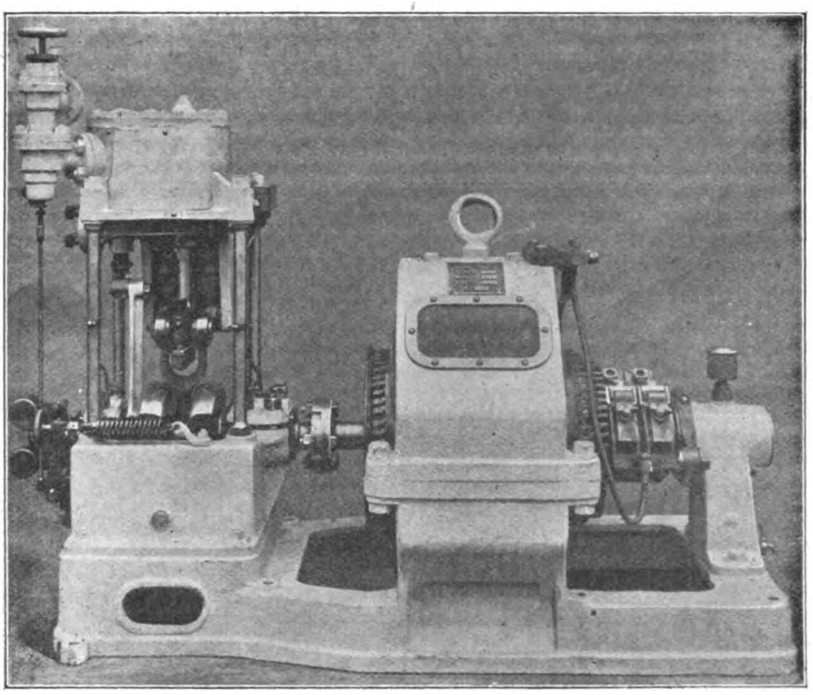

FIG. 6.—Vedette Boat Steam Dynamo, 6 kw. (Thames Iron Works).

was standard in our navy. The size of unit varies in our navy by steps of 100 amperes from a machine giving 100 amperes in the case of torpedo boat destroyers, small gunboats, and the like, to a machine of 600 amperes as now used in all modern battleships and large cruisers. The standard voltage is 80 in all cases, this having been settled long ago as a convenient compromise between the pressure required for working searchlights and that giving the best efficiency in the ordinary electric light circuits. With the growing demands for current, this low voltage is becoming increasingly inconvenient—a matter which will be referred to again further on. For all sized sets, from 200 amperes upwards, the standard speed is 300 to 320 revs. per min., though in the smallest sets speeds occasionally run up as high as 500 revs. per min. Engines running up to 500 revs. per min. with forced lubrication are now being introduced for the larger sizes. By the provision of clauses in the specification requiring the engine to work the dynamo with a low steam consumption, and requiring that the temperature of the dynamo after six hours' run at full load shall not exceed 80°F. above the surrounding air, the essential conditions for obtaining a well-built machine of high efficiency and moderate weight are secured. Fig. 1 shows the general appearance of a British Admiralty steam dynamo of the ordinary two-pole horse-shoe type. These machines almost invariably had smooth cores. "Ironclad" machines were introduced some five years ago, to overcome a difficulty which had been discovered on ships equipped with ordinary dynamos—namely, that considerable disturbance of the compass readings was observed, depending on the stray magnetic field produced by the dynamos and varying with the number of dynamos that were at work. Until this interference had been actually proved to be due to the dynamos themselves, it had been attributed to induction from the currents in the wires about the ship; but it was found that their action was much less important than the direct influence of the dynamos. With an ironclad machine the stray magnetic field is reduced to one-half, or less, of what it is with an ordinary open-type machine, the stray field from the magnets (provided the machine is liberally designed as regards the mass of iron) being almost nil, while the leakage of magnetism axially along the armature shaft is greater.

The chief difficulties in designing ironclad dynamos arise in designing to a minimum weight and in providing adequate ventilation. Figs. 2 and 3 show an ironclad dynamo of the author's design, in which thorough ventilation is secured by the device of coring slots through the bottom, sides, and ends of the magnet castings. The weight of an ironclad dynamo is greater by 50 per cent. to 75 per cent. than that of an ordinary Admiralty open-type machine of the same output, which reason has led to the ironclad type being superseded by an open four or six-pole machine, which on the whole provides the best combination of good ventilation, minimum external leakage, and accessibility of parts. Fig. 4 shows a recent 600 ampere Admiralty set, by Messrs. W. H. Allen, Son and Co. Most modern Admiralty dynamos have slotted cores. The total weight of such a set is about 6½ tons, of which the armature represents about 1½ tons. The United States navy usually employs a four-pole machine, their largest units being of 50 kilowatts at 80 volts at 400 revs. per min. The temperature limit is, however, 50°F., which involves a heavier dynamo than the British for the same output. Fig. 5 shows such a set, constructed by the General Electric Co., of Schenectady.

By way of contrast to these large machines, a small steam dynamo (Fig. 6) may be mentioned which was recently designed by the author and fitted into 40ft. and 56ft. steam pinnaces for the Russian Government for working searchlights. In this particular case the required output was 60 amperes × 65 volts at 500 revs. per min., though the set has a maximum output of 6 units, on a total weight of 12 cwt.

Steam engines of the open type are usually employed for dynamo driving. They have to be constructed strongly enough to work with the full steam pressure from Belleville boilers (275lb. to 300lb. per sq. in.), though with cylinder areas large enough to furnish their nominal full output at 150lb. to 200lb. pressure. Among the essential conditions for successful working are ample bearing surfaces, with thorough lubrication to ensure cool working for long periods, and ability to get rid of large volumes of water which come over with

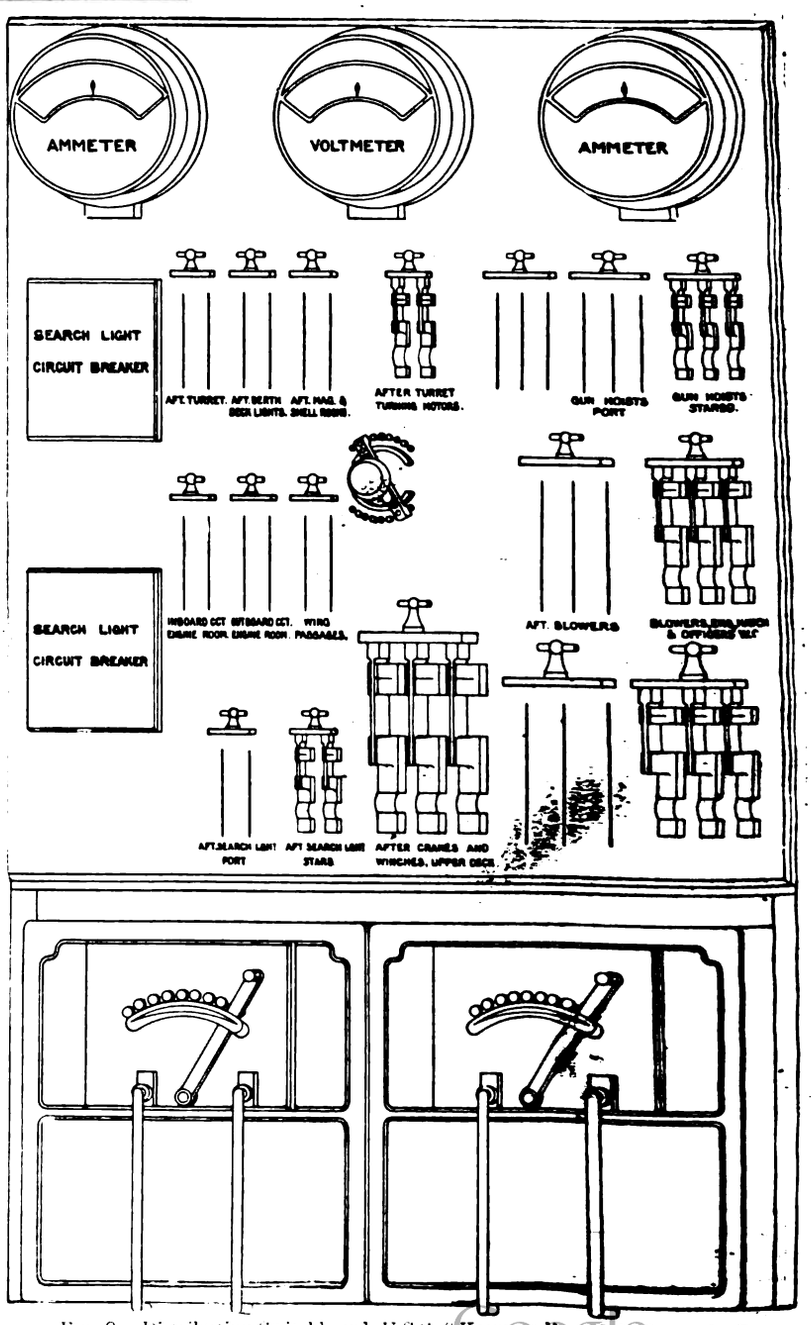

FIG. 9.—Distributing Switchboard, U.S.S. "Kearsage" and "Kentucky."

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the steam when auxiliaries on the same range of steam pipes are started.

The importance of preserving the dynamos unharmed in war is so great that at least a sufficient number of sets to supply all the fighting parts of the ship must be kept under protection. Unfortunately, this generally means placing the machines in a warm, ill-ventilated space, so that their durability is impaired. Again, if all the dynamos are together, an injury to the compartment, or to the steam and exhaust pipes serving the electric light engines, would place the whole *hors de combat* and put the ship in darkness. Our Admiralty practice is to put one of a set of three or four dynamos in some daylight position on the upper or main deck to supply all the ordinary lighting current in peace, and to place the dynamos that are used in action below the water line. Nations differ as to the advisability of doing this, the control being certainly less convenient when the machines are in separate places. The United States navy place all the dynamos in one compartment. The Japanese divide the dynamos between the fore and aft auxiliary machinery rooms, but keep them all under protection.

Switchboards.—This standard British Admiralty pattern switchboard consists of a slate or slates carrying horizontally upon them a series of omnibus bars, connected severally with the positive and negative terminals of the dynamos; and bridging over these, a series of vertical slotted bars leading through fuses to the circuits, and carrying sliding contact plugs which can be pressed down so as to make contact on the top and sides of the omnibus bars, being locked in the "on" position by a spring handle, and maintained in the "off" position by the action of an internal spiral spring, which also gives a quick break. The switchboard has the merit that all the current-carrying parts are on its face, and it is fairly compact; but the method of making electrical contact leaves much to be desired, and the switch parts consist of a number of components which give complexity and add to the cost of maintenance. The present design of board grew out of that older type known to telegraph engineers as the "Umschalter," in which contact was made between any one of a series of vertical bars and any other of a series of horizontal bars by screwed or coned plugs uniting them at their intersection: this style of board failed in service because of the practice of making and breaking circuit on the plugs, which led to their speedy destruction.

tionable. Time was when the parallel working of compound-wound dynamos was attended with difficulty; but the conditions are now well understood, and parallel working is, in fact, in successful operation on many ocean liners and in other navies. These switchboards are usually made up to standard drawings and arranged for

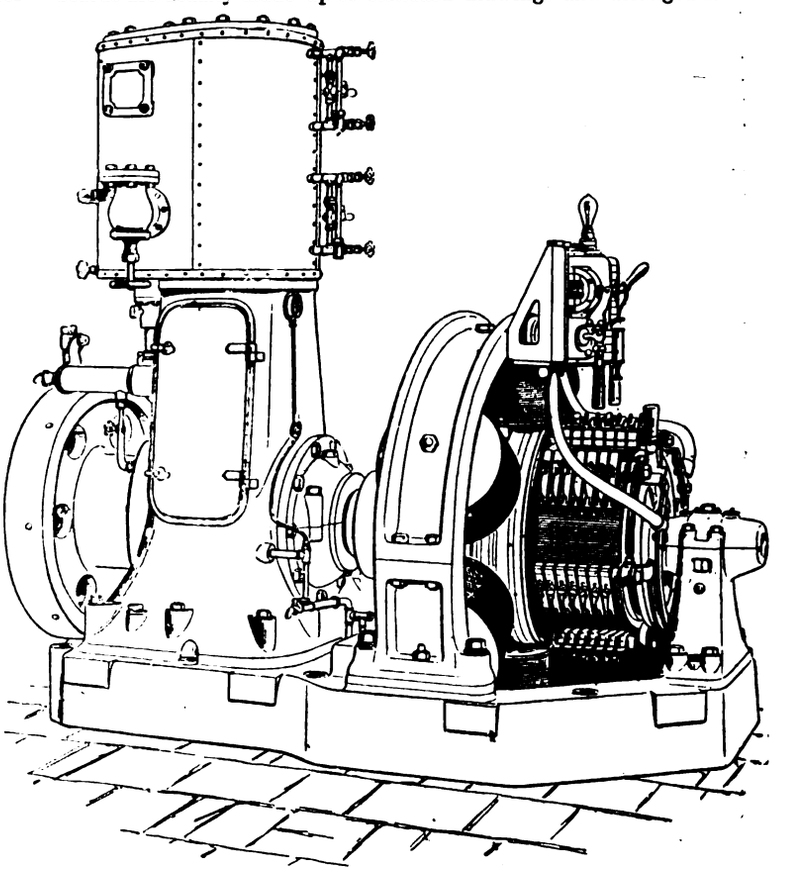

FIG. 5.—United States Navy Generator, 50 kw. (General Electric Co., Schenectady).

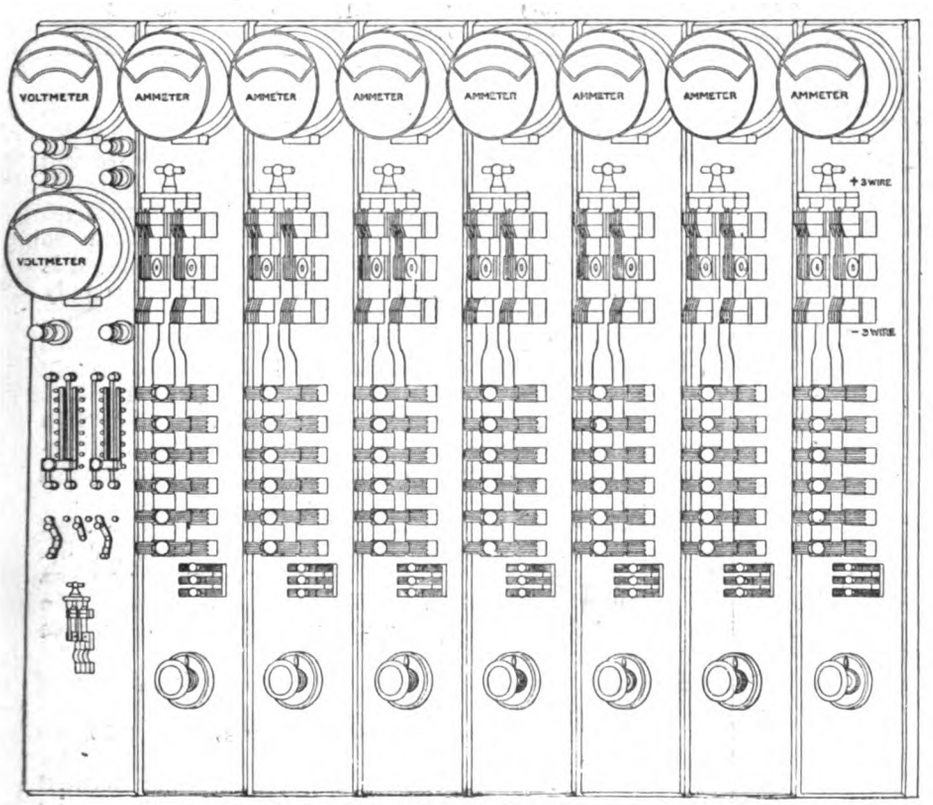

FIG. 8.—Main Generator Switchboard, U.S.S. "Kearsage" and "Kentucky."

In the English Admiralty board, while any circuit or any number of circuits can be worked from one dynamo, it is not possible to work two or more dynamos in parallel on the same circuit; and in transferring a circuit of lights from one machine to another, it is necessary to extinguish them during the process, which is objectionable. Time was when the parallel working of compound-wound dynamos was attended with difficulty; but the conditions are now well understood, and parallel working is, in fact, in successful operation on many ocean liners and in other navies. These switchboards are usually made up to standard drawings and arranged for three dynamos and six circuits. When, as is commonly the case, the number of circuits exceeds six, one or more additional boards are fitted and their dynamo bars coupled. Fig. 7 gives a view of three such boards coupled in position on the Japanese battleship "Shikishima," which carries three 600 ampere dynamos and 18 circuits, six circuits supplying incandescent lights, four projectors, and the remaining eight, motors. The battleships of the "Formidable," "Duncan," and more recent classes, and the cruisers of the "Drake" class will carry four 600 ampere dynamos, usually running at 400 revs. per min., and a large number of circuits, some of which will supply current to powerful motors. The design of switchboard described above appears to be quite unsuitable for such installations.

The Cardew hot-wire voltmeter and the Siemens torsion spring ammeter are the instruments chiefly to be found on Her Majesty's ships, though these are no longer standard, having been replaced by dial instruments of the well-known Evershed pattern. The instruments are usually placed in close proximity to the dynamos, and not upon the switchboard. Circuit breakers are not used in the dynamo circuits of our navy, though double-pole fuses are now generally fitted in the machine leads.

The United States navy standard switchboard is planned with its dynamo bars vertical and circuit connections horizontal, and is designed for parallel working. Fig. 8 shows the main generator board fitted in the recent battleships "Kearsarge" and "Kentucky," which each carry seven 50 kw. dynamos. Each dynamo bar is surmounted by its ammeter and main throw-over switch. A panel at one end contains the instruments used in common by all the dynamos. The field terminals of the machines are brought to the switchboard, where they may be connected either for self or separate excitation. Equaliser switches are fitted on a separate panel in another part of the room. From the main board feeders

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are run to three three-wire main distributing boards (Fig. 9) located respectively forward, aft, and amidships, from which the several power, searchlight, and lighting circuits are run. Each of these boards receives from the main generator board five cables, a pair of "outers" for lighting, a similar pair for power, and a common neutral. Four sub-distribution boards for groups of motors are supplied from the main distribution boards. A circuit breaker and a short-circuiting switch for the series winding are carried by each generator on the terminal board from which its main cables are led (Fig. 5). The electrical principles involved in this scheme of connections seem, in the main, right; but the multiplication of switchboards is a bad feature, which is said to have been necessitated by restrictions of space in the ship.

(To be continued).

BOOKS RECEIVED.

(Copies of any of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price.)

"*Proceedings* of the Royal Society." No. 427. Vol. LXVI. (London: Harrison and Sons.) 2s.

"The Official Gazette of the United States Patent Office." No. 13. Vol. XC. Published by authority of Congress. (Washington: Government Printing Office.)

"Electric Ship Lighting." By J. W. Urquhart. 2nd edition. (London: Crosby, Lockwood and Son.) 7s. 6d.

"Zum Thema des Rechtsschutzes der Elektrischen Stromkreise und Betriebsstellen." By Dr. W. Reuling. (Berlin: A. Seydel.) 1 Mark.

"Wireless Telegraphy and Hertzian Waves." By S. R. Bottone. (London; Whittaker and Co.) 3s.

ELECTRICITY WORKS ACCOUNTS.

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

Aberdeen (Municipal)	Jan. 12, 1900	Kingston-on-Thames (Mun.)	April 21, 1899
Ayr (Municipal)	Sept. 22, 1899	Lancaster (Municipal)	Jan. 19, 1900
Bath (Municipal)	Feb. 9, 1900	Leeds (Municipal)	Dec. 1, 1899
Bedford (Municipal)	May 19, 1899	Leicester (Municipal)	Jan. 26, 1900
Belfast (Municipal)	Sept. 15, ,,	Leyton (Municipal)	Sept. 8, 1899
Birmingham (Company)	Sept. 15, ,,	Liverpool (Municipal)	June 9, ,,
Blackburn (Municipal)	Jan. 19, 1900	Londonderry (Municipal)	Feb. 16, 1900
Blackpool (Municipal)	Sept. 29, 1899	Manchester (Municipal)	Aug. 11, 1899
Bournemouth (Company)	April 28, ,,	Newcastle and District (Co.)	Oct. 6, ,,
Bolton (Municipal)	Nov. 24, ,,	Newcastle-upon-Tyne (Co.)	April 14, ,,
Bradford (Municipal)	April 14, ,,	Newport (Mon.) (Municipal)	Dec. 15, ,,
Brighton (Municipal)	May 12, ,,	Northampton (Company)	Oct. 20, ,,
Bristol (Municipal)	July 14, ,,	Norwich (Company)	Nov. 17, ,,
Brompton & Kensington (Co.)	Mar. 23, 1900	Notting Hill (Company)	Mar. 16, 1900
Burnley (Municipal)	Aug. 25, 1899	Nottingham (Municipal)	July 21, 1899
Burton-upon-Trent (Mun.)	April 21, ,,	Oldham (Municipal)	Dec. 1, ,,
Bury (Municipal)	Sept. 22, ,,	Oxford (Company)	April 13, 1900
Cambridge (Company)	April 13, 1900	Pontypool (Company)	May 5, 1899
Cardiff (Municipal)	Dec. 15, 1899	Portsmouth (Municipal)	July 14, ,,
Charing Cross (Municipal)	Mar. 9, 1900	Prescot (Company)	Dec. 8, ,,
Chelsea (London) (Co.)	Mar. 23, ,,	Preston (Company)	Sept. 29, ,,
Cheltenham (Municipal)	Nov. 10, 1899	Reading (Company)	Oct. 13, ,,
Chester (Municipal)	June 23, ,,	Richmond (Company)	Oct. 13, ,,
City of London (Company)	May 12, ,,	Salford (Municipal)	Feb. 13, 1900
Clerkenwell (Company)	Aug. 18, ,,	Scarborough (Company)	Nov. 3, 1899
Coventry (Municipal)	Feb. 23, 1900	St. Helens (Municipal)	Dec. 8, ,,
Croydon (Municipal)	Feb. 9, ,,	St. James' & Pall Mall (Co.)	Feb. 16, 1900
Derby (Municipal)	Jan. 26, ,,	St. Pancras (Vestry)	May 26, 1899
Dewsbury (Municipal)	Nov. 24, 1899	Sheffield (Municipal)	Dec. 29, ,,
Dover (Company)	June 2, ,,	Shoreditch (Vestry)	Oct. 27, ,,
Dundee (Municipal)	Jan. 12, 1900	Southampton (Municipal)	Nov. 10, ,,
Eastbourne (Company)	Feb. 2, ,,	Southport (Municipal)	July 7, ,,
Edinburgh (Municipal)	Nov. 17, 1899	South Shields (Municipal)	July 7, ,,
Exeter (Municipal)	Aug. 5, 1898	Stafford (Municipal)	Dec. 29, ,,
Glasgow (Municipal)	Sept. 1, 1899	Sunderland (Municipal)	July 28, ,,
Guildford (Company)	May 5, ,,	Taunton (Municipal)	June 16, ,,
Halifax (Municipal)	July 21, ,,	Tunbridge Wells (Mun.)	Sept. 1, ,,
Hammersmith (Vestry)	May 26, ,,	Wakefield (Municipal)	Dec. 1, ,,
Hampstead (Vestry)	Aug. 25, ,,	Walsall (Municipal)	June 23, ,,
Hanley (Municipal)	April 28, ,,	Wandsworth (Company)	Aug. 18, ,,
Harrogate (Municipal)	Oct. 20, ,,	Westminster (Municipal)	Mar. 9, 1900
Harrow (Company)	June 16, ,,	Whitehaven (Municipal)	July 28, 1899
Hastings & St. Leonards (Co.)	Feb. 2, 1900	Windsor (Company)	Dec. 22, ,,
Hove (Company)	Mar. 10, 1899	Woking (Company)	Dec. 22, ,,
Huddersfield (Municipal)	Oct. 6, ,,	Wolverhampton (Municipal)	June 30, ,,
Islington (Vestry)	Oct. 27, ,,	Woolwich (Company)	Jan. 12, ,,
Kensington & Knightsbr' (Co.)	Mar. 16, 1900	Worcester (Municipal)	April 7, ,,
Kingston-upon-Hull (Mun.)	June 9, 1899	Yarmouth (Municipal)	Nov. 8, ,,

Worcester Municipal Electric Supply Works.

It is most satisfactory to be able to chronicle another year with good results at Worcester. A superficial glance at our table might give the impression that in point of merit the 1898 figures had been barely maintained, but the conditions under which the results of last year were obtained invest them, we think, with increased merit.

With 51 new consumers, the total equivalent lamp connections were increased to 31,202—a rise of a little over 12 per cent. The output shows the good advance of over 16 per cent.—viz., from 474,344 to 551,437 units sold. Of the latter figure, 116,918 units were supplied to the waterworks motors, realising £731; 109,600 units to the public lamps (£1,322), 1,408 units for the private day load (£15), and 323,511 units to the incandescent lamp circuits, earning £6,022 net.

Although the plant capacity has been increased to 900 kw. normally (or 800 kw. in flood or drought of water supplying the turbines), the new Ferranti plant has not, we learn, been available for much use during the period covered by our analysis.

Notwithstanding that most of the generating costs have increased, they are all still satisfactory. The fuel bill shows a rise of 0·09d. per unit, the reason given being that last year was the driest experienced since the station was started, and instead of 53·6 per cent. of the output being generated by water power, only about 41·7 per cent. was so generated; besides, coal was slightly (about 6d. per ton) dearer than in 1898. It is stated that in the months of January, February, September, and December the water power was not at times available, in consequence of drought or flood.

Even considering the high load factor of 14·3 per cent., the total works costs at 1·55d. per unit are satisfactory, and in combination with the excellent figure of 0·43d. for management and property charges, have the effect of keeping the aggregate costs well below the average.

After satisfying the interest charges of £1,945, the working profit has afforded £1,756 for the sinking fund, and a balance carried forward of £91.

The following table facilitates a general comparison of the 1899 results with those of preceding years:—

Year.	No. of consumers.	Equiv. 8 c.p. lamp connections.	Output. Units sold.	Total revenue	Total costs.	Deficit.	Total costs per unit.
1895	181	13,522	246,912	£3,254	£3,061	£1,977	2·975d.
1896	241	21,959	333,644	4,758	3,155	1,616	2·270d.
1897	291	24,712	429,270	6,292	4,097	1,475	2·290d.
1898	382	28,495	474,344	7,154	3,941	460	1·996d.
1899	406	31,202	551,437	8,331	4,540	91*	1·976d.

* Balance.

Bath Municipal Electric Supply Works.

The Bath accounts for 1899 show a marked improvement in the costs generally. Unfortunately, nearly all the items still stand at figures so much above the normal that there is yet ample room for further economies before the results can be considered satisfactory. The rate of increase of the output is disappointingly slow. Last year the increase was only 8·8 per cent. over the 1898 figure.

There is some promise of better results next year contained in the increased lamp connections, which advanced about 21·3 per cent. The load factor last year was 11·6 per cent., as compared with 12·4 per cent. in 1898; and taking this into account, and the small advance in the output, the diminution in the costs—small as it is—assumes a more hopeful sign.

The fuel charge, while it has been reduced from 1·42d. per unit to 1·05d., is still quite 0·3d. above what it should be. Another item of generating costs which is nearly double what it should be is that of oil, waste, water, and stores, while management and property charges exceed the normal by quite a farthing per unit.

Having thus picked out the more unsatisfactory aspects of the accounts, it is only fair to direct attention to the high proportion of "units used on the works," as they contain 10,340 units used in tests of new plant. To this in some degree may be due the increase in the item of oil, waste, &c.; also the still high fuel charge. The distribution costs show much reduced figures.

The net financial result of the year's operations was a deficit of £1,363, as compared with one of £1,220 in 1898. Besides the interest charges of £1,782, there was, however, last year set aside to the sinking fund £1,797, representing 3·14 per cent. of the mean capital expended.

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	WORCESTER.		BATH.	
Undertaking Worked by	Worcester Corporation.		Bath Corporation.	
Date of Commencement of Supply	October 11, 1894.		December, 1889.	
System of Supply	Alt.-current transformers in sub-stations and		Alt.-current trans. sub-stations and separate	
Chief Engineer	E. J. Hoadley.	[houses.	G. F. Metzger.	[house transformers.
YEAR ENDED	DEC. 31, **1898.**	DEC. 31, **1899.**	DEC. 31, **1898.**	DEC. 31, **1899.**
QUANTITIES—				
Units generated	610,492	710,416	537,052	569,986
„ SOLD (TOTAL)	474,341	551,437	356,700	388,203
„ sold to consumers	365,944[a]	441,837[a]	187,315	208,947
„ sold for public lighting, &c.	103,400	109,600	169,385	179,761
„ used on works	6,180	8,495	19,800	31,560[d]
UNITS SOLD PER 8 C.P. LAMP CAPACITY	30·4	19·6	11·4	12·4
Maximum supply demanded	854 kilowatts	939 kilowatts	330 kilowatts	382 kilowatts
Number of public lamps	56 arc, 5 incan.[b]	57 arc, 3 glow[b]	83 arc, 21 (16 c.p.) glow	88 arc, 13 (50 c.p.) glow
Number of consumers	355	406	221[a]	257
Connections to mains in 8-c.p. lamps	27,783	31,202	17,802	21,600
CAPACITY OF PLANT IN 8-C.P. LAMPS	15,600	28,100	31,240	31,240
CAPACITY OF PLANT IN KILOWATTS	500	900	1,000	1,000
CAPITAL—	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.
AUTHORISED (TOTAL)	£71,738	£143	£74,738	£83·1	£50,823	£50·8	£50,823	£50·8
Share	—	—	—	—	—	—	—	—
Loan (including Debenture charges)	71,738	143	74,738	83·1	50,823	50·8	50,823	50·8
RECEIVED (TOTAL)	63,140[c]	126	63,175[j]	70·2	50,823	50·8	50,985	51·0
Share	—	—	—	—	—	—	—	—
Loan (including Debenture charges)	61,747	124	63,175	70·2	50,823	50·8	50,823	50·8
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	9,990	20	11,563	12·8	nil	—	nil	—
Share (unissued)	—	—	—	—	—	—	—	—
Share (uncalled)	—	—	—	—	—	—	—	—
Loan (including Debentures)	9,990	20	11,563	12·8	nil	—	nil	—
REPAID (TOTAL)	—	—	—	—	—	—	nil	—
RESERVE OR SINKING FUND	6,109	12·2	8,022	8·91	1,347	1·35	3,593	3·59
DEPRECIATION FUND	—	—	—	—	—	—	—	—
EXPENDED (TOTAL)	74,397	149	79,236	88·0	51,562	51·6	63,006	63·0
Lands and buildings	26,242	52·5	26,245	29·2	11,958	12·0	14,465	14·5
Plant	47,124	94·2	51,960	57·5	25,112	25·1	32,036	32·0
Mains					12,553	12·6	14,133	14·1
Miscellaneous	1,031	2·06	1,031	1·15	1,941	1·94	2,370	2·37
BALANCE OF CAPITAL ACCOUNT	−11,257[d]	−22·5	−16,061	−17·8	−739[b]	−0·74	−12,021[b]	−12·0
REVENUE—	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.
TOTAL	£7,154	3·620d.	£8,331	3·626d.	£7,113	4·780d.	£7,289	4·506d.
Revenue from supply	5,620	2·845d.	6,767	2·944d.	4,374	2·940d.	4,654	2·878d.
„ meters, &c.	166	0·084d.	182	0·079d.	237	0·159d.	259	0·160d.
„ public lighting	1,281	0·649d.	1,322	0·575d.	2,291	1·541d.	2,335	1·444d.
„ sale of lamps, &c.	4	0·002d.	—	—	123	—	33	0·022d.
„ miscellaneous sources	84	0·043d.	60	0·026d.	83	0·059d.	9	0·005d.
EXPENDITURE OUT OF REVENUE—								
TOTAL COSTS	£3,944	1·996d.	£4,540	1·976d.	£5,635	3·783d.	£5,124	3·170d.
WORKS COSTS	3,062	1·550d.	3,553	1·549d.	4,108	2·763d.	3,700	2·288d.
Generation of electricity	*2,574*	*1·304d.*	*3,115*	*1·356d.*	*3,552*	*2·389d.*	*3,408*	*2·108d.*
Fuel (including cartage, &c.)	1,212	0·614d.	1,626	0·708d.	2,107	1·418d.	1,701	1·052d.
Oil, waste, water, stores	212	0·107d.	157	0·068d.	432	0·291d.	554	0·342d.
Wages at station	953	0·482d.	953	0·415d.	675	0·454d.	731	0·483d.
Repairs and maintenance at station	197	0·103d.	379	0·165d.	275	0·185d.	353	0·218d.
Distribution of electricity	*82*	*0·043d.*	*133*	*0·058d.*	*113*	*0·076d.*	*43*	*0·027d.*
Wages, &c.	40	0·020d.	133	0·058d.	113	0·076d.	2	0·001d.
Repairs, renewals of mains, &c.	42	0·021d.					41	0·025d.
Public lighting	*407*	*0·206d.*	*310*	*0·135d.*	*443*	*0·298d.*	*249*	*0·154d.*
Attendance	407	0·206d.	310	0·135d.	443	0·298d.	249	0·154d.
Renewals								
MANAGEMENT AND PROPERTY CHARGES	882	0·447d.	982	0·428d.	1,526	1·026d.	1,424	0·880d.
Royalties	—	—	—	—	—	—	—	—
Rent, rates, taxes	*80*	*0·041d.*	*47*	*0·020d.*	*137*	*0·092d.*	*131*	*0·081d.*
Management	*803*	*0·406d.*	*935*	*0·407d.*	*1,389*	*0·934d.*	*1,293*	*0·799d.*
Salaries	477	0·242d.	460	0·200d.	1,217	0·819d.	1,081	0·670d.
Stationery, &c.	43	0·022d.	64	0·028d.	40	0·027d.	40	0·025d.
Establishment charges	34	0·017d.	32	0·014d.	49	0·033d.	56	0·035d.
Law charges, &c.	248[e]	0·126d.	379[k]	0·165d.	83[c]	0·056d.	113[c]	0·070d.
FINANCIAL RESULTS—	Total. / % to mean cap. exp'nded.	Total. / % to mean cap. exp'nded.	Total. / % to mean cap. exp'nded.	Total. / % to mean cap. exp'nded.
WORKING PROFIT FOR YEAR	£3,210	4·53%	£3,791	4·91%	£1,478	3·50%	£2,166	3·78%
Sum carried to Depreciation Fund	—	—	—	—	—	—	—	—
Sum carried to Reserve or Sinking Fund	1,725	2·44%	1,755	2·23%	1,106	2·83%	1,797	3·14%
Net interest on loans (incl. Debenture charges)	1,946	2·75%	1,945	2·53%	1,501	3·55%	1,732	3·02%
BALANCE FROM LAST ACCOUNT	nil	—	nil	—	645	1·53%	−575	−1·05%
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	—	—	91	0·118%	—	—	—	—
Deficit	*460*	*0·650%*	—	—	*575*	*1·36%*	*1,938*	*3·38%*
ORDINARY DIVIDEND PAID	—	—	—	—	—	—	—	—
PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE	55·1%		54·5%		79·3%		70·3%	
Expenditure per kilowatt capacity	£7. 17s. 10d.		£5. 0s. 10½d.		£5. 12s. 8d.		£5. 2s. 6d.	
REVENUE PER KILOWATT CAPACITY	£14. 6s. 0d.		£9. 5s. 2½d.		£7. 2s. 3d.		£7. 5s. 9d.	
Expenditure per 8-c. lamp capacity	5s. 0¾d.		3s. 3d.		3s. 7¼d.		3s. 3½d.	
REVENUE PER 8-C.P. LAMP CAPACITY	9s. 2d.		5s. 11d.		4s. 6½d.		4s. 8d.	
REVENUE PER 8-C.P. LAMP CONNECTED	5s. 1¾d.		5s. 4d.		8s. 0d.		6s. 8¾d.	
Price charged for lighting, per unit	6d. to 2½d.[f]		6d. to 2½d.[f]		6d. to 4½d.		6d. to 4½d.	
Price charged for power, per unit					3d. [ann.		3d. [ann.	
Price charged for public lighting	£22. 9s. 3d. per arc[l]		£22. 16s. 0d. per arc[l]		£25. 17s. 6d. per arc per		£25. 17s. 6d. per arc per	

WORCESTER.—REMARKS—*a* Includes 96,114 units in 1898 and 116,918 units in 1899 taken by waterworks motors. *b* The arcs are 500 watt and the incandescents 112 watt lamps. *c* Includes £1,871 premium on stock, £116 on sale of boilers, &c., and £506 from General District Fund. *d* Over-expended. *e* Includes £36 to law, £21 to insurance, £13 to "Free Wiring Co." and £178 to "lamps." *f* 6d. for first hour, 2½d. after. *h* The arcs are 600 watts each and the glow lamps 200 watts. *i* In flood time or drought the capacity is 800 kilowatts. *j* Inclusive of premiums £1,968, miscellaneous sources £385, and £1,042 from General District Fund. *k* Includes £30 net to insurance, £192 law, £47 "Free Wiring Co." and £129 to "lamps." *l* Assuming an equivalent of 57 arcs in 1898 and 58 in 1899.

BATH.—REMARKS—*a* With 234 installations. *b* Over-expended. *c* To insurance. *d* Including 10,310 used in tests of new plant. *e* Includes insurances £81.

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The Oldest Electrical Journal (established as a weekly Journal 1861—1878

Published every Friday, Price Sixpence; Post Free, Sixpence-Halfpenny.
Editorial Publishing and Printing Offices,

1, 2 & 3, SALISBURY COURT, FLEET ST., LONDON,

Telephone: 949 Holborn. *Telegrams:* "ELECTRICIAN NEWSPAPER LONDON."

All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher "THE ELECTRICIAN," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN" *Printing and Publishing Company, Limited, and be crossed "Coutts and Co."*

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STORAGE BATTERY PROBLEMS.

The chemistry of the lead cell has long been a fruitful source of controversy, and from the discussion which followed the reading of Mr. WADE'S Paper on "Storage Battery Problems" it does not appear that we have made much progress towards the solution of these recondite problems since Dr. GLADSTONE propounded his double sulphation theory 18 years ago. That the chemical equation by which this theory is usually represented is not a true battery equation was pointed out by Mr. DESMOND FITZGERALD in 1887, when the subject was fully discussed before the Institution of Electrical Engineers. But then, as now, it was generally admitted that although this expression stated the actual chemical facts observed in the cell, it needed some correction to make it stand true as an electro-chemical equation; and various suggestions have been made from time to time to attain this end. Discarding these minor corrections, Mr. WADE has boldly rejected all the attempts which have been made to harmonise the theory with the facts which long experience of the working of the lead cell has brought to our notice, and he has developed a theory of his own based on the performance of the cell itself. His theory is that in the cell we are never dealing with simple lead peroxide and lead sulphate alone, but with more complex substances which contain both. In fact, put shortly, the latest theory of the lead cell, and the one which is to explain away all our difficulties, resolves itself into one of allotropic modification and polymerisation. It may therefore be as well to examine into the evidence for and against this theory.

With regard to the behaviour of the negative plate, the evidence in favour of allotropy is not thoroughly convincing, for, as is well known, although ordinary lead, however finely divided by mechanical means, only oxidises very slowly in the air, lead prepared in a very fine state of division by chemical means takes fire at once, as is demonstrated by the well-known experiment of the lead pyrophorous. Now it has never been suggested that the lead so prepared was in an allotropic state, and yet, so far as its chemical activity in combining with oxygen is concerned, it differs more widely in its behaviour as compared with mechanically-divided lead than the latter does as compared with electrolytic lead. The lead obtained by the zinc precipitation method is, as Mr. WADE pointed out, really electrolytic,

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and it is a comparison between the E.M.F. and capacity yielded by this lead that we would like to see made with that which the chemically prepared lead affords. As the latter is very liable to ignite on exposure to air, a comparison of E.M.F. would present some experimental difficulties, but they should not be insuperable, and we should then be in a better position than now to decide whether the spongy lead is an allotropic modification of ordinary lead or not. The experimental evidence which we possess at present on the subject is most conflicting, and it appears highly desirable that M. Darrieus' experiments should be repeated, care being taken to avoid any possible source of error such as might be introduced by employing electrolysed acid instead of pure acid in the experiments. Many of the contradictory results obtained by different observers are probably due to the conditions of experiment not having been comparable.

The case of the positive plate is somewhat different, for while electrolytic peroxide of lead is crystalline, that which has been prepared by ordinary means is amorphous, and it is generally held that the E.M.F. yielded by electrolytic peroxide of lead is higher than that which is obtained from any sample of the chemically prepared article. A difference in the specific resistance of the peroxide has also been noted, but according to the determinations made by Dr. Shield, this difference is so small that, in Mr. Hibbert's opinion, it cannot be taken as evidence that the electrolytic peroxide is in an allotropic state. Here again we are met with a conflict of opinion due to the different value attached to the existing experimental evidence by different authorities. The nature of the sulphate formed in the cell has long been a matter of dispute, if not of investigation, since Messrs. Gladstone and Tribe published their first work on the subject, but the weight of evidence leans in favour of those who hold with Mr. Wade that pure sulphate of lead is exceedingly difficult to reduce electrolytically, whereas the electrolytic sulphate is comparatively easy of reduction. The problems presented by the electrolysis of sulphuric acid and of solutions of lead compounds are exceedingly complex, as Dr. Armstrong pointed out, and we do not yet understand how lead peroxide is formed from the sulphate. So there is room for speculation concerning the intermediate steps of the process. But if the molecular compounds which Mr. Wade's theory postulates do exist, there is not much likelihood that they can be isolated, because of the extreme feebleness which he himself attributes to them. This, however, is no reason why an attempt should not be made to test the theory by experiment.

Although Mr. Robertson was unable to find any trace of a suboxide in the healthy E.P.S. plates examined by him, some analyses recently made by Dr. Peters show that whilst no difference is observable between the composition of the outer and inner layers of pasted plates in a healthy condition, the percentage of oxygen and of peroxide of lead in the central layers is distinctly higher in the case of plates which have become unhealthy and softened, so that it seems desirable that the subject should receive further investigation. Much information has been gleaned concerning what are the normal healthy functions of certain of our bodily organs by careful observations made of the disturbance of the system which is occasioned when they become diseased, and it is in a somewhat similar manner that we shall have to deduce by inference what the normal healthy reactions occurring in the lead cell really are.

Turning now to the general theory of the cell, we find that, while Dr. Armstrong agrees with Mr. Wade that the equation which expresses the double sulphation theory deals with final results only, he does not consider that we possess at present any evidence concerning the intermediate stages which may possibly exist. Mr. Hibbert and others support the double sulphation theory, while Mr. Allingham and Mr. Cooper each has an opinion of his own, so that Mr. Wade's statement that the conventional theory was not thoroughly satisfactory was fully justified by the divergence of opinion manifested during the discussion on his Paper. But if the theoretical portion disclosed a lack of unanimity among its hearers, the same cannot be said of the practical portion, concerning the merits and value of which all were agreed. Prof. Ayrton had much to say concerning the care which accumulators require, and pointed the moral of his observations by a reference to the failure of the London Electrical Cab Co. Mr. Wade could not explain by his theory the rise in potential difference to which Prof. Ayrton had alluded as occurring during the first few minutes of discharging a cell after a prolonged rest, but he showed how it could be made to account for the fact that much more energy could be put into a cell by constant potential charging than by constant current. In common with the other speakers, Prof. Ayrton dwelt on the importance of having a free circulation for the electrolyte and plenty of it, as well as a porous active material. The value of porosity was insisted on by one speaker after another, and it is to be hoped that Mr. Wade may one day realise his dream of securing an active material with a porosity comparable with that of charcoal. He has shown the direction in which our efforts should be directed if we wish to improve the lead cell, and for this we ought to be grateful to him, for according to his own showing it is exceedingly unlikely that any other combination of materials would give the same almost perfect reversibility in their chemical actions which lead, lead peroxide, and sulphuric acid do, and on which the successful storage of electrical energy by chemical means depends.

REVIEWS.

Copies of any of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price.)

La Télégraphie sans Fils. By André Broca. (Paris: Gauthier-Villars. 1899.) 3f. 50c.

It must be confessed that this book is disappointing, coming as it does from the pen of a physicist who is known to have devoted considerable attention to the subject of wireless telegraphy, and dedicated as it is to "those who, without being specialists, are nevertheless curious with regard to the progress of science, and to those also who wish to be *au courant* with the recent progress realised in its applications." The first chapter deals shortly with telegraphy by means of wires, and leads the way to the first section of the second chapter, "La Période variable." This variable period is elucidated by a pendulum analogy and then by a hydraulic analogy, and the remainder of the book is diluted with the latter to such an extent that it is at times difficult to taste the real spirit of it. (It should be mentioned, by the way, that the book is one of the "Actualités Scientifiques" series.) Here and there words of encouragement occur, telling us that the bearing of this or that on wireless telegraphy will appear later, but it is not until the reader has turned over the pages of half the book that he comes to a description of a Hertzian oscillator. To reach this point he has to pass, chiefly by analogy, through a long consideration of the propagation of an electric disturbance along a wire having capacity, resistance, and inductance, and thence to oscillatory discharges and their hydraulic counterpart. At this point we may quote the author: "Ceci a été démontré mathématiquement depuis longtemps." The title of Chapter V., "La Production des Ondulations rapides," raises hopes that we are at last entering upon the subject of the book, but here we are doomed to disappointment in the very first para-

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graph. The reader is told that there are two conditions for the production of an oscillatory discharge: one is that the disturbance may be considered as absolutely simultaneous in all parts of the conductor producing the rythmic oscillation; the other—will be understood by a further study of "our hydraulic model," and is only enunciated after two more pages of liquid, taps and pipes. But finally, at the eighth page of this chapter, we do come to the Hertzian oscillator.

The remainder of the chapter, describing various forms of oscillator, the next chapter (devoted to receivers) and Chapter X., on the arrangement of a wireless telegraphic station, are clearly written, but neither so complete nor of such a practical nature as might be desired; and the intermediate chapters are devoted to physical optics and to the author's hypothesis as to the *rôle* of the vertical wire. This latter, although not to be accepted without question, is the most interesting and novel part of the work. It would therefore be unfair to the author to reproduce it here, and we recommend those readers who wish to ascertain M. Broca's views to purchase the book for themselves.

Transmission de l'Electricité sans Fil. By EMILE GUARINI FORESIO. 2nd edition. (Liège: Henri Poncelet, 1900.) Price 2*f*.

The practical application of Hertzian waves to telegraphy, and the popular acclamation with which Mr. Marconi's work in this direction was greeted, have encouraged many to devote their attention to improving and extending the methods employed by this inventor. Some of these workers are proceeding quietly, working out detail after detail, and waiting to put the fruit of their labours to a public test until a favourable opportunity arises, the only evidence of what they are doing in the meantime being carefully filed in the Patent Office. Others conceive what they think to be epoch-making inventions, and, without going to the pains of submitting them to searching experimental test, take the sensational journalist into their confidence and trumpet far and wide the great discoveries they have made. The author of the brochure before us is apparently an inventor of the latter class. He has been duly mentioned in the lay and also in the technical press, and in fact a few weeks ago he sent us a copy of one of his patent specifications, with the demand that we should reprint it in our columns.

On the cover of the book now under review we read the announcement of a Guarini system of wireless transmission of electric energy for motive power, light, and heat, a Guarini system of wireless telephony, and Guarini telephone relays, and as a frontispiece there is a portrait of this energetic 20-year old inventor. With characteristic modesty, the preface commences:—

La télégraphie sans fil, système Marconi, était, dès sa naissance, destinée a de nombreuses applications: ces applications se multiplieront toujours davantage, grâce à nos répétiteurs.

The preface is succeeded by a reprint of a long appreciative article from the *Messager de Bruxelles*, in the course of which it is stated that M. Ernest Gérard, "chef de cabinet et ingénieur-en-chef au ministère des postes et télégraphes," has lectured on the subject of M. Guarini Foresio's system of wireless telegraphy at the Association Belge des Electriciens, and that, with the co-operation of the ministry, experiments are to be made between England and Brussels. Two more extracts from newspapers, and then we come to the main part of the book—namely, descriptions of M. Guarini's two patents. The first of these is for a repeater for use with wireless telegraphy. The conception of such an instrument is obvious. When the distance between two stations is so great that direct signalling by the Marconi method cannot be effected, an intermediate station can be added in which the receiving relay, instead of being connected to a Morse writer or syphon recorder, closes the circuit of a coil for retransmitting the signals by the same Herzian system. The solution of this problem is evidently nothing more than the proper working out of matters of such small detail that probably it will not be found difficult when occasion demands it: it will merely be a question of telegraph connections, shielding, and the diminution of sparking. M. Guarini's method of carrying out the translation of the message, however, shows several defects, of such a nature that one cannot believe that he has made any tests with it on a really practical scale. The first obvious necessity in such a repeater is to shield the coherer from the effects of the oscillator employed for retransmitting. Naturally, this can be done by placing the coherer in an iron box, as Marconi does, and adding an inverted relay or interrupter in the primary circuit of the induction coil, so connected that, as soon as a current passes through its main circuit to the coil, the connection between the coherer and the vertical wire is broken. A still better method would be to combine this relay with the main one, so that the same tongue which connects the coil to the battery disconnects the coherer from the vertical wire. Instead of doing this, however, M. Guarini places his interrupter in shunt with the coil, through a resistance; and it is not surprising to find that the working of the interrupter required "une certaine surveillance," so that this method is not considered quite suitable for repeaters which have to work automatically. He therefore suggests as an alternative that separate vertical wires should be employed for the receiving and transmitting instruments, and that they should be shielded from one another by metal partitions. He proposes to utilise this system to telegraph from London to New York by employing a suitable number of repeaters placed in the Bermudas, Azores, on anchored buoys, in Portugal, Spain, and France.

The second patent describes systems for telephoning and the wireless transmission of electrical energy for motive power, &c., and is too ridiculous for any detailed comment. Suffice it to say that the inventor describes combinations of spark-gaps, transformers, coherers, batteries, and relays, with coils of wire wound on conductors surrounded with a second U-shaped conductor. The one clear thing in the description of this second "invention" is that M. Guarini's knowledge of physics leaves much to be desired. There is an opportunity of obtaining excellent scientific instruction in his own country, Italy, and we should advise him to resume his studies before endeavouring to make further inventions and obtain greater notoriety.

Laboratory Note-Book for Chemical Students. VIVIAN B. LEWES and J. S. S. BRAME. (Archibald Constable and Co.)

This little work is in the shape of a reporter's note-book, and contains various directions to students interleaved with blank pages for notes. The authors say that "it cannot be too strongly impressed on students that the most valuable notes are their own." Having carefully regarded the text, and also the blank pages rich in potentiality, we are disposed to agree with this dictum.

The book embodies an endeavour to combine the old "test-tubing" with the modern method of teaching pseudo-quantitative chemistry. It attains the degree of success which might be predicted. The old plan was certainly far from ideal, but at least it did not pretend to do more than teach the student the grammar of analysis; the new replaces this with a number of experiments intended to demonstrate the quantitative basis of all chemical knowledge, but in reality calculated to implant in him inaccurate methods of thought and incurable sloppiness of manipulation. Such drawbacks are inherent in the system. This book has in addition errors in fact of its own.

The Practical Electrician's Pocket Book for 1900. Edited by H. T. CREWE, M.I.Mech.E. (London: S. Rentell & Co., Ltd.) 1*s*.

This pocket book contains, in a handy form, 50 pages of advertisements with a tabulated index, 200 pages of other reading matter, and some useful forms for entering particulars for estimates of wiring work and for jotting down notes of material required for work in hand. In reviewing a book it is generally considered sufficient to give an indication of its scope and literary style, its merits and its demerits. This is done for us in the following three quotations, the second of which is from the preface:—

As our readers will be probably those who are for the most part practically engaged in one or the other of the many branches of trade in which electricity now enters, and forms an important part of, it is not requisite to refer extensively to the different variety of applications in which this useful agent enters into the service of man, but only to note a few of its more general uses, and to place briefly and in simple language certain useful data and particulars as well as advisory remarks, which it is hoped

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may prove interesting as well as instructive and helpful to all who may be engaged in ordinary practical electrical work.

The great favour with which the first issue of the "Practical Electrician's Pocket Book and Diary" has been received, and the free and multitudinous expressions of appreciation and gratification which have been tendered by its patrons, serve fully to justify the opinion that this publication—notwithstanding the many shortcomings and faults unavoidable perhaps in a first edition—did indeed meet a want which was felt in the electrical trade, and particularly in those branches of the trade engaged in the more common forms of practical electrical work and its application to the ordinary commercial and domestic uses of everyday existence.

The ampere expresses a unit of volume of electrical current, and conveys the idea of quantity. . . .

The volt expresses a unit of intensity or force in the sense of pressure. . .

The watt expresses a unit of power or energy in a current, and is determined by multiplying the quantity of electrical current passing in a circuit in amperes by the pressure or intensity as expressed in volts. . . .

The ohm expresses a unit of resistance, and is used to signify the value of electrical energy absorbed in overcoming resistance of whatever nature in the path or course of an electrical current. . . .

Telephones: their Construction and Fitting. A Practical Treatise on the Fitting-up and Maintenance of Telephones and the Auxiliary Apparatus. By F. C. ALLSOPP. 5th edition. (London: E. and F. N. Spon, 1899.) 3s. 6d.

Except for the last chapter, which sketches briefly the principles upon which a multiple exchange is designed, the book is exclusively devoted to private line work. The first half explains in a simple manner, without making great demands on the reader's theoretical knowledge of electricity, the construction of the commoner forms of telephones and of their auxiliary appliances. A chapter on line construction is not unimpeachable; but the diagrams of the connections of simple private circuits, and also the hints given for locating and remedying defects, may serve their purpose, although few telephone engineers will agree with the author that "rubbing contacts may have the minutest drop of oil placed on them with advantage." The chapter on intercommunication systems is incomplete, and the final chapter, already alluded to, is not deemed worthy of mention in the "Contents." In a fifth edition it is surprising to find references to the old Birmingham wire gauge throughout, and to meet with the curious spelling "make-and-brake."

STORAGE BATTERY PROBLEMS.

DISCUSSION.

(*Concluded from page 895.*)

Prof. AYRTON, continuing, said that the curves (Figs. 5 and 6) gave results of an investigation communicated to the British Association in 1898, on charging a Tudor cell at constant current and constant potential. Keeping the current constant, the potential difference must rise very

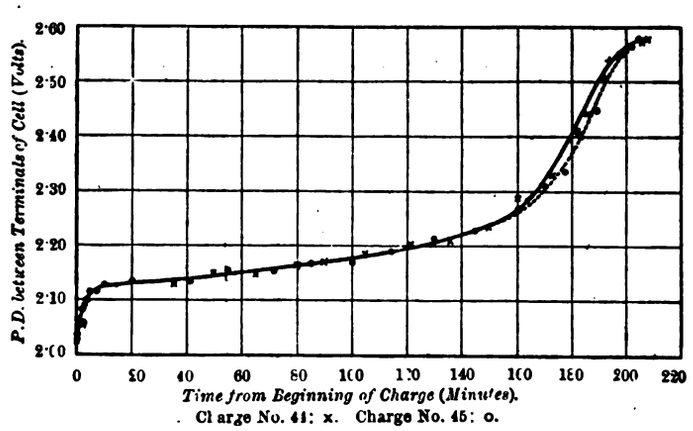

FIG. 5.—Tudor Cell Charging at a Constant Current of 20 Amperes.

rapidly towards the end, and there was a period during which there was a considerable waste of energy (Fig. 5). Mr. Wade had explained, or given what he considered was an explanation of the causes. But suppose, instead of having 20 amperes constant current and gradually increasing the potential, they started with 2·5 volts constant P.D. They would be able to put in the charge in a very much shorter time (see Figs. 5 and 6); in fact, the major portion of the charge could be put in in about 40 to 60 minutes, instead of 3 hours and 20 minutes; and, what was more important still, there was no "gassing." Apparently then it was not the high voltage that produced "gassing," as this did not occur until the end of the charge at constant P.D. The charging at constant P.D. puts more energy into the cell in a shorter time. Starting with a current of 170 amperes, and letting it fall, they diminished the time of charge to less than one-third, prevented all "gassing," and put more energy into the cell than by charging at constant current. Further, not only was more energy put into the Tudor cell at each of the charges at constant P.D. than at each of the charges at constant current, but, what is equally important, more energy was given out by the cell at each of the discharges after a constant P.D. charge than at each of the discharges after a constant current charge. This is shown clearly in the following table:—

Method of charging.	Watt hours put in.	Watt hours given out
Constant current	151·8	123
Constant P.D.	231·2	163

This, I venture to think, rather disproves Mr. Wade's views regarding the effect of rapid charging, for he says (*The Electrician*, March 23,

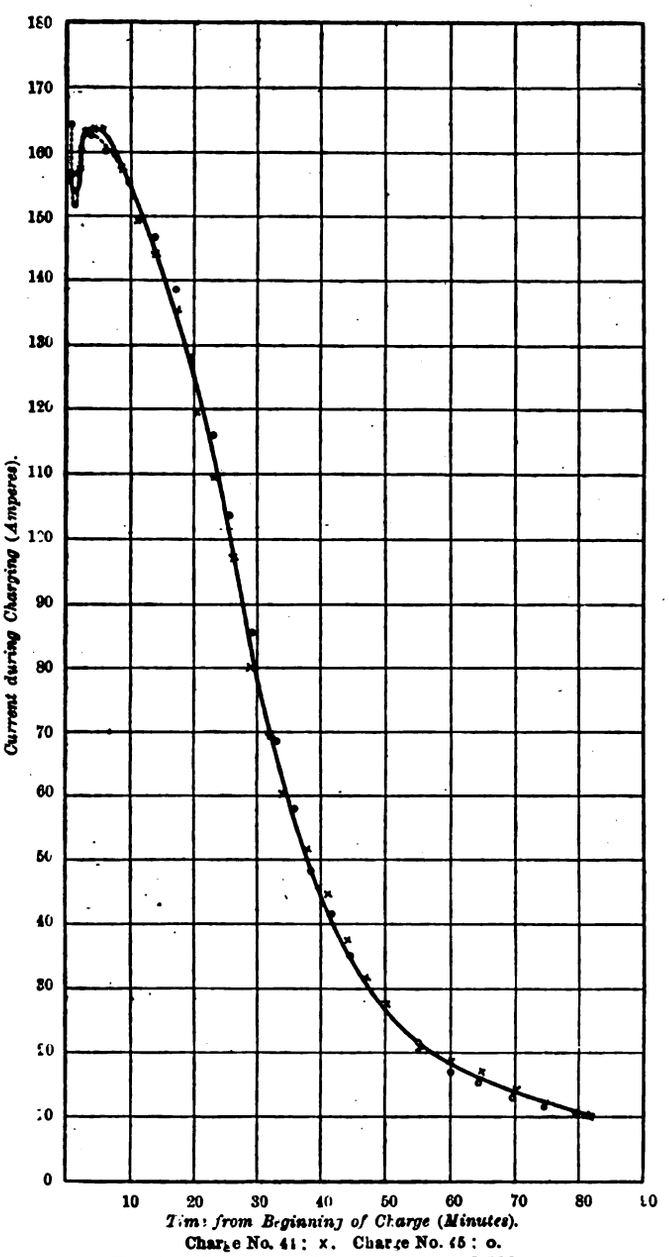

FIG. 6.—Charging at Constant P.D. of 2·508 Volts.

page 789): "The outer layers of active material will absorb more than their due proportion of the current, and by the time they are fully desulphated the inner layers, as yet only partially charged, will be surrounded by abnormally strong acid to enable them to maintain an equivalent voltage. Unless, therefore, the current is prolonged for a time after 'gassing' has commenced and the end of the recharge only determined by a sufficiently high potential difference being attained, there is some likelihood of the inner layers not receiving their proper charge at all." Whereas the above experiments show that by the use of a constant P.D. instead of a constant current, both the charge and the subsequent discharge can be increased without the use of a high potential at all and without any "gassing" having to be produced.

Mr. W. HIBBERT said that while he had a very high opinion of the Paper—perhaps as high as that expressed by Dr. Armstrong and Prof. Ayrton—he would not be able to so constantly agree with the author as they had done. After the experiments referred to by Dr. Armstrong in

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the very early days—the first year after Faure brought the accumulator to Lord Kelvin—he began working in Dr. Gladstone's laboratory on this subject, and personally had conducted every experiment made there from that day to this, so that both on the chemical and physical side he knew exactly the history of the storage battery. Up to the time at which that work was begun it had been the common practice to attribute the actions going on simply to hydrogen and oxygen, the presence and function of sulphuric acid being ignored. When the first Papers were originally published the new theory was not accepted. Dr. Frankland in the following year, 1883, proposed the same theory in a slightly different form, and since then repeated analyses had been made, all of which tended to confirm the notion, admitted even by Mr. Wade, that sulphate of lead *was* the thing which was actually formed in the cells. In the January number of *Science Abstracts* (p. 91) there was an exceedingly good Paper on the "Theory of Lead Accumulators," by M. Mugdan, which deserved close study, and which, he was afraid, would not altogether confirm some of the conclusions and positions taken by Mr. Wade. To begin with, Mr. Wade explicitly said that he founded his position very largely on the fact that the lead on the one side and the lead peroxide on the other were in allotropic conditions. Dr. Armstrong had said the Paper was exceedingly logical, and he would not venture for a moment to say a word about the logic of the Paper, but he did say the premisses were not right. He challenged the statement that the lead and peroxide of lead were in allotropic condition. This, as a matter of fact, depended on experimental trial and examination; and clearly, if Mr. Wade had wished to put the full force of this theory before them, he should have extended his work in that direction. The reason for his challenge was this: Mr. Wade quoted the work of Darrieus, who certainly did make certain experiments tending to show that the lead in an accumulator was in a different condition from that of ordinary lead, and in support of the argument quoted the fact that no mechanically prepared lead, even in a finely divided state, would give anything like the same capacity as lead prepared by electrolysis; and again, that the lead in a negative plate, if it be exposed to the air, rapidly underwent change, giving rise to a good deal of heat. But he himself had found, on repeating Darrieus's experiments, no confirmation of the result obtained. The experimental results differed somewhat. It was not an easy experiment to make, although superficially it looked like it. But he had made the experiment some 20 times, and did not generally get any confirmation at all of Darrieus's theory. It would be a folly for him to attempt to give any notion of the experiments that evening. On the other hand, his reason for stating that he did not think the peroxide plate was in allotropic condition was that Dr. Shield determined the electrical resistance of peroxide of lead prepared electrolytically on the one hand and by pure chemical agency on the other, and the specific resistance of the two materials differed by so small an amount that he thought it told very strongly in favour of the idea that they were not allotropic modifications of any material. Moreover, 17 or 18 years ago he himself made accumulators in which the negative plate was made of lead that had been precipitated from the acid by means of metallic zinc, a well-known method of getting finely divided lead; and so far as he remembered—he had not access to the books containing particulars of these experiments, which were made 18 years ago—they were really as good, having the same E.M.F. and the same capacity, to all intents and purposes, as when the negative plates were prepared electrolytically. For these reasons he ventured to say that the premiss of Mr. Wade's argument was not sufficiently well founded, and at the present time he did not think there was sufficient reason for supposing that lead and peroxide of lead were in allotropic conditions. He frankly confessed, as Dr. Armstrong had said, that there was a great deal yet to be discovered; but it was very important, in trying to find these things out, that they should remember what was already known. Now, in the Paper there was the following statement: "Fully-charged active materials maintain their normal condition with considerable tenacity, but it is quite possible that the very gradual loss of capacity so often experienced by negative electrodes, and for which no satisfactory explanation has yet been offered, may be due to a change of molecular structure." Clearly there was a tendency here to find explanations of changes in changes of molecular structure, yet in a Paper of Prof. Ayrton's—but which had not been referred to by Prof. Ayrton himself that evening—an explanation was given. In this Paper, published in the *Journal* of the Institution for 1890, the explanation given was that as the cells were allowed to stand, hydrogen gas was evolved from the lead plates by simple direct chemical action, without any action of the electric current. Lead sulphate was being formed in the pores of the lead plate, and the capacity necessarily diminished with time. Dr. Gladstone and himself had described the same effect in the *Philosophical Magazine* a month before Prof. Ayrton's Paper. Another German worker, and Mr. Swinburne, had noted the same effect, so that it would not do to go on making new observations until they were informed of what had already been done with regard to these matters. Again, the author had referred to the importance of porosity, and pressed it home—and very rightly so. But he ventured to draw the attention of the meeting to an addendum to a Paper read by Dr. Gladstone and himself in the session following Prof. Ayrton's Paper. The Paper was entitled "On the Cause of the Changes of E.M.F. in Secondary Batteries," and the addendum read: "Although we did not undertake this investigation with the object of improving secondary batteries, there is one suggestion we should like to make—*i.e.*, the desirability of promoting diffusion as much as possible. We believe that this is becoming more and more the practice among those who make accumulators, and the previous considerations furnish three reasons for such a procedure. It is well known that the accumulation of stronger acid at the lower part of a cell during its working is disadvantageous. This is believed to create differences of current density in different parts of the plate, and we have shown that it will give rise to potential differences of fairly large value on each of the plates, and thus produce local action and the formation of lead sulphate. This inequality would be diminished if the diffusion of the acid could be promoted." (Mr. Hibbert here interpolated that although no one appreciated Mr. Wade's Paper better than he, this first part of his addendum was a paraphrase of a passage in Mr. Wade's Paper.) "The fall of E.M.F. at the close of discharge leaves a large fraction of the effective material not acted upon. This is mainly due to the weakness of the acid against the plates on account of the interstices being so much clogged, and it would be counteracted to a considerable extent if the diffusion could be increased. When a cell has been discharged at below 1·8 volts, there occurred the destructive action called 'scaling.' We are disposed to attribute this to abnormal chemical action arising from the very weak acid, and if this be true, increased diffusion would in this case also act as a remedy." The next point, said Mr. Hibbert, was an attempt to give an explanation why it was advantageous not to work along the last part of the curve Prof. Ayrton had referred to. Why was it advantageous to cut off that last part of the curve? The Paper which he had referred to, and the addendum which he had read, gave the reason. The main argument of this Paper was that as the acid strengthened in the working materials, the E.M.F. changed, and consequently the P.D. varied very largely. Repeated experiments were described which showed that when the E.M.F.—and by that he *meant* the E.M.F.—had a value of 1·76, the strength of the acid in the pores of the plates was 1·2 per cent. When the E.M.F. had fallen to 1·5 the strength of the acid in the pores was but a trace only—it was not a measurable quantity. There was acid there—it was not pure water—but it was only just removed from it. If they would compare the data in the Paper of Dr. Gladstone and himself, from which he had been quoting, and the data derived from the curve exhibited by Prof. Ayrton, they would see that it was almost absolutely certain that at that point (viz., 1·5 volt) the acid had altogether left the pores of the cell, and they had, to all intents and purposes, pure water. As long ago as 1882 Gladstone and Tribe published not only the "double sulphation" theory, but also showed that if at any time or for any reason the acid chanced to disappear, the chemical action changed altogether—that was to say, they no longer got those normal sulphates. In the presence of a liquid which no longer contained sufficient SO_4 they got reduction, and therefore, after passing a P.D. of 1·8, they were dealing with a region in which the chemical action could no longer be the "double sulphation" theory. There are undoubtedly travelling molecules of hydrate of lead, and these existed, not in the electrolytic circuit where the sulphate was commonly formed, but in regions where it was no longer susceptible to action, and in its working it gave rise to sediment and scales. This was the reason why Prof. Ayrton and his colleagues got a sediment at the bottom, which, on analysis by Mr. Robertson, was found to be $PbO_2 + PbSO_4$. Again, the Paper stated that the sulphation theory could not altogether be true, because there ought to be a definite equation for a definite E.M.F., but the E.M.F. or P.D. was continuously falling, and consequently no equation could hold strictly throughout. This was a perfectly fair position to take; but Mr. Wade had ignored the fact that H_2SO_4 was something which could not be used alone. Water was also there, and if the equation was to be put in a different form, it must contain the term $H_2SO_4 . nH_2O$. Consequently the E.M.F. ought to change very slowly, which as a matter of fact it did.

Mr. G. H. ROBERTSON said he was quite unprepared to speak, but congratulated the author very heartily upon his Paper. It was one of the clearest statements he had heard for a very long while, and he thought they would be able to make progress in consequence of it.

Mr. G. L. ADDENBROOKE made some observations on the commercial aspect of secondary batteries, and referred to the value of accumulators as compared with the cost of supplying current by steam, having regard to the fact that steam engines were very often idle and that at other times it was inconvenient to run them. He had collected some information on this subject which he would communicate separately for publication in the *Journal*, and from which he concluded that it was possible to charge accumulators for something like ½d. per unit, and they could supply current at something like this figure. The cost of passing current or passing energy through accumulators, including the loss, did not therefore add much more than 1d. per unit on to the cost of electricity if it was furnished by steam engines working under good conditions. Hence, if they could increase the capacity of accumulators for the same price by about 20 per cent. or 30 per cent., as Mr. Wade had suggested, this would increase the field for accumulators three or four times.

Mr. G. C. ALLINGHAM wished to bring before the notice of the Institution that the primary action in discharging a cell was really one of single sulphation. Roughly speaking, when sulphuric acid was electrolysed hydrogen ions were given off the oxide plate and sulphate ions off the lead plate. The hydrogen ions simply reduced the peroxide to a lower oxide, which might probably be described as Pb_2O_3, and this would correspond to what Mr. Wade called 50 per cent. sulphation. This formula also seemed to him to explain very simply why the active materials could never be more than 50 per cent. discharged. The lead in the peroxide had an atomicity of 4, while when the peroxide was fully discharged the atomicity was 3. This way of looking at the matter seemed to him to modify one or two of Mr. Wade's arguments. Thus, the sulphation of the peroxide plate, being produced by a chemical action, depleted the pores of the plate in exactly the way Mr. Wade had described—the acid which was used for the sulphation of the spongy lead plate being acted upon electrolytically—and therefore the sulphation of the spongy lead plate was not carried out at the expense of the acid at all, and there seemed no reason why the spongy lead plate should be weakened. In fact, if it were possible that the spongy lead plate could be imperfectly sulphated, the acid in its pores would positively get stronger owing to the sulphated ions carried to the plate not being entirely absorbed by it. Any clogging of the spongy lead plate then would be due not to exhaustion of the pores, but simply to the conductivity of the active materials causing the outer layer to take more than its fair share of the load. During the discharge of course acid was liberated at both plates, but according to

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this view more acid would be liberated at the peroxide plate than at the spongy lead plate. Mr. Wade's Paper, to his mind, showed the importance of diffusion, not only into the pores of the plates, but also into the body of the cell. If there were no diffusion in the cell the acid would gradually exhaust and collect at the two plates, and this seemed to him to render hopeless the various attempts to make so-called dry accumulators by filling up some of the spaces between the plates with absorbent materials.

Mr. W. R. COOPER said that, although he appreciated the clearness of Mr. Wade's Paper, he thought it was a mistake to introduce further complications into a subject already so very complicated, if it could possibly be avoided. One felt tempted to ask whether all these complications were really necessary. If the accumulator had been born a primary battery instead of a secondary one, much of this trouble would have been missed. The difficulty had arisen from various causes, among which might be mentioned the attempts to deduce a satisfactory value for the E.M.F. from the Kelvin equation. The more general equation due to Helmholtz was commonly disregarded for unaccountable reasons. Further, most thermo-chemical data were inexact, and had been determined under conditions which differed from those in the cell. If the cell was looked upon as a primary one consisting of lead, sulphuric acid, and lead peroxide, the voltaic reaction which suggested itself was simply the formation of lead sulphate at the lead plate, the lead peroxide acting as a depolariser and being reduced by the polarising hydrogen to PbO or metallic lead, any sulphate formed at the peroxide plate being due to a secondary reaction. This view did not meet with approval, because the E.M.F. deduced from these reactions by thermo-chemical data was much lower than the observed E.M.F. of a secondary cell. But it was necessary to remember that the secondary cell differed very considerably from the primary cell. The electrolyte was not merely sulphuric acid, and that which was in the pores may be relatively concentrated. Spongy lead might also differ considerably from ordinary lead. Consequently, the usual thermo-chemical data might be inapplicable. This point of view had been taken up by M. Darrieus, who found that the voltaic difference between spongy and ordinary lead was 0·34 volt; and therefore concluded that the calculated E.M.F. was equal to that observed if such considerations were taken into account. Although Dr. Hibbert had apparently failed to confirm the results of M. Darrieus, he did not think that this simple view had received sufficient attention. A simple view was preferable to a complicated one, and it was to be hoped that further investigations would be carried in the direction indicated by M. Darrieus. Turning now to the Paper itself, Mr. Wade suggested a complex molecule for lead and the various lead compounds. He thought that there must be some misunderstanding on this point, as this view was held generally for all solids. In the case of spongy lead it would be expected that the molecules were *less* complex rather than *more* complex than those of ordinary lead, as this would more easily account for greater activity. We should expect activity to increase as the number of atoms in the molecule diminishes, for it was only necessary to go to the limit of atomic subdivision to obtain the maximum of activity. The author also suggested various complicated sulphates which conduct, but which were liable to pass into ordinary lead sulphate and thus lose their conductivity. There did not, however, appear to be any reason why these complicated salts should be better conductors than $PbSO_4$, and it was questionable whether the change in the conductivity of lead sulphate which was obscured when "sulphating" took place could not be more reasonably explained by simpler changes such as crystallisation, hydration, &c. The various complicated salts proposed by the author were theoretically somewhat improbable, and it is doubtful whether they gave a really simpler explanation than that afforded by mixtures. Prof. Ayrton appeared to regard charging at constant potential as a thing not easily done. He did not think this was the case. When the current was high there was a great deal of work to be done, and it could be easily done. When the current was low there was very little work to be done, and therefore very little "gassing."

Prof. AYRTON remarked that what he said was that they could charge the inner portions without "gassing." According to Mr. Wade's idea, they could not charge the inner portions of the porous material without having a high E.M.F. and "gassing."

Mr. COOPER thanked Prof. Ayrton for his explanation.

Mr. JAMES SWINBURNE thought Mr. Wade had gone over a great deal that had been gone over 10 or even 20 years ago, without giving any new reasons for his rather revolutionary ideas. The phenomena of secondary batteries could be explained, he thought, by the simple sulphate theory that had been accepted by very many people for nearly 20 years. There were of course matters which obscured the results. Firstly, sulphate of lead was a non-conductor. Mr. Wade seemed to regard the materials as mixtures of other compounds of very curious chemical composition, but most of the facts could be explained by remembering that the sulphate formed was an insulator, and that the sulphuric acid in the coatings was apt to get used up as the cell was discharged, so that the E.M.F. was dependent upon the strength of the acid in the pores. In dealing with the question they should always remember that the chief chemical action in the process of running a secondary battery down was the formation of water. Water was so cheap that they were apt to look upon it as nothing, but in chemistry this was a vital matter. Mr. Wade's statement that sulphate of lead could not be reduced to oxide was first mentioned by Lord Kelvin something like 20 years years ago, but unfortunately this was not the fact. They could take pure sulphate of lead, and either reduce it or oxidise it. On the other hand, Mr. Wade seemed to think that a battery could not possibly run down to pure sulphate: it might run down to one of his curious compounds, which would change for some reason of its own to pure sulphate. As a matter of fact, if they took a thin coating they could run it down until it was quite white. Anyone who had worked much with batteries must have been astonished at the difficulty to secure contact in the reduced plates, and this was always due to these very thin films of sulphate. The mixture of a conductor and an insulator would generally conduct until they got down to 15 per cent. conductor, at which point they would find as a rule it did not conduct. He was now having a large amount of work done in making heaters for the Nernst lamp, and the phenomenon of mixtures for insulators and conductors was very curious. The fact that a salt would sulphate was probably explained by the conducting body, consisting of sulphate of lead, and containing very little peroxide which would conduct, or very little reduced lead. Reduced lead, especially if left in contact with acid, was very apt to go into sulphate of lead. Thus the coating was practically insulated, and only with a considerable pressure could they make contact with the support, and they could not reduce it again. In conclusion, he made the remark that in all scientific inquiries, when there was a very simple explanation and a very complicated one, there were a large number of people who habitually preferred the very complicated one. Personally he preferred the simple explanation.

Mr. E. J. WADE said he must thank them for the leniency with which they had received some of his views, even when not agreeing with them, for he was painfully aware that in advancing new theories not supported by more direct experimental evidence he could not have complained had they been subjected to much severer handling. The first point he would deal with was the doubt expressed by Mr. Swinburne and Mr. Cooper as to the need for further attempts to explain what went on in lead cells. Had not the matter already been substantially thrashed out and stated in its simplest terms, and was he not merely setting up imaginary difficulties in order to knock them down again with ingenious and complicated arguments? This question was most vital to the whole scope and purpose of the Paper, for were the answer in the affirmative he would stand convicted of having most unnecessarily occupied the valuable time of the Institution. Mr. Cooper thought that if secondary cells had only been used as primary cells there would not have been all this bother about them. Possibly there would not. As long as their employment in the engineering and electrical world had been limited to that of primary cells, the general statements already available might have been quite sufficient for all practical purposes; but the speaker thought they might rather reverse Mr. Cooper's dictum, and say that if primary cells had been born secondary cells many of the accepted explanations regarding them would long ago have had to be overhauled and far more explicitly stated. Mr. Swinburne had considered that the discharge of a cell could be expressed, so far as the electrodes were concerned, in terms of the formation of normal lead sulphate, and that the cell's behaviour could in all respects be reconciled with that assumption. Here they came to what was and always had been the crux of the whole matter, and he had stated in his Paper the chief and to his mind fatal objection to that view. He read the few lines referred to: "Normal lead sulphate is probably quite irreducible if not unperoxidisable, in a dilute sulphuric acid electrolyte of the strength ordinarily used in storage cells, *provided all the materials are absolutely pure*, for the smallest traces of impurities make a remarkable difference in this respect. But however that may be, there is no doubt as to its being acted upon with extreme slowness, under the most favourable conditions in admixture with other materials of a more conductive nature, and then only with an excessive outlay of energy in proportion to the result obtained; whereas both the active materials can be brought back to their original states of lead and lead peroxide with great rapidity and the expenditure of very little more current than is theoretically necessary. This discrepancy, as well as the almost complete masking of other properties of the normal sulphate, can hardly be explained as due to its state of extreme subdivision and intimate admixture with unaltered active material, for under certain well-known conditions of treatment it does appear in full possession of its distinctive colour and with its conductivity and irreducibility aggressively in evidence." Before writing that he had carefully considered all the experimental evidence bearing on the subject, and he did not think he had said anything that could not be justified. The most debateable part referred to the reduction of normal lead sulphate. Both Lord Kelvin and Dr. Lodge were unable to reduce lead sulphate electrolytically. Then Messrs. Gladstone and Tribe obtained its reduction, and later on Mr. Swinburne also found that it reduced. But meanwhile Dr. Lodge, aware of the results obtained by Messrs. Gladstone and Tribe, carefully repeated his experiments, and still he could not reduce the pure sulphate. He himself had several times tried to reduce it electrolytically without success, but had found that the result may be very easily modified by the presence of impurities. It appeared to him that all the evidence was against the possibility of the normal sulphate being either reduced or peroxidised with anything approaching the rapidity and efficiency with which those operations are performed every time a cell is charged; and he maintained that, if for no other reason, this alone would render it necessary to somewhat modify or supplement the usual explanation. At present they tried to explain the reaction of lead with sulphuric acid as if it were an exactly similar one to that of zinc and sulphuric acid, whereas there was an essential difference between them. In the latter case the resultant compound was a soluble one; the molecules of zinc taking part in the reaction passed into solution and their relations with the remainder of the electrode were thereby entirely ruptured. But in the case of lead, the sulphate being insoluble, the lead molecules did not acquire the same freedom of motion and were unable to change their position. This being so, it seemed extremely probable that, besides reacting with the sulphion ions in the electrolyte, they also remained in feeble and unstable combination with other lead molecules in the active material; and this was what the view he had ventured to put before them practically amounted to. He need hardly remind them that the question to be decided was not which was the simplest theory, but which was the true one. It was no use sticking to a simple theory on account of its simplicity if it did not really explain the facts. At the same time he did not think, if properly looked at, his

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account of the cell's reactions was really more complicated than the one generally accepted. All he proposed was that for any given output, instead of saying, as they should in the case of a zinc electrode, that so many molecules had been fully converted into normal sulphate, they should say that the whole number of molecules in the electrolytic circuit had passed through a certain degree of sulphation. He thought perhaps in his Paper, by assuming for illustrative purposes lead molecules of a specified constitution and working out a formidable series of compounds on that basis, he had chosen a rather clumsy method of expressing himself, and had obscured his real meaning. If he had merely given the general case in the form of an algebraical equation it would probably not have appeared so complicated. Dr. Armstrong put the query as to whether the sulphated compounds really helped matters much, because they had to be assumed of such very unstable constitution. No doubt in some ways it must appear something of a quibble to attach so much importance to the difference between an extremely intimate mixture and an extremely feeble compound, but all the same the two phrases served as the basis for two entirely distinct lines of reasoning, and very important differences of physical structure and properties might sometimes result from most insignificant alterations of chemical equilibrium. As he had been somewhat reproached with introducing unnecessary complications into an extremely simple problem, he was very glad to hear someone who could speak with so much authority as Dr. Armstrong calling attention to the fact that there were other complications connected with the formation of lead peroxide and the changes occurring in the electrolyte of which he had practically taken no notice at all. This was simply due to his endeavour to leave out everything that did not directly bear on the special points he wished to bring before them, but it was as well they should be reminded how much obscurity was still attached to what was after all the fundamental action in a storage cell—the electrolysis of dilute sulphuric acid.

Mr. Hibbert had given several reasons for not considering the active materials to be in an allotropic condition. Of course, so far as he had obtained results opposed to those of Darrieus, he weakened the positive evidence in favour of allotropy, and, as was generally the case in all attempts to clear up those matters, they were left in the puzzling position of having to decide between conflicting data. He did not think his other two reasons applied to the case. He certainly expected spongy lead precipitated from solution by zinc to give the same E.M.F. effects as ordinary negative active material, for he believed lead obtained by all such processes to be in an allotropic state, and did not think there was any electrolytic method, such as the one in question essentially was, by which lead could be deposited in a normal condition corresponding for instance with ordinary electrolytic copper. As to the comparison of the specific resistances of electrolytically and chemically prepared lead peroxide, he doubted the possibility of any conclusions bearing upon the question of allotropy being drawn from Dr. Shield's experiments on these substances in the form of compressed powders. The measurements were only incidental to an investigation carried out with quite another object, and the results would probably vary with every difference in the degree of pressure and the size of the particles of which the powders were composed and the precise electrolytic process by which the peroxide was procured. As it was, the results showed a difference in resistance of over 15 per cent., which might equally well be construed in favour of allotropy as against it; but had the difference been 50 per cent. or nothing at all he should, under the circumstances, attach no value to it.

He was sorry that the portion of the Paper relating to the necessity for increasing the porosity of the active materials and the rate of diffusion into them had been somewhat misunderstood. After giving some definite figures to show how defective the active materials of commercial cells were in this respect, he had, he said, stated in his Paper that "As long ago as 1889 Messrs. Duncan and Wiegand called attention to some of the results that must ensue if proper diffusion were not provided for; and Messrs. Gladstone and Hibbert, in their communication to this Institution in 1892, also indicated some of the effects probably due to this cause. In the latter instance, however, they were considering the matter chiefly in its relations to the E.M.F.s of cells under various conditions; and I think it yet remains to be recognised how far-reaching are the consequences of defective diffusion, and how many of the faults and shortcomings of the cells may be attributed to it." He thought that had made his position in the matter quite clear, and he had then proceeded to work out the whole case against insufficient porosity, indicating in what parts of the active materials and under what conditions the different effects occurred. Mr. Hibbert was quite right with regard to the extract he read at the last meeting from Dr. Gladstone's and his own Paper in 1892 regarding the effect of the weak acid in the pores in a cell's output and the production of abnormal compounds. Although considerably elaborated and with some important modifications, its substance did appear again in his (the speaker's) Paper; and it was essential to his object that it should do so, for he was endeavouring to collect the previously scattered and sometimes indefinite statements, and embody them all in a precise and definite whole. He did not think there was anything to suggest that he imagined he was the first person to study porosity and diffusion. As a matter of fact, the paragraphs quoted by Mr. Hibbert were in their turn covered by a still more general statement of the same points made by Mr. Swinburne in the Paper he read before the Institution in 1886.

There was a second point in the Paper which appeared to have been still more completely misapprehended, and that was with reference to the gradual loss of capacity so often experienced by negative electrodes, which he had said had never yet been satisfactorily explained. Mr. Hibbert had pointed out that this was due to the discharge or sulphating of the spongy lead by local action with the electrolyte, and he gave quite a number of authorities who had previously mentioned the fact. He thought perhaps he might have made himself clearer, but it never occurred to him that he should be thought at that time of day to be still trying to explain that simple and well understood effect. The loss of capacity referred to was one spread over a much longer period and much more permanent in its nature. It was usually supposed that negative plates would outlast two or more sets of positives. Where the conditions of working were severe and the life of the positives for this or other reasons short, such was generally the case; but if the battery had been well treated and the positives had lasted a long time, it did not usually follow. Thus, after five or six years the capacity of a battery had fallen very low, and the negatives apparently were in as good condition as when first put in, but the positives had shed most of their active material and were with difficulty prevented from buckling. Obviously the positives were at fault and must be replated; but when this had been done the capacity was found to be not a whit improved, and finally the negatives had to be renewed also. This was a very usual occurrence and illustrated the phenomenon he was alluding to. Without any loss of active material, the capacity of all negatives of whatever type steadily decreased in the course of time. In some cases it would be an extremely slow process; in other cases, perhaps in certain types or even only in certain batches of cells, but without any apparent reason, a large proportion of the capacity would be gone in a year or two; and when a manufacturer had to guarantee a battery to still give a specified output at the end of a certain time, he would probably be considerably more anxious about the negatives and the margin of capacity he should allow in them than he would be about his positives. It was also curious that the capacity might be restored by renewal if the electrodes were of a construction which admited of that treatment. The late Mr. F. King was, he believed, the first to call attention to that behaviour of negatives in the course of the discussion on Prof. Ayrton's Paper on "The Chemistry of Secondary Cells" in 1892, and he then pointed out that it was accompanied by shrinkage of the active material. The effect was certainly not due to sulphation. The loss of capacity might be chiefly a matter of loss of contact with the support, and such Mr. King seemed to think it was; but even then it would only be the result, not the cause, of the shrinkage, and he (the speaker) was inclined to put it down to some molecular change. He was relieved to find that the most trenchant portion of Prof. Ayrton's criticisms was directed against the Electric Cab Co. and not against himself. He, however, put two questions. The first was as to the cause of the rise in potential difference observed during the first few minutes of discharging a cell after a prolonged rest. He had often puzzled over the curves showing this effect, but had never been able to hit upon an explanation which was at all satisfactory. He might hazard something to meet the case, as had previously been done, were it not for two things: First, there were other curves in the series from which those in question were taken that did not show rise of potential difference on discharge after a similarly prolonged rest; and secondly, it took several discharges, each following directly on the previous charge, before the rise was wiped out and the curve restored to its normal shape. The second question was how so much more energy could be put into a cell by constant potential charging than by constant current, especially having regard to his view that the higher the charging current the more liability would there be for the inner layers not to receive their proper share. The two certainly did not at first sight appear to fit well together, but he thought the explanation might be that he assumed the outer surface of the active materials worked in an electrolyte of the same, or nearly the same, strength as that contained in the main body of the cell. This must hold good for all ordinary charging rates, and if so an unequal distribution of the current would necessarily follow. But when such relatively enormous currents were used as flowed during the first portion of a charge at constant potential, the acid would be released in the pores of the active materials with such extreme rapidity that the main body of the electrolyte would be pushed back, and every portion of the active materials would be surrounded by much stronger acid. When that happens, although the whole potential difference of the cell would rise rapidly, the distribution of the current throughout the active material would become more uniform and consequently the inner layers would receive a better charge. By the time the current had dropped down to what would, under ordinary circumstances, be considered a high charging rate, the whole charge of the cell would then be too nearly completed for the unequal distribution that then set in to make much difference to the final result.

ELECTRIC MOTOR CARRIAGES AT ISLINGTON.

An interesting and instructive exhibition of the latest types of automotor vehicles is in progress at the Agricultural Hall, London, N., and remains open to the 21st inst. The exhibitors include several well-known firms in the electrical industry, who have on show some excellent examples of electric vehicles. The centre of the vast hall at Islington is arranged for trials of speed and control of the vehicles on exhibition, and on the occasion of our visit we were much impressed with the advances made since the last show of the kind. Opinions may differ as to the probability of the early advent into the crowded city thoroughfares of the auto-motor car and carriage, but the show at Islington proves conclusively that the pioneers in the invention and construction of this class of vehicle are showing laudable enterprise in its evolution. Such a show as is now being held would have been regarded but two or three years back as a quite remarkable one, and this point applies, we think, with especial truth to the electric carriages, which, without noise, vibration, or apparent effort, traverse the driving track and pass in and out of the obstacles with ease and grace. So much is this the case that it seems unfortunate

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that more control and direction is not given to these speed and handiness tests. There is too much go-as-you-please in the railed-off space large as it is, with the result that the more venturesome of the drivers act in a manner which tends to alarm the more timorous onlookers. Those who are responsible for these shows may rest assured that the travelling public are not likely to take more kindly to the horseless vehicle from seeing its almost uncanny handiness displayed in a reckless manner. On Tuesday evening an accident occurred which, to our knowledge, made a considerable impression upon a number of persons present in the hall, and this spill was wholly occasioned by the recklessness (or, perhaps, selfishness would be a better term) of one of the drivers in "showing off." Not nearly enough attention is given to this question of the careful education of the public in the observation and ultimate admiration of the mechanically driven vehicle. This is, we urge, unquestionably the main point (we had almost written the only point) to be observed in shows of this character.

The electric vehicles shown by Mr. Carl Oppermann, by Headland's Co., and by Messrs. Shippey Bros. are unquestionably far ahead of any electric vehicles previously exhibited, and, judging by remarks made by the spectators, came in easily first for public favour. An entire absence of smell, of bumping or kicking, and the idea of smart compactness which these vehicles convey is their great recommendation. The electric vehicle exhibits will be found at stands No. 11 (Mr. Carl Oppermann), where two Victorias and a dogcart are shown; Nos. 32 and 33 (Electrical Undertakings, Ltd.) (here there were no vehicles exhibited on the occasion of our visit); No. 41 (Shippey Bros., Ltd.), a three-wheel "Runabout," a four-wheel phæton to carry three persons, an Oxford sporting dogcart to seat four persons and a Victoria (this is a well-equipped exhibit on a fairly large scale, and compares favourably with any exhibit at the hall); No. 54 (Headland's Patent Electric Storage Battery Co., Ltd.), where two mail phætons and a Victoria can be seen. Any of the electric vehicles are ready for running, we believe, at very short notice, and one at least from each exhibit takes its place in the show arena throughout the day and evening.

Most of the oil-motor vehicles are fitted with electric ignition devices, several of which are on show. The remaining electrical exhibits include a display at No. 6 of the Hart Accumulator Co. (a good show of traction cells, &c.), at No. 48 of Messrs. Peto and Radford (accumulators for sparking coils, &c.), at No. 77 of Le Carbone (dry cells, carbon brushes, sparking pieces, &c.), at No. 85 of the Meyra Electric Co. (Meyra dry batteries, electric clocks, &c.), and at No. 42 of Messrs. Stern Bros. (lubricants, jointing materials, and general motor-car sundries).

Altogether it will be seen the exhibition is really well worth a visit, not only from those engaged in motor-car work, but from the general public, who can spend a pleasant hour among the hundreds of spick and span vehicles of multifarious design and their accessories which go to make up the outward and visible signs of the progress of the very much alive horseless vehicle industry. The exhibition is under the control of the Automobile Club of Great Britain, whose committees of management and list of members give evidence of the interest taken in the auto-motor movement by leading members of the electrical profession at home and abroad.

THE INFLUENCE OF VAGRANT CURRENTS FROM ELECTRIC TRAMWAYS UPON MAGNETIC OBSERVATORIES.*

BY DR. J. EDLER.

The following investigations were made at the instance of the director of the Royal Meteorological Society (Dr. von Bezold), who, in order to protect the Potsdam magnetic observatory, which is under his charge, lodged an objection to the establishment of an electric tramway with overhead supply and rail return within a radius of 15 kilometres of the observatory. Such a large area of protection appeared desirable in view of the delicacy attained by the terrestrial magnetic observations at Potsdam, since Herr Strecker had succeeded in detecting the influence of a "cut-up" continuous current even at a distance of 17 kilometres, under conditions which might easily occur in tramway practice. But in order to meet all possible objections, it was thought better to justify the demand by observations of our own.

The apparatus used for those observations were those described by Eschenhagen, consisting in the first place of a sensitive intensity variometer indicating the disturbances normal to the magnetic meridian. The instrument had a magnetic system weighing 2·3 grammes, suspended by a thin quartz fibre. By the torsion of this fibre the magnet was brought out of the magnetic meridian into the direction at right angles to it, and in that position it indicated the variations of the horizontal intensity. The sensitiveness of the instrument was obtained with great accuracy by comparison with Potsdam curves for those periods during the night at which the railway was out of use. For the amplitudes of the natural variations can be safely taken as identical for places as close together as Spandau and Potsdam. In the curves obtained an ordinate of 1mm. corresponds to a disturbance of 4×10^{-6} absolute C.G.S. units.

Another instrument was used for determining disturbances in other directions. It consisted of two induction coils (Fig. 1), which, in conjunction with a galvanometer, indicated disturbances produced by currents at right angles to the axis of the two coils. Each of them had 3,000 turns of copper wire with a total resistance of 20 ohms. The core consisted of transformer plates, with a weight of 48 kilogrammes and a length of 45cm. When the core coincides with the magnetic meridian, the deflection of the variometer produced

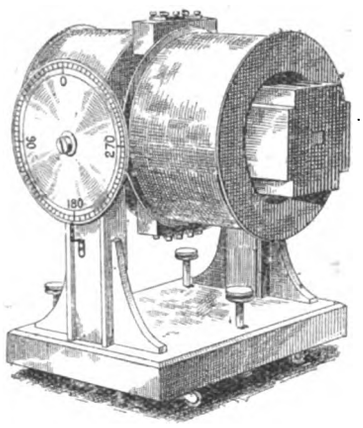

Fig. 1.

by a sudden change in the strength of the vagrant currents is proportional to the current induced in the coils, and hence also to the deflection of the galvanometer. The ratio of the two deflections is the reduction factor by which the deflections shown by the galvanometer in any direction may be reduced to absolute measure. In this particular the present observations differ from preceding ones, in which, as far as I know, only declination disturbances have been observed. But these may very well be negligible and yet be accompanied by profound variations of the horizontal intensity.

In order to obtain information as to the manner in which disturbances decrease with increasing distances from the tramway, it was desirable to carry out measurements on tramways of the simplest possible shape. For this purpose the electric tramway of Spandau

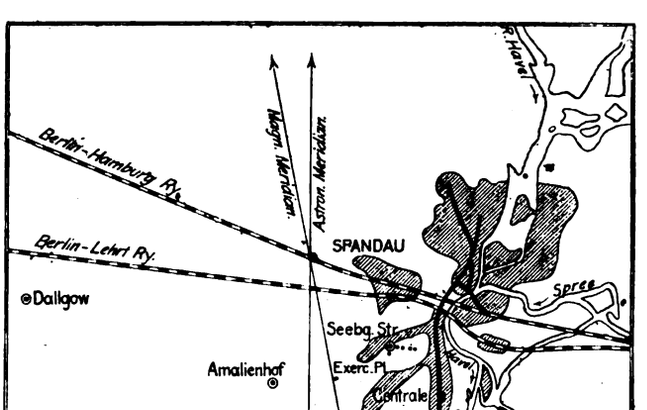

Fig. 2.

appeared very well suited, since it has practically only one direction, north and south, and because a chance offered of determining whatever influence the river Havel might possess upon the course of the vagrant currents. The distance between the two extreme ends of the tramway is 5 kilometres. The central station is not far from the southern end of the tramway at Pichelsdorf (see Fig. 2). On week days about 15 motor cars and two trailing cars are running, and on Sundays and holidays there are about 21 motor cars and six trailing cars. The supply wire of the continuous current is overhead, as usual. Two stout copper ropes serve to convey the current from the rails to the machines. The E.M.F. is 500 volts.

Experiments made by the company show that only a small proportion of the current returns through the earth instead of the rails.

* Abstract from *Elektrotechnische Zeitschrift*, March 8.

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I must remark at once that within the area in which a direct effect of the current rectangle was to be expected no observations were made, and that that source of disturbances was excluded in all the actual records. The situation of the various observing stations with respect to the tramway and the river is shown on the map (Fig. 2). The curves in Fig. 3 show the disturbances of the horizontal intensity at Amalienhof, Dallgov, Pichelsberg (across the Havel), and Pichelswerder, compared with the undisturbed records obtained during the same periods at Potsdam. The scale differs on the various records. It is annexed to each curve in terms of $1\gamma = 0{\cdot}00001$ C.G.S. unit. The magnetometer was in all cases made highly sensitive, but it must be borne in mind that for all stations near Spandau the greatest possible magnetic disturbance takes place in a direction different from the meridian, and that this chief disturbance in some cases is several times the disturbance of H. For the numerical evaluation of the disturbances the peaks of the disturbance records were measured one by one along parts of the curves about 20 cm. long for each of the stations, and then the mean amplitude of the disturbance was calculated. The average time between two reversals was 5·4 seconds.

In the following table are given the distances D of each station from the tramway, their heights H above level of the Havel, the disturbances of horizontal intensity in a N.S. direction a_x, an E.W. direction a_y, and their vector sum a_f as well as the disturbances of of the vertical intensity a

Station.	D.	H.	a_x.	a	a_f	a_s.
Spandau—	km.	m.	γ.	γ.	γ.	γ.
Exercierplatz.....	0·38	3·5	3·3	6·9	9·5	20·2
Ditto	0·64	3·5	2·3	5·6	6·1	10·6
Ditto	0·92	3·5	1·7	4·0	4·3	4·3
Amalienhof	3·01	3·5	0·74	1·1	1·3	0·95
Dallgow	7·48	3·5	0·20	0·39	0·44	0·24
Pichelsberg	1·54	16·0	1·2	0·71	1·4	1·0
Pichelswerder	0·92	8·0	1·3	1·1	1·7	1·1

The absolute maximum disturbances are often two or even three times as great as the mean disturbances.

At a station near Neu-Zehlendorf, south of Berlin, only such disturbances could be traced as would correspond to the maximum disturbances of the curves shown.

On multiplying the disturbance a_f by D for each station, it is seen that for all stations whose situation is similar with respect to the railway the product is practically constant. This implies that the disturbance is inversely proportional to the distance. Assuming that a_f is proportional to the density of the vagrant currents, it follows that this density also is inversely proportional to the distance. This would mean that the currents are propagated approximately in a plane. It is indeed very probable that these vagrant currents, like ordinary earth currents, are propagated at a small depth below the surface of the earth in the better conducting moist ground.

The case is quite different for the vertical intensity. Near the tramway Da_s is considerably larger than Da_f, but at greater distances it is smaller. Assuming that a relation exists between D and a_s of the form

$$a_s = \frac{K}{D^n}$$

the value of n is easily determined from the observations.

By a graphic representation in accordance with the logarithmic equation

$$\log a_s = \log K - n \log D$$

we find

$$n = 1{\cdot}5 \text{ and } \log K = 0{\cdot}7.$$

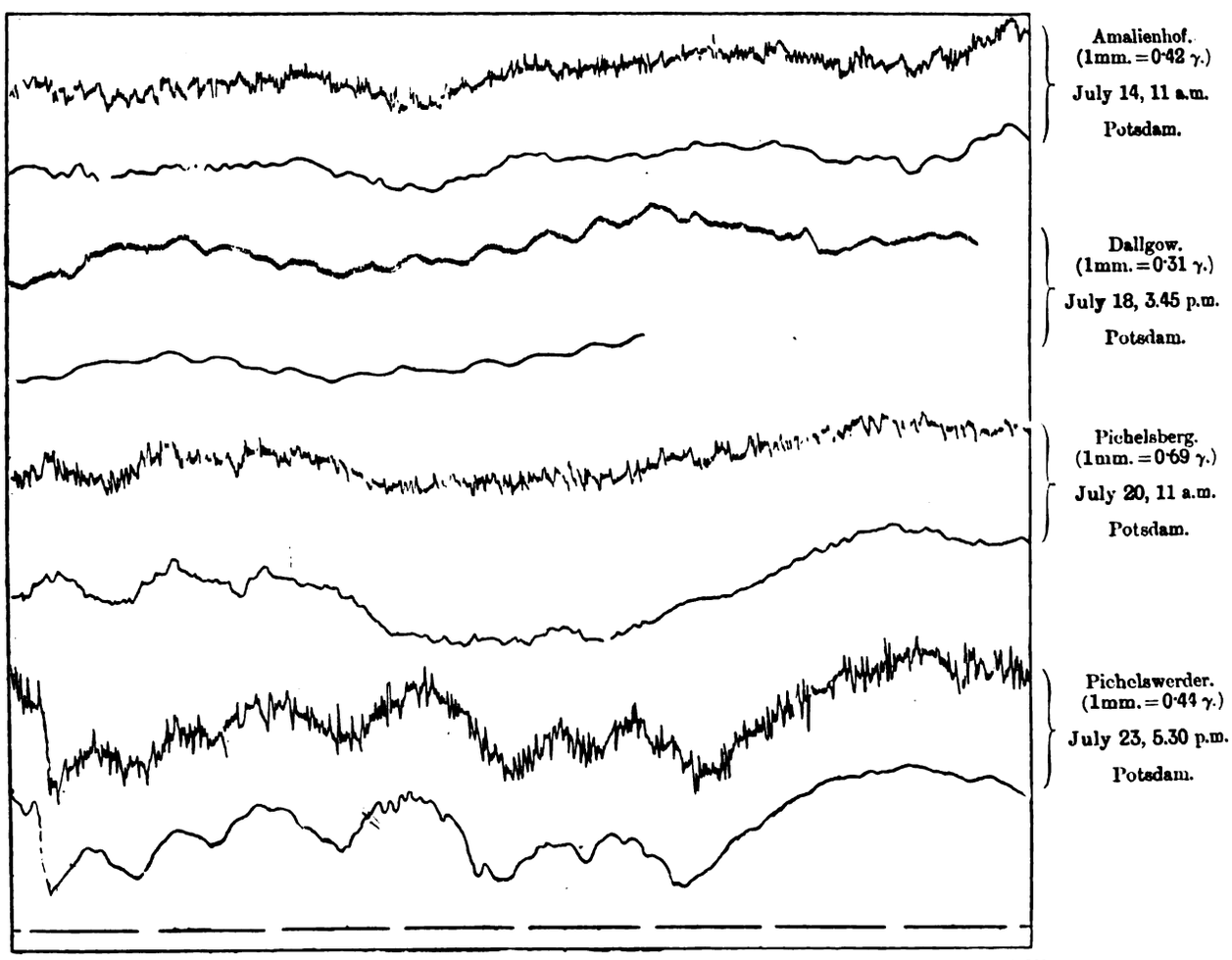

FIG. 3.

With these approximate values, the calculation was carried on by the method of least squares, and the result was

$$n = 1{\cdot}521, \text{ and } \log K = 0{\cdot}6913.$$

The difference between these and the approximate values is slight and lies within the errors of observation. The equation

$$\log a_s = 0{\cdot}7 - 1{\cdot}5 \log D,$$

or

$$a_s = \frac{5{\cdot}012}{D^{1{\cdot}5}}$$

renders the observed values very closely.

For our further investigations we shall consider a portion of the tramway in which the vagrant currents have a direction nearly parallel to the rails, as shown in Fig. 4. A horizontal iron bar would, if approached from the left side in a direction normal to the current, be magnetised more and more by the lines of force due to the current until it reaches the current itself. Hence the magnetisation decreases symmetrically towards the right, but in such a manner that the sense of the disturbance (magnetisation) remains the

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same on both sides. A vertical iron rod is at every point influenced by the current lines close to the rails in a manner opposed to the influence of the current lines at greater distances from the rails. We have here to deal with a differential effect, and hence the vertical disturbance depends upon the decrease in the density of the current lines with increasing distance from the rails. Hence also the magnetisation of the iron rod is reversed when it arrives at the opposite side of the rails. The reverse process happens when the operation is performed in the vertical direction

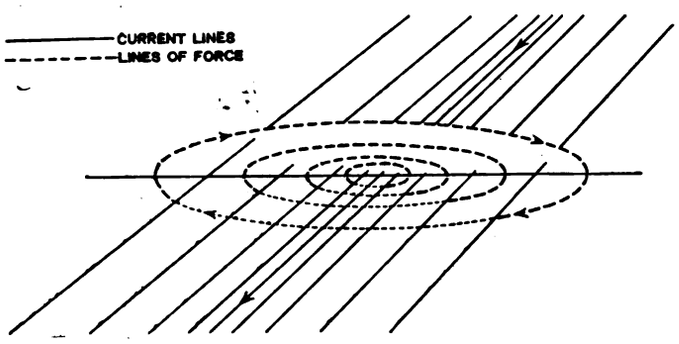

FIG. 4.

In Fig. 5 these relations are shown in a graphic manner, the disturbances a_f and a_s being abscissæ and the disturbances D ordinates. The two branches of the a_s curve may also lie in the other quadrants, but it is characteristic that they lie in diagonally opposite quadrants, whereas the a_f curves lie in adjoining quadrants. To express these facts mathematically we have to write

$$a^2 = \frac{k^2}{D^2},$$

and

$$a_z^2 = \frac{K^2}{D^3},$$

The right-hand side of the last equation may be considered as obtained from the first by differentiation. Such a connection

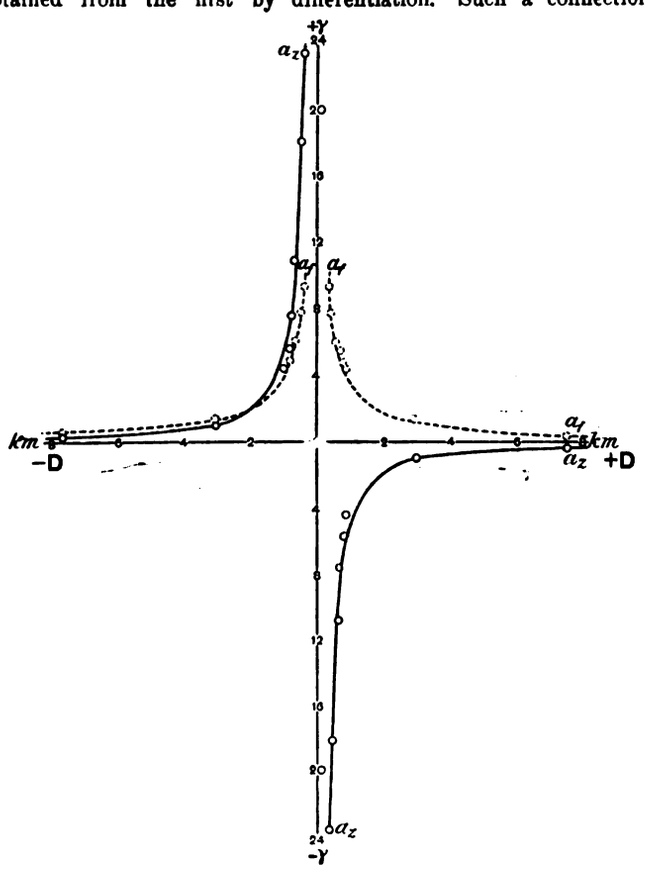

FIG. 5.

between a_f and a_s is made probable by the fact that a_f must be regarded as proportional to the sum of the current lines at the station in question, whereas a_s must depend in some manner upon the decrease of the current lines—*i.e.*, upon the differential coefficient of the current with respect to the distance. Then, since

$$\frac{d}{dD}\frac{k^2}{D^2} = \frac{2k^2}{D^3},$$

we must have $-2k^2 = K^2$, or $i\sqrt{2}k = K$.

The imaginary quantity i indicates that the disturbance a_s deduced from a_f is normal to the latter, as we know to be actually the case. For K we had the value 5·012. The mean value of $k = Da_f$ for the first few stations is 3·75, while

$$\frac{K}{\sqrt{2}} = 3{\cdot}54.$$

The agreement is somewhat remarkable if we consider that all the values found are mean values derived from very varying individual values. The decrease of the horizontal disturbance is related to that of the vertical disturbance in a somewhat similar manner as is the decrease in the action of a single magnet pole to that of a pair of poles. The circumstance that a_f and a_s appear squared is accounted for by the fact that the whole energy of the vagrant currents is forced to develop itself in a plane instead of in open space.

For the easterly stations, Pichelsberg and Pichelswerder, the products Da_f and Da_s have essentially lower values. This shows that the squared equations above only apply fully to those parts of the tramway at which the vagrant currents have the maximum lateral expansion and their course is nearly parallel to the rails. If the central station is nearer to one end of the tramway, the region of maximum expansion of the currents will not lie quite in the middle, but nearer to the central station, and the nearer the more numerous the cars running on the tramway at the same time.

In our case we may assume with sufficient accuracy that the point of greatest lateral expansion lies there where the Seeburger Strasse and Kloster Strasse meet. Let this place be indicated by the line $-DS+D$ in Fig. 6.

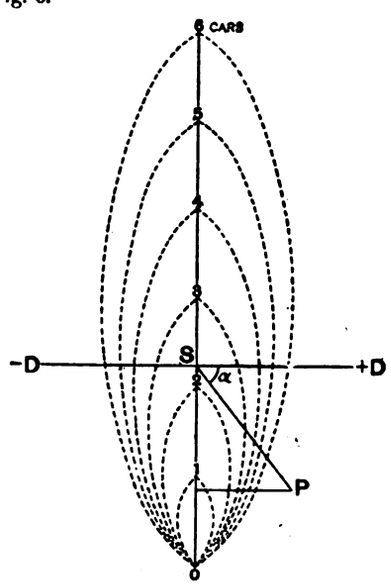

FIG. 6.

From the observations at Pichelsberg and Pichelswerder we may conclude that for any point P outside the line $-D+D$ the formulae retain their validity if D is divided by $\cos\alpha$, where α is the angle between PS and the line DD. For Pichelsberg and Pichelswerder we then obtain by the formula

$$k = a_f \frac{D}{\cos\alpha}$$

the values 3·7 and 3·5 respectively for k.

The second equation would give us $k = 2{\cdot}9$ or $2{\cdot}6$. Since both stations lie considerably above the level of the Havel, we may conclude that the vertical disturbance rapidly decreases with higher elevation, whereas this is not so much the case for the disturbance in the horizontal intensity. Possibly also the water of the Havel and its branches has some effect in reducing the disturbances. In any case it is clear that k must be a function of the vertical distance from the conducting layer. The horizontal disturbance must, for instance, be reversed below the conducting street, since the lines of force are reversed and must therefore be zero at a middle stratum of the conducting layer.

Apart from the conditions mentioned, the value of k is chiefly determined by the total current used, by the distance between the supply station and the tramway termini, and by the transition resistance between the rails and the earth. Hence it is only under certain restrictions that the distance to which a magnetic observatory is affected by an electric tramway may be indicated. The present case dealt with is a tramway in one straight line. For differently shaped tramways or railways the considerations are of course much more complicated, though the results above obtained give some guidance even for such a case.

If we assume that in the direction of greatest lateral expansion the constant k is 3·75, we obtain for D = 8 km. a mean horizontal

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disturbance of 0·47γ. This would give an absolute maximum disturbance two or three times as great, or roughly of 1γ. That this value is not too high is shown by the disturbances observed at Greenwich, Washington, and Toronto, which yield a much higher value of *k*. About the conclusions which may be drawn concerning a necessary protective area for the Potsdam observatory, Herr von Bezold* has expressed himself in his lecture of Dec. 10, 1899.

Let me remark, in conclusion, that the results obtained possibly contain a contribution to terrestrial magnetism themselves. If we were justified in assuming that in some cases the natural earth currents, running as they do in a plane, were the immediate cause of the variations of the terrestrial magnetic elements, we could apply the same formulæ as for disturbances by tramways, and could thus determine the distance of the disturbing cause. The formulæ would of course have to be modified in case of an expansion in three dimensions.

It would be very desirable if further investigations could be carried out in the case of electric tramways which run in the neighbourhood of mines, so that it would be possible to investigate the conditions below the conducting layer. In this process a simultaneous measurement of the total current leaking from the rails into the earth—say by Kallmann's method—would be very valuable.

NEW CENTRAL DISTRIBUTING STATION IN PHILADELPHIA.

The methods of distribution of current for lighting and power service in Philadelphia have been radically changed since the merging of all the different independent companies into the Philadelphia Electric Co. Mr. C. Walton Swoope gives some interesting particulars in the *Electrical World* of New York. Previous to this consolidation the lighting area of the city (about 132 square miles) was supplied from 18 separate generating stations, some companies competing for business in the same territory and operating several systems of distribution with an assortment of generators, boilers, and engines of various sizes.

A flexible plan of operation has been attained by an intercommunicating system of "tie-line" feeders between the generating stations, permitting the most advantageous operation of each plant; such connections being established either directly or through a sub-station. Any one or more of the stations can, at certain times, be shut down, the continuity of the service being maintained by suitable switching devices through these tie-lines from another station.

A new generating plant has been erected in the power house of one of the old companies. It includes four General Electric 1,000 kw. two-phase alternators of the revolving field type, with 72 poles, running at 100 revs. per min. and delivering current at 5,500 volts at 60 ∼ per sec. Two of the machines are directly connected to Greene tandem-compound engines, and two to Pennsylvania Iron Works engines. One 80 kw. multipolar belt-driven dynamo is driven from each engine shaft, and furnishes the field-exciting current for the alternator connected thereto. The energy is transmitted by cables through underground ducts to the high-potential switchboard located at one end of the generator room, and there is a low-potential board and gallery just above from which the generating units and local feeders are controlled. For lighting in the vicinity of this staton the pressure is reduced by stationary transformers to 2,040 volts; but for supply to distant stations, which is the primary function of this plant, the generators are directly connected through oil-immersed cylinder rotative switches and time-limit circuit breakers to the 5,500 volt high potential 'bus bars, from which distribution is effected through the outgoing feeders.

At present five sets of feeders, each consisting of a triple-conductor cable, 115,000 circular mils per conductor, and tested to 15,000 volts, transmit power on the three wire two-phase system to the original Edison central station, where it is transformed to direct current through rotatory transformers and paralleled with the existing Edison three-wire system supplying the principal business district of the city. Other feeders connect a second of the old stations with this plant for receiving or transmitting current, and a third group terminates in a new sub-station located centrally in the northern district of the city.

This sub-station is of particular interest, because it was especially designed and erected to meet all the requirements of a distributing centre for either the local stations displaced by it or as a medium through which the other stations of the system might be interconnected. The building contains a basement and three storeys. The step-down transformers, potential regulators, and switching mechanism are located in the basement, the local and station feeder switchboard panels and measuring and controlling instruments being directly above on the first floor. The second floor is equipped for meter testing and repair work, while the entire third floor has been fitted up as living apartments. The cables pass from the street into a vault underneath the vestibule, and thence through vitrified terra-cotta ducts built in with the foundation wall to the rear of the basement, where the connections are made. The electric current received into this station is distributed over their respective feeders to the systems of the several companies. The tie-line feeders previously mentioned are looped into this station, and by suitable switchboard devices become available for auxiliary service if required. The connections are made through a double set of high-potential 'bus bars, each feeder being connected through General Electric high-potential expansion fuses by triple-pole, double-throw, oil-immersed cylinder switches, each operated by a vertical shaft of hard wood terminating in a polished handwheel in front of the respective station panel on the first floor. Each switch shaft has an index at the floor level to designate the position of the switch.

For local distribution from this sub-station the potential is reduced to 2,200 and 1,100 volts by eight transformers of the regulating type, six of which are of 250 kw. and two of 100 kw. The primaries are directly connected to the high-potential 'bus bars in the same manner as the feeders, while each of the secondaries is connected through a 10 kw. potential regulator to the low-potential local 'bus bars on the first floor. The potential regulators (General Electric type) are operated from the switchboard above by sprocket chains geared to handwheels, and give a total regulation of 15 per cent., 7.5 per cent. above and 7.5 per cent. below the normal voltage, the latter regulation being obtained by reversing the connections and boosting against the supply mains. Each of the transformers also permits of a 17 per cent. potential regulation by varying the turns in the primary winding by a quick-break segmental switch. With a constant potential maintained by the generating station, there will thus be at this station a total regulation of 24·5 per cent. above and 7·5 per cent. below the normal voltage. The transformers are cooled by an air blast forced through a brick duct directly beneath them, the air being supplied by a blower driven by a two-phase motor. In winter the air will circulate from the top of the transformers through suitable galvanised-iron ducts and heat the switchboard room above, while in summer it will be directed outside the building by a damper. Although it is not at present contemplated to parallel machines located at different stations, this may also be accomplished through the sub-station.

The reason for a partial operation at 1,100 volts is that it was not deemed expedient to submit the older local underground cables to a pressure of 2,200 volts. Another district has been laid out for the Edison three-wire conductor tube system, but is being supplied by 10 kw. transformers placed in pairs in manholes until the district is sufficiently developed for a continuous-current distribution.

A New American Fire-Alarm System.—The chief fire marshal of Kansas City (Mr. G. C. Hale) has just devised a new fire-alarm system, which, apart from its probable costliness, should prove satisfactory. The new feature consists in supplementing the electrical thermostat, found in every electric fire-alarm system, with a phonograph which is automatically switched into circuit and gives full particulars of the location of the fire at the same time that the alarm bell at the central station is rung.

* *Elektrotechn. Zschr.*, Feb. 22, 1900, p. 161; *The Electrician*, March 9, p. 706, note.

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LEGAL INTELLIGENCE.

National Telephone Co. v. Tunbridge Wells Corporation.

Judge Emden has given judgment in this case, particulars of which were set out in our issue of March 23. In delivering judgment his Honour said that the first question was one of jurisdiction only. That question, however, meant the consideration of the whole matter in dispute, and a consideration of the several sections of the Telegraph Acts which had been cited. He did not think the terms of sec. 5 of the 1892 Act were cut down as argued. He was of opinion that the National Co. were placed in the same position as the Postmaster-General. He referred at length to the agreement between the company and the Corporation, whose general consent, it had been contended by the latter body, had been cut down by clause 2. In his opinion it had not been so cut down ; but if fresh work were rendered necessary, as was now the case, a fresh consent might be on different terms. The Corporation refused to give their consent, hence this application. He was of opinion the contention of non-jurisdiction could not in any way hold good in respect to this refusal of consent. The National Co. therefore stood in the same position in a case like the one under consideration as the Postmaster-General in respect of the powers delegated to them, and those powers included those sought by this application. He was not really asked to give consent, or he should give it. It was only the point of jurisdiction that he was then asked to decide, and he could not see how he could give consent that day. He wished the parties would go direct to the Railway Commissioners. His Honour ultimately reserved his final decision in the matter, and his consideration of the terms of consent, to the next county court, either at Lambeth or at Tunbridge Wells. Decision will probably be given at the Tunbridge Wells May County Court.

Claim for Wages.

In the Edinburgh Sheriffs' Small Debt Court last week, 11 workmen, lately employed by Messrs. D. Bruce Peebles and Co., sued that firm for sums varying from £1 downwards for wages. Defenders counterclaimed for £5 against each of the men as damages for breach of contract. Plaintiffs alleged that on March 12 they were told they need not come to work next day unless they gave up the society they were connected with —the Electrical Trades Union. The employers denied this, and stated that the men left of their own accord. They further asserted that the union had been urging the men to strike, and they were not disposed to be dictated to by the union. Accordingly they intimated that all would be treated alike—union and non-union men. By the men's action a number of important contracts had been delayed, and in one special case a bonus of £100 had been forfeited, and a penalty incurred. Interim Sheriff Dove Wilson gave decree for the wages earned by the men, and dismissed the counterclaim.

Workmen's Compensation.

In the High Court an appeal action was heard recently—Sysons v. Andrew Knowles and Sons (Ltd.)—which was an appeal from an award of the judge of the Salford county court in an arbitration under the Workmen's Compensation Act, 1897. Appellants were colliery owners, and respondent a pitman who went into appellants' employ as a piece-worker at 6s. a day wages, and did one day's work. The next following day was a holiday at the pit, and on the following day another day's work was in progress when respondent was injured by the falling of a piece of coal. On the following day he was paid 6s. for the work done on the first day, and at the end of the next week a further 6s. for the work done on the second day of his employ. The question at issue was how were the man's wages to be calculated under the "average weekly earnings" section (1*b*) of Schedule I. of the Act? The county court judge decided that as respondent had earned 12s. within seven days his average weekly earnings were that sum, and made an award for a weekly payment of one-half that sum—6s. For the appellants it was argued that the respondent did not come within sec. 1 of the Act, which provides the amount of compensation where total or partial incapacity from work results from injury at a rate not exceeding 50 per cent. of the injured person's average weekly earnings during the previous 12 months. It was urged for the appellants that it was impossible to ascertain the average weekly earnings of a man who had only worked for two days. For the respondent it was contended that the word "average" applied only where there was anything to average ; if there was not, then the maximum sum, which was not to be exceeded, was the sum which the worker had actually earned.

The appeal was argued before Lords Justices A. L. Smith, Collins, and Romer. Lord Justice A. L. Smith said the appeal raised a question of great importance—whether a workman came within the purview of the Workmen's Compensation Act who, having entered into an employment and gone to work, was injured on the first day of his employment. In this case the workman had worked for two days, but the question was the same—whether the man worked on two days or only on one day. In this case the applicant went into the masters' employ on the Tuesday, and did a day's work. On Wednesday the pit was not at work, and applicant did not go there at all. On Thursday he went into the pit to do a day's work, and while he was at work on that day was injured. Was he within the Act? If he had not been in employment for two weeks, it was impossible to give any meaning to the words "average weekly earnings."

Lord Justice COLLINS agreed. He thought the schedule contemplated that the relation of master and servant should have existed for not less than two weeks.

Lord Justice ROMER said he felt great doubt as to this case, but he did not differ from his learned brethren.

The appeal was allowed.

In the Glasgow Sheriff Court last week an interesting case, under the Workmen's Compensation Act, came before Mr. Sheriff Guthrie. On Aug. 29, 1899, a labourer named Dorran received an injury to his left ankle whilst in the employment of Messrs. James Allen, sen., and Son, ironfounders, Possil-road, Glasgow. About four weeks after the accident defenders' foreman called on pursuer, and, having informed pursuer that defenders' doctor had advised them that pursuer would be fit for work in another fortnight, gave him the sum of £2. 7s. 4d., being half wages up to date, in return for which he signed a receipt and discharge in full satisfaction and extinction of all claims in respect of the accident. Pursuer was, however, completely incapacitated for an additional five months, and brought the present action to have the receipt declared null and void, on the ground that he had signed it under essential error. The Sheriff held that pursuer had laboured under essential error in signing the receipt ; that he was entitled to have it set aside and declared null and void and to receive his half wages to the date on which he actually recommenced work.

At Glasgow last week Sheriff Spens heard an action brought by a labourer named M'Gavigan against the National Conduit and Cable Co. for compensation for injuries. M'Gavigan was employed in the construction of the electric tramway in Great Western-road, for which the company have contracted with the Glasgow Corporation, and while holding a wedge which another labourer was hammering into the ground the hammer missed and struck his hand, inflicting injuries. The sheriff awarded 10s. per week during the period of incapacitation from work.

At the Leeds County Court last week, Robert Coe, labourer, of Leeds claimed compensation under the Workmen's Compensation Act from Messrs. Cuttriss, Wallis and Co., electricians. Coe had lost an arm while in the service of respondents, and now claimed 10s. per week, half his weekly wage. The claim was not opposed, and the award was made as desired. The respondent company is in liquidation.

TRADE NOTES AND NOTICES.

[Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.]

NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers, or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London :—

READY.

(Price 12s. 6d., by post, 13s. 3d. ; Colonies, 14s. ; abroad, 14s. 6d. (United States, 15s.)

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"Wireless Telegraphy : Signalling across Space without Wires by Electric Waves." A Review of the Work of Hertz and his Successors.—By Dr. O. J. Lodge, with a large number of illustrations, bringing this latest application of electrical science quite up to date. New and Enlarged Edition, 5s. nett. *Now ready.*

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"MOTIVE POWER AND GEARING FOR ELECTRICAL MACHINERY."—By E. Tremlett Carter, C.E., M.I.E.E. Price 12s. 6d., post free. In this comprehensive work an account is given of the scientific principles and modern practice in the use of engines for dynamo driving, not only for isolated power plants, but also for public electric lighting and power stations. The various forms of gearing in the power station and for electric motors are also dealt with; and the book contains, in addition, numerous tables giving exact data of the equipment and working of electric power stations.

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TENDERS INVITED.

The *Central Electric Supply Co. (Ltd.)* invite tenders for the supply delivery and erection of electricity generating plant, particulars of which are set out in an advertisement. Copies of specifications, with forms of tender, &c., can be obtained from the general manager (Mr. F. J. Walker), 19, Carnaby-street, Golden-square, London, W. Specifications and drawings can be seen at but not obtained from the offices of Dr. Alex. B. W. Kennedy, 17, Victoria street, Westminster, S.W., and tenders must reach Mr. Walker by 10 a.m. of May 22.

The *Rhyl* District Council invite tenders for the supply and erection of electricity generating plant, particulars of which are set out in an advertisement. Specifications, &c., can be obtained from the consulting engineers, Mr. W. H. Trentham (39, Victoria-street, Westminster, London, S.W.) or of Mr. G. R. Peers (93, Deansgate, Manchester). Tenders must be delivered to the clerk (Mr. Arthur Rowlands), Council Offices, Rhyl, by 2 p.m. on May 14.

As announced in an advertisement, the directors of the *Great Eastern Railway Co.* require tenders for the supply of stores, including telegraph materials, bolts, screws, rivets, hardware, tools, &c. Forms of tender may be had on application to the secretary's office, Liverpool-street Terminus, E.C., after 30th inst., and patterns may be seen at the company's stores, Stratford. Tenders must be sent to the secretary (Mr. W. H. Peppercorne), by 10 a.m. on May 8.

The Commissioners of the Royal Burgh of *Perth* invite tenders for the supply and erection of 45 enclosed arc lamps and ornamental cast-iron and steel pillars, with switch gear, &c. An advertisement contains additional particulars, and specifications may be obtained at the offices of the clerk (Mr. John Begg), City Chambers, Perth. Plans can be seen and further information obtained at the offices of the consulting engineer (Mr. W. C. C. Hawtayne), 9, Queen-street-place, London, E.C., and Central Chambers, 93, Hope-street, Glasgow. Tenders must be delivered before noon on May 7.

The *Dundee* Gas Commissioners invite tenders for supplying cables and laying down distribution mains on the solid system. An advertisement contains further particulars, and specifications, &c., may be obtained from the city electrical engineer (Mr. Walter H. Tittensor), Dudhope-crescent-road. Tenders must be sent to the clerk (Sir Thos. Thornton) by 25th inst.

The *Dundee* Town Council also invite tenders for supply and erection of a traction switchboard and equipments. Further particulars are set out in an advertisement, and specifications can be obtained from the city electrical engineer (Mr. Walter H. Tittensor), Dudhope-crescent road. Tenders must be lodged with the town clerk (Sir Thomas Thornton, LL.D.), City Chambers, Dundee, by 25th inst.

The *Glasgow* Corporation invite tenders for electricity meters. Specifications, &c., can be obtained from the engineer of the electricity department (Mr. W. A. Chamen), 75, Waterloo-street, Glasgow, and tenders must be lodged with the town clerk (Sir J. D. Marwick) before May 5. See advertisement.

The *Glasgow* Corporation require tenders for opening trenches and supplying and laying underground conduits for telephone purposes, &c. An advertisement contains further particulars, and specifications may be obtained from the telephone engineer (Mr. A. R. Bennett), City Chambers, Glasgow. Tenders to town clerk (Sir J. D. Marwick), by Monday, the 30th inst.

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The *Plymouth* Corporation invite tenders for overhead line construction, &c. Further particulars are set out in an advertisement, and specifications, &c., can be obtained from the borough electrical engineer (Mr. John H. Rider), Prince Rock, Plymouth. Tenders by May 2.

The *Sunderland* Corporation invite tenders for two additional switchboard panels, with instruments, &c. Tenders to chairman, Lighting committee, by noon, 27th inst.

The *Southampton* Corporation invite tenders for a 300 kw. continuous-current generator. Tenders to Town Clerk, by May 1.

The *Wimbledon* District Council invite tenders for wiring their new isolation hospital. Tenders to Clerk, Council offices, Broadway, Wimbledon, by noon of 24th inst.

The *Brighton* Corporation invite tenders for the supply of incandescent lamps for 12 months from July 1 next. Tenders to Town Clerk by June 11.

The *Brighton* Corporation also invite tenders for electricity meters for one year from June 1, 1900. Tenders by 23rd inst.

Tenders are invited for wiring the nurses' homes (about 100 lights) at the workhouse, Brownlow-hill, *Liverpool*. Tenders to clerk to Select Vestry, Brownlow Hill, Liverpool, by 25th inst.

The *Barking* District Council invite tenders for the construction of an electric railway, with bonding, &c. Tenders by May 7.

The *Dublin* Electric Lighting committee invite tenders for electric lighting plant. Tenders by 4 p.m. April 26.

The *Salford* Electricity committee require tenders for the erection of electricity station buildings at Pendleton. Tenders to chairman by 26th inst.

The Streets committee of the Corporation of *London* invite tenders for the hire of electrically-driven dust carts. Tenders to the town clerk, Public Health Department, Guildhall, E.C., by June 1.

The *Great Indian Peninsula Railway Co.* require tenders for iron telegraph wire and signal fittings. Tenders to secretary, 48, Copthall-avenue, London, E.C., by 26th inst.

The *Moguer* Municipal Council (Huelva, Spain) require tenders for electric lighting for 20 years. Tenders to el Secretario del Ayuntiamento by May 5.

TENDERS RECEIVED AND ACCEPTED.

The following tenders have been accepted by the Sunderland Corporation :—

W. T. Henley's Telegraph Works Co., indiarubber covered cables.
Watson, Gow and Co., cast-iron piping and box frames and covers.
John Spencer (Ltd.), wrought-iron piping.
Doulton and Co., stoneware casings.

The tender of Messrs. Dick, Kerr and Co. has been accepted by the Dundee Tramways committee for the supply of 20 tramcars complete, at £630 each.

The Keighley Town Council have accepted the tender of the Callender Co. for electric cables and arc lamps at £10,432, and of Thomas Parker (Ltd.) for switchboard and balancer at £1,905.

APPOINTMENTS VACANT AND FILLED.

The Brighton Corporation require a resident electrical engineer to act under the consulting engineer to the Corporation electricity works (Mr. Arthur Wright). An advertisement contains further particulars, and applications must reach the town clerk (Mr. F. J. Tillstone), Town Hall, Brighton, before 10 a.m. of 30th inst.

The Manchester Tramways committee require a foreman platelayer, a foreman pavior, and a yard foreman. An advertisement gives additional information, and further particulars may be obtained from the general manager of tramways department (Mr. J. M. McElroy), Town Hall, Manchester. Applications (addressed chairman Tramways committee) must be lodged with the town clerk (Mr. W. H. Talbot) by 30th inst.

A chief draughtsman is required for the electrical engineering department of the Thames Iron Works, Shipbuilding and Engineering Co. Applications to secretary, Blackwall, E. See advertisement.

A second assistant engineer is required at the York electricity works. Applications to the city electrical engineer (Mr. C. A. Midgley) by May 7. See advertisement.

The Ayr Police Commissioners require a mains superintendent. Applications to burgh electrical engineer (Mr. Arthur J. Fuller) by 23rd inst.

A second assistant lecturer in the physics and electrical engineering department of the Blackburn Municipal Technical School is required for next session. Applications to the secretary (Mr. A. W. King) by 28th inst. See advertisement.

Mr. John Macfee, M.I.E.E., district manager for the National Telephone Co. at Bolton, has been appointed assistant manager of the Glasgow Corporation telephones. Mr. Macfee was born in Paisley, and received his technical training in the Glasgow College of Science and Art, where he gained various prizes, including the Pender gold medal, for the best electrical engineering student of the year. Since 1882 Mr. Macfee has been in the service of the National Co., joining the Glasgow staff as electrical inspector, and acting subsequently as local manager in Paisley, Hull and Sheffield. Since 1893 he has had sole charge of the Bolton district. The salary attached to the new appointment is £275 per annum.

Mr. H. A. Clark, Wh.Sc., A.I.E.E., A.R.C.S., is leaving the engineering department of the South Western Polytechnic, Chelsea, at the beginning of May to take up the directorship of the engineering department at the Crewkerne Schools, Somerset.

Mr. C. C. Smyth has been appointed mains superintendent at Southampton.

Mr. J. M. Blair, of Messrs. Crompton and Co., has been appointed junior assistant engineer at Henley electricity works.

Mr. W. G. Keats, of Messrs. Siemens Bros. and Co., has been elected as istant electrical engineer by the Plumstead Vestry.

BANKRUPTCIES, LIQUIDATIONS, &c.

The resolution to wind up the Eastbourne Electric Light Co (Ltd) voluntarily, consequent upon the purchase of the undertaking by the Corporation, was confirmed on 9th inst.

A meeting of the Bournemouth and District Electric Supply Co. (Ltd.) will be held at Moorgate-court, London, E.C., on May 17, to receive an account of the voluntary winding up.

A meeting of the Merveilleuse Electric Arc Lamp Syndicate (Ltd.) will be held on May 14, at the offices of Mr. A. Conder, Dashwood House, London, E.C, to receive an account of the winding up.

An application for the discharge in bankruptcy of W. B. O'Reilly, manufacturing electrician, 397, Edgware-road, lately trading at that address and at 124, Old Broad-street, E.C., will be heard on 27th inst. at Bankruptcy-buildings, London, W.C.

Claims against the Chitty Dynamo and Motor Co. (Ltd.), 4, Hythe-road, Willesden, must be in by May 4. Mr. G. S. Barnes, 33, Carey-street, W.C., is trustee.

In the bankruptcy of J. H. Crawford, agent, Cannon-street House, E.C., it was reported at the recent first meeting of creditors that debtor had been adjudged bankrupt in June, 1894, and had not yet obtained his discharge. In Nov., 1895, he recommenced business, and had been interested in the promotion of several companies, including the London and Provincial Electrical Co. (Ltd.) Debtor made no offer, but said he believed that if certain patents proved to be of value the debts would be paid in full. He was adjudged bankrupt.

The first meeting of creditors of W. Vevsy, described as a "financier," late of 36, Victoria-street, London, S.W., was recently held at the London Bankruptcy Court. Debtor, whose full name is Geza Vevsy de Somoskeoy, was adjudged bankrupt at the London Court, in 1888, with liabilities £16,875 and no assets. On the present occasion his liabilities amounted to £70,052 and assets, subject to realisation, £48,850. He had been interested in the Westminster Automatic Telephone Syndicate, British Cinematograph Co., and Wright's Patent Gas Meter Co. His interest in the Westminster Automatic Telephone Syndicate would, he averred, be sufficient when realised to pay his debts several times over. Examination concluded.

B.T.H. Plant.—Pamphlet No. 61, issued by the British Thomson Houston Co., describes and illustrates the G.E.-60 traction motor specially designed for narrow gauge tracks. This motor can be provided with a 2, 3, 4 or 6-turn armature, according to voltage and nature of service required. The motor is adapted for use with either nose or yolk suspension.

Westinghouse Plant.—Circular No. 1,024 issued by the British Westinghouse Co. deals with direct-current switchboards, type 7, for 110 to 250 volts. The switchboard described is in three panels, the arrangement of which can be made suitable for the control of any plant of not more than 600 amperes per circuit at an E.M.F. not exceeding 250 volts.

Fire.—A fire occurred at the works of W. T. Henley's Telegraph Works Co. in Stanley-street, North Woolwich, on Saturday morning. We are informed that the fire, which was entirely confined to part of one of the company's mechanical indiarubber shops, was of small extent, and will cause no interruption whatever to business.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) on April 11 and 12, with the ports of destination :—

Africa—Alexandria, £10. *Australasia*—Brisbane, £115; Freemantle, £102; Perth, £189. *Belgium*—Ghent, £18. *Burma*—Rangoon, £604. *Ceylon*—Colombo, £13. *Denmark*—Copenhagen, £140 (telegraph material). *France*—Boulogne, £35. *Holland*—Amsterdam, £125; Rotterdam, £61 (telegraph material). *Hong Kong*—£680 (including £63 telegraph mate

rial). *India*—Bombay, £12. *Japan*—Yokohama, £129. *Russia*—St. Petersburg, £450 (ships telegraphs). *Siam*—Bangkok, £706. *Straits Settlements*—Penang, £196 (telegraph cable); Singapore, £505. *West Indies*—St. Thomas, £38,000 (telegraph cable). Total £42,090, against £10,987 for one week last year (April 12 to 18).

MUNICIPAL, FOREIGN, AND GENERAL NOTES.

Anglo-German Cable.—This cable is announced to have been cut—it is believed maliciously—near Boulogne, and the German Government has offered a reward. The same cable was similarly cut about twelve months ago.

Ashton-under-Lyne.—Owing to the increasing demand for electric current the Electric Light committee recommend the Council to make provision for considerably increasing the capacity of the plant at the station, and for extending the mains.

Big American Electrical Combination.—It is reported that the General Electric Co., U.S.A., has purchased the undertaking of the Siemens and Halske Electric Co. of Chicago, Ill. The two companies are to be merged, and it is rumoured that the consolidation implies a close alliance with the Siemens and Halske Aktien Gesellschaft of Berlin.

Brighton.—The difficulty in connection with the position of Mr. Arthur Wright at the electricity department has now been satisfactorily solved. Mr. Wright is to be consulting manager and engineer, at a salary of £600 per annum, and he will be assisted by an acting manager, a position which is advertised in our current issue.

Dock Lighting.—A report from Messrs. Handcock and Dykes, estimating the cost of lighting the entire Tyne dock system at £5,972 has been referred to the engineer of the Tyne Improvement Commission for report.

Dumfries.—Several members of the Council have been under the impression that there was sufficient water power available in the vicinity for generating electric current for public lighting, but a consulting engineer (Mr. Thomson) advises that the idea must be abandoned, as it would be impracticable to use either the Nith or the Cairn for the purpose suggested.

Earsdon (Newcastle-on-Tyne).—The District Council are negotiating with the Seaton Delaval Co-operative Society for a supply of electric current for public and private lighting.

Edinburgh.—It was announced at the meeting of the Electric Light committee on Tuesday that during the past week the applications for electric current were equivalent to 4,500 8 c.p. lamps, and included 14 motors.

Egypt.—In the course of his exhaustive annual report on the finances of Egypt in 1899, Lord Cromer refers to the construction of telegraphs, and states that good progress has been made in this work. About 1,000 miles of line were constructed during the year. Gedaref is now in communication with Kassala, and the line has also been extended from Abu Haraz, on the Blue Nile, to Sennaar and Karkoj. On the White Nile, the southernmost station is at Goz Abu Goma. The line to El-Obeid is in course of construction.

Electric Organ.—Mr. and Mrs. Carnegie have decided to present a Hope-Jones electric organ for the Town Hall of Kirkcaldy at an estimated cost of £3,000.

Electric Tramway Systems and the Local Authorities.—The following clause has been inserted in the London County Council Tramways (No. 2) Bill, relating to the use of overhead trolley systems:—

This Act shall not authorise the Council to place in any parish or district any post or wires on or over any street for working tramways by electrical power, unless the Vestry of such parish or the Board of Works for such district shall, by resolution, have consented to the adoption therein of a system of traction conducted by means of posts and wires placed overhead. A copy of such resolution, under the seal of the Vestry or District Board, shall be delivered to the Council and shall be evidence of the due passing of such resolution.

A proviso has also been inserted in the bill empowering the road authorities to be heard before the Board of Trade both in regard to any system proposed by the County Council and the regulations which may be made by the Board in relation to public safety and other matters.

Farnworth (Bolton).—The Farnworth, Moses Gate and Bolton electric tramway route was opened on Friday last.

Glossop.—The Council have adopted the proposals of Edmundson's Electricity Corporation for the erection of electricity works and for the construction of electric tramways in the district. The company suggest that the Corporation obtain a tramway provisional order and they would lease it on the same terms as to purchase, &c., as those contained in the transfer of the electric lighting order. The Corporation would have the power to repurchase the tramways at the expiration of any seven years at a valuation. A sub-committee has obtained authority to agree to terms, subject to confirmation by the Council.

Great Grimsby.—An inquiry was recently held into the Council's application to borrow £11,500 for electricity supply, and of this sum £5,066 has been sanctioned, the Local Government Board intimating that the consideration of the other portion of the loan, which appeared to be required almost entirely for plant for the supply of electrical energy to the tramways, has been deferred until the Council has either definitely decided to take over the tramways at the expiration of the existing lease and to equip them for electric traction, or has entered into an agreement with a company of good standing and accustomed to similar undertakings to carry out the necessary work of reconstruction, and to take the supply of electrical energy from the Corporation.

Handsworth.—The Council have intimated to the Midland Electric Corporation for Power Distribution their objection to the company's application for a provisional order as they propose to establish municipal electricity works. The consulting engineer (Dr. Kennedy) has already visited the district preparatory to submitting a report.

Imports of Electrical Goods into the United Kingdom.—The accounts relating to the trade and navigation of the United Kingdom show that the value of electrical goods and apparatus imported during March was £73,085, and in February £60,780. The total for the three months ended March 31 is £197,018.

Kalgoorlie (West Australia).—At a meeting of the West Australian Gold Fields (Ltd.), the chairman (Mr. A. H. P. Stoneham) referred to the concession secured by the company for constructing an electric tramway in this town. He said the traffics from the Perth electric tramway, the first of the kind in West Australia, were exceeding expectations, and he was told by the American engineers who were constructing it, that Kalgoorlie was a better town for tramways than Perth was. He thought they had done wisely in taking up the Kalgoorlie concession, and it would be well for them to construct the tramway themselves, and keep the shares as a permanent dividend-earning investment. As soon as the necessary materials could be obtained and shipped, the construction would be begun and pushed on energetically.

Light Railway.—A public meeting has been held at Lofthouse (Leeds) to consider a proposal to construct a light (electric) railway from Pateley Bridge to Lofthouse, a distance of seven miles. It was stated that the promoters (Power and Traction, Ltd.) had surveyed the route and recommended the construction of a 2ft. 6in. gauge line, with stations at Pateley Bridge, Wath, Ramsgill and Lofthouse. The preliminary expenses in obtaining Parliamentary powers would probably be about £1,000, and provided residents subscribed £500, the company undertook to find the remainder. If the line were constructed, the £500 would be returned in shares. After discussion £320 was subscribed in the room, and the remainder will doubtless be forthcoming in due course.

Liverpool.—The conversion to electric traction of the tramway route along the Victoria-road to the Bootle boundary has been commenced. Up to the present nearly 50 miles of single track have been laid for electric traction. This year more than 10 miles of single line have been dealt with. Altogether a total of 63 miles of horse-car lines have to be converted, and 24 miles of additional lines constructed, the latter having been sanctioned under the 1898 order.

Manchester.—The Electricity committee have recently discussed the estimates of the department for the past financial year, and it is stated to be unlikely that anything out of the profits of the department will be devoted to the relief of the rates. It will be remembered that last year the amount so dealt with was £10,000. The expenditure out of revenue on works, repairs, and unforeseen charges have exceeded anticipations.

Marylebone (London).—The Board of Trade have decided to grant the application of the Marylebone Electric Supply Co. for a provisional order for this district. The application was opposed both by the Vestry (who had already unsuccessfully applied, and proposed to again apply for an order) and by the Metropolitan Electric Supply Co., who possess electric lighting powers and are supplying electric current under those powers. The confirmatory bill is likely to meet with strenuous opposition from both bodies.

Memorial.—The marble bust of James Bowman Lindsay, executed by Mr. G. Webster for ex-Lord Provost M'Grady, of Dundee, has been handed over to the Dundee Free Library committee. In the communication accompanying the bust ex-Lord Provost M'Grady states that: "In 1835 Mr. Lindsay lighted his own humble dwelling by electric light, and in the same year he publicly exhibited the light in Dundee. In 1854 he succeeded in telegraphing through water without connecting wires."

Newington (London).—166 gas lamps in the side streets are to be adapted for incandescent electric lighting. Current will be supplied at 2½d. per unit, and the total increased cost of lighting will be £132 per annum. The present lamp-posts will be utilised, and the distance between the columns reduced to 120ft.

Oban.—Mr. Malcolm Sutherland has been appointed consulting engineer, at a fee of 15 guineas, to report upon the advisability of establishing municipal electricity works.

Paisley.—Messrs. S. Z. de Ferranti (Ltd.), the contractors for the electrical plant, recently offered to replace the 100 kw. generator with a 150 kw. one, and also to replace one of the others by a 350 kw. machine. The offer was made subject to the Electric Lighting committee giving, as soon as they required an extension of plant, an order for another 350 kw. plant. The Corporation have now requested Messrs. Ferranti to submit a specification and plan of the proposed new plant.

Private Bill Legislation.—After receiving a deputation from the Charing Cross and Strand Electricity Supply Corporation the Whitechapel District Board of Works have reaffirmed their decision to oppose the company's bill for erecting a generating station at West Ham to supply electric current in the City of London.

St. Austell.—The Council have consented to the transfer of the St. Austell Electric Lighting Order (1894) to the United Kingdom Tramway, Light Railway, and Electrical Syndicate (Ltd.).

St. Nazaire (France).—The French Government is considering a project for the establishment of an electric tramway in this district. In the neighbouring district of La Rochelle an extensive system of tramways is being established connecting with the Port of La Pallice, the motive power adopted being compressed air.

St. Pancras (London).—The accounts of the Electricity committee were presented and discussed at the meeting of the Vestry last week. The total of loans raised for electric lighting amounted to £236,780, of which £17,246 had been repaid. The capital expenditure in 1899 was £47,915, making a total capital expenditure of £288,146. The gross revenue for the year was £44,880, and the net profit £6,841. Adding the balance (£1,892) from 1898, there was a total net profit of £8,734. Writing off £1,600 for depreciation the committee proposed the appropriation of £2,000 as a contribution to the lighting rate; that £4,000 be transferred to reserve, and that the balance (£1,134) be carried forward. The committee recommended that, after the June quarter, the charge for electric current for public lighting be reduced from 4d. to 3d. per unit; to consumers under the maximum demand system from 6d. to 5d.; to consumers using the maximum demand system from 6d. per unit for the first 1½ hours, and 3d. after, to 6d. for the first hour, and 2d. after. The committee also recommended that the price for motive power, &c., be reduced from 3d. to 2d. per unit, these reductions to apply only to consumers supplied at 220 volts, and to consumers willing to change from 110 volts to that pressure. The chairman (Dr. Walter Smith) in moving the adoption of the report, stated that during the nine years the electric supply of the parish had been in the hands of the Vestry, they had made a net profit of £34,980. The report was unanimously adopted.

Telephone Trunk Extensions.—The telephone trunk line service has been extended to Sleaford, Lincs.

Tramway Provisional Order Transfer.—Application has been made to the Board of Trade for authority to transfer the undertaking authorised by the Oldham, Ashton-under-Lyne, Hyde, and District Electric Tramways Order, 1896, from the British Electric Traction (Pioneer) Co. (Ltd.) to the Oldham, Ashton, and Hyde Electric Tramway (Ltd.). Objections must be lodged with the Board before May 1.

Tunis.—A new British Chamber of Commerce has been established at Tunis, the objects of which are to supply gratuitously to members confidential information in regard to the standing, credit and reliability of local firms throughout Tunisia, and to obtain for its members statistical and other information from official and other reliable sources.

Workmen's Compensation Act.—The Employers' Parliamentary Council, 7, Victoria-street, Westminster, London, in their circular No. 9, call attention to certain bills which are or have been before Parliament during the present session. Amongst those that remain may be mentioned a bill down for second reading on Wednesday, May 2. This bill is introduced by Mr. Woods, Mr. John Burns, Mr. Pickard, and Mr. Steadman, all claiming to be representatives of the "working man." The bill in question is known as the Workmen's Compensation Act (1897) Amendment (No. 3), and the scope of its proposed action is given in the circular as follows:—

To extend the Workmen's Compensation Act, 1897, to all employments; to compel employers to pay compensation for "personal injury by accident or *otherwise*": such compensation to commence from the date of the *accident*; to prevent an employer from getting up the defence of contributory negligence or "any other defence"; to abolish contracting out; to abolish the doctrine of common employment; to enable an employer who pays rents or royalties to deduct from such rents or royalties one-fourth of any compensation which he may have been compelled to pay to workmen. It is further proposed that average weekly earnings shall be taken to be six times the average daily wages.

We have always regarded the Workmen's Compensation Act, 1897, as an extremely liberal and beneficent Act, and one reflecting the highest credit upon Parliament, whose members, taken in the aggregate, may still be considered to represent the capitalist interest, and from this class of legislation are themselves the sufferers—at least, if any suffering is involved. The proposed amending bill has received the support of Messrs. Woods, Burns, Pickard, and Steadman, and would, if passed, which is very unlikely, bring an otherwise excellent Act into ridicule. The looseness of the phraseology, the radical nature of the extensions suggested, and the obvious unfairness to the employers of several of the provi os point pretty clearly to the incompetence of the average "labour" member of Parliament to draft a bill without infusing into its clauses conditions which, while apparently in the interest of the employed, would in the long run prove inimical to their interests and in restraint of trade. The objections taken by the Employers' Parliamentary Council are as under:—

In the first place, the bill is very loosely worded: the words italicised above are an instance. The effect of the bill would be to take away from employers all the safeguards which were left to them under the Act of 1897. Under Clause 3, which takes away the right to set up the defence of contributory negligence or "any other defence," every person who sued, whether he had a ground of action or not, would be certain to succeed, as in the absence of a defence judgment goes for the plaintiff. The provision against contracting out would prevent the establishment or continuance of any benefit funds in connection with industrial enterprises, no matter how beneficial these latter might be to the workmen. The provision that compensation shall be paid from the date of an accident, instead of from the end of two weeks after the accident, takes away a most valuable check upon malingering which was wisely inserted in the Act of 1897. The proposal that one-fourth of any compensation paid shall fall upon rents or royalties, although doubtless providing some relief to the employer, is objectionable in principle, inasmuch as it interferes with existing contracts, and on the expiration of current leases would certainly make the employer's position worse than at present. The provision that average weekly earnings are to be deemed to be six times the average daily wages is decidedly unjust, as it would enable a workman who had only been employed occasionally for a few days on odd jobs to claim compensation as if he had been employed continuously at the average daily wage which he received while actually working.

Dinner.—Mr. D. F. Sugrue, who was for nearly 20 years manager of the Swansea Tramway Co., and has recently taken up a position in London with the British Electric Traction Co., was entertained at a complimentary dinner at Swansea on Wednesday evening. Sir J. J. Jenkins, M.P., presided.

PATENT RECORD.

The following list of Applications for Patents and Specifications published has been compiled for this journal by Messrs. J. C. CHAPMAN and Co., *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs, and Trade Marks may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after the acceptance of the complete Specification. The names within parentheses are those of communicators of inventions. When complete specification accompanies application, an asterisk is affixed.*

March 12, 1900.

4,639. W. HARLEY and J. DUGGAN. Liverpool. Improvements in overhead electric railway trolleys.

4,672. W. WALKER, Junr. London. Improvements in the terminals and insulators of the holders of electrical incandescent or glow lamps, which improvements are also applicable to other electrical terminals.

4,680. A. MÜLLER. London. Improvements in electric accumulators.

4,685. A. WRIGHT and THE REASON MANUFACTURING CO. (LTD.). London. Improvements in or connected with electricity meters.

March 13, 1900.

4,706. J. LIGHTFOOT. Manchester. Improvements in electric switches principally for high-voltage circuits and also applicable to switch lampholders.

4,709. G. H. NISBETT. Liverpool. Improvements in or connected with electric cable joint-boxes.

4,719. J. MARR and W. C. LAIDLER. Newcastle-on-Tyne. Improvements in electric motors.

4,720. G. M. BRAND. Glasgow. Improvements in and relating to the electric lighting of railway carriages, cars, ships, and the like.

4,774. A. FORD-LLOYD. London. An improvement in switchboards.

4,784. M. DÉRI. London. Improved magnet winding for continuous-current machines and converters for effecting simultaneously a sparkless commutation and a pressure regulation.*

4,785. M. DÉRI. London. An alternating-current motor.*

4,795. J. DULAIT and O. GARBE. London. Improvements in the distribution of electric current and apparatus therefor.

4,803. R. A. FESSENDEN. London. Improvements in incandescent lamps. (Date applied for under Patents, &c., Act, sec. 103, Aug. 25, 1899, being date of application in United States.)*

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March 14, 1900.

4,818. E. T. Parker. Wolverhampton. Improvements in and in the means of supporting electrodes or plates of electrical accumulators, and in the manufacture of such electrodes and tools or appliances for use in such manufacture, and a method of constructing such tools or appliances.
4,829. J. G. Booth. Bury. An improved method of suspending, raising, and lowering electric lamps and other articles.
4,831. A. C. Richardson. Newcastle-on-Tyne. A patent asbestos application to wires and insulated wires for electrical purposes.
4,842. W. O. Wood. London. An electric fire-damp detector or indicator.
4,844. J. Baxeres de Abzugaray. London. Improvements in obtaining metals from their fused ores, oxides, and salts by electrical action.
4,848. W. Aitken. London. Improvements in telephone divided multiple board system.
4,850. J. G. Childs. London. An electric mechanism for operating a clutch in connection with electric motors.

March 15, 1900.

4,885. G. D. A. Parr. Leeds. Improvements in electrical instruments for measuring current pressure and power in electric circuits.
4,892. J. Joly. Dublin. Improved electric furnace.
4,921. J. Grant. Aberdeen. Improved electrical method for securing uniform time in clocks.
4,926. A. J. Howard. Newport. Improvements in automatic time switches.
4,932. V. A. Fynn. London. Improvements in or connected with electric motors and generators, and other electric apparatus and instruments.
4,933. The British Thomson-Houston Co. (Ltd.). London. Improvements in register dials for meters and the like. (G. H. Alton, United States.)*
4,934. J. W. Ehlers. London. Improvements in current-feeding devices for electric motor cars or the like.*
4,936. E. O. Everett. London. Improvements in sparking plugs for explosion engines.

March 16, 1900.

4,976. C. J. Spencer. Bradford. Improvements in the means or method of signalling on electric tramways.
5,003. M. C. Mengis. London. Means for automatically reviving or reinforcing exhausted pulsations upon a telephone line.*
5,016. T. J. Holland and A. P. Laurie. London. Improvements in porous diaphragms for electrolytic apparatus.
5,032. A. Malignani. London. Improvements in electrical cut-out devices especially adapted for preventing excessive flow of electric current.*
5,046. A. Wright and The Reason Manufacturing Co. (Ltd.). London. Improvements in electricity meters.
5,050. W. P. Thompson. London. Improvements in asynchronous rotatory converters. (Helios Electricitäts Actien-Gesellschaft, Germany.)

March 17, 1900.

5,069. H. E. Darrah (of the firm of Baxendale and Co.). Manchester. Improvements in connection with inverted arc lamps.
5,072. G. Bayliff. Liverpool. Improvements in and connected with electric incandescent lamp holders.
5,085. E. L. Thorp and L. B. Codd. Leeds. Improvements in or relating to apparatus for regulating the arc in electric arc lamps.
5,088. R. Thomson. Glasgow. Bonding for iron or steel electrical conductors. (C. Brown, Switzerland.)*
5,135. A. Morley. London. Improvements in mercurial thermometer alarms in connection with electric contacts for visible or audible indications.
5,136. M. Byng and F. G. Bell. London. Improvements in inter-communication telephone systems.*

March 19, 1900.

5,146. F. Shaw and F. Greenfield. Birmingham. Improvements in or connected with fittings for electric lighting.
5,154. S. G. Bennett. Wolverhampton. Improvements in electric traction.
5,167. J. Yates, W. Yates, and J. B. Bent. Manchester. Improvements in and relating to alternating-current electromotors.*
5,178. C. A. Day. London. Improved means for connecting electric cables. (J. G. White, United States.)*
5,183. H. E. Newton. London. Improvements in electric locks. (H. G. Carleton, United States.)*
5,184. F. B. Aspinall and J. Ireland. London. Improvements relating to electric tramways.
5,187. A. E. Lamkin. London. An automatic telephone call recorder.
5,191. The Westinghouse Brake Co. (Ltd.). London. Improvements in electric heating systems for cars. (F. C. Newell, United States.)
5,196. C. Adams-Randall. London. Improvements in simultaneous electric telegraphy and telephony.
5,216. A. J. Boult. London. Improved manufacture of filaments for electric incandescent lamps. (A. Blondel, France.)*
5,221. G. Davis. London. Improvements in the distribution and collection of current for electric traction.

March 20, 1900.

5,232. P. Kennedy. London. Improvements in storage batteries.*
5,252. L. Higginbottom, J. H. Hindle, and T. Mannock. Manchester. Improvements in apparatus for controlling and regulating electric motors.
5,257. W. G. Heys. Manchester. Improvements in apparatus for winding or producing coils, bobbins, helices, or the like, such as are used for electrical purposes. (J. Scott, R. Varley, and J. C. Anderson, United States).*
5,274. W. Y. Buck. London. An improved process of and apparatus for the electro-deposition of metals.*
5,293. D. P. Thompson. Liverpool. Improvements in or connected with lead presses for making plates for electric accumulators and the like. (Accumulatoren and Electricitäts Werke Act.-Ges. vorm. W. A. Boese and Co., Germany.)*
5,294. W. R. Wynne. London. Improvements in electric bells.
5,321. H. J. Haddan. London. Improvements in plates for storage batteries. (C. A. Lindstrom, J. Hewitt, and T. Hewitt, United States.)*
5,325. J. H. Simpson and E. H. Walker. London. Improvements in and relating to backing or holding blocks for stereotype and electrotype plates.

March 21, 1900.

5,327. G. Davis. London. Improved system of distribution and collection of current for electric traction.
5,353. E. H. Tyler. London. Improvements in electric traction.
5,356. R. K. Gray. London. Improvements in or relating to electric cables.
5,361. E. G. Sheppard and Nernst Electric Light (Ltd.). London. An improvement in lamp caps for bayonet socket electric lamp holders.
5,376. E. Hopkinson and A. T. Smith, Jun. London. Improvements in electrodes for electrolytic purposes.
5,382. L. M. Casella. London. Improvements in step-by-step printing telegraph instruments.
5,387. G. Marconi. London. Improvements in apparatus for wireless telegraphy.
5,389. J. Shoecraft and C. C. Gardiner. London. Improvements in and connected with electrically-operated railway signals.*
5,393. R. P. Strachan. London. Improvements in trolley poles and standards for electric traction.
5,394. E. Nappert. London. An improved method of insulating electrical conductors. (O. Schaefer, Germany.)

March 22, 1900.

5,402. E. J. Wade. London. Improvements in and connected with primary and secondary galvanic cells.
5,429. H. Oppenheimer. London. Improvements in and connected with granulated carbon transmitters. (Actiengesellschaft Mix and Genest, Germany.)
5,430. H. Oppenheimer. London. Cable suspenders for multiple switchboards or similar apparatus. (Actiengesellschaft Mix and Genest, Germany.)
5,431. H. Oppenheimer. London. Improvements in and connected with multiple switchboards for telephone exchanges. (Actiengesellschaft Mix and Genest, Germany.)

March 23, 1900.

5,482. J. Enright. London. Improvements in driving vehicles by electricity.
5,496. E. Quintaine. London. A process for depositing pure tin by electrolysis.*
5,512. A. W. Gattie. London. Electrical balance or contact device suitable for operating various kinds of mechanism when the equilibrium of a voltmeter or other sensitive instrument is disturbed.
5,521. M. Leclanché. London. Improvements in the manufacture of primary batteries.
5,528. L. Gumiel. London. Improvements in electric accumulators.*

SPECIFICATIONS PUBLISHED.

Note.—All Specifications can now be obtained at the uniform price of 8d. each.

1898.

21,982. Smith. Appliances for overhead electric traction.

1899.

5,137. W. C. Gale. London. Improvements connected with incandescent electric lamps.
3,786. Lorrain (Macdonald). Electric incandescent lamps.
4,078. Honeywood. Machine tool particularly applicable for re-facing or turning commutators of electric generators and the like.
4,121. Best. Miners' safety lamps and means for electrically igniting the same.
4,801. Holmes and Broadbent. Resistance switches for electric circuits.
4,865. Round, Round and Round. Electro-gilding process and apparatus to be used in connection therewith.
5,250. Hill. Electric brake.
5,310. Germain. Microphones.
5,356. Bennett. Electric arc lamps.
5,398. Bede. Electric traction on the conduit system.
5,514. Morgan. Electric light apparatus for taking photographic portraits.
5,874. Siemens Bros. and Co. (Ltd) and Schloemer. Telephones.
5,934. Gehre. Wave motors or devices for utilising the power of sea waves, more particularly for the generation of electricity.
6,349. Siemens Bros. and Co. (Ltd.) and Perry. Telegraph and such like posts.
6,819. Jones. Electric switches.
8,168. Moul and Lind. Mounting incandescing electric lamp bulbs.
8,726. Watson. Switches for electrical purposes.

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8,312. COWANS LTD. (Cowan and S ill). Resistance coils.
8,358. NIBLETT AND SUTHERLAND. Electric storage or secondary batteries.
8,497. BARTENSTEIN. Bulbs for electric incandescence lamps.
10,164. SIMON. Interrupters for electric currents.
11,374. WARRINGTON AND BROWN. Apparatus for lighting miners' safety or other enclosed lamps by electric currents.
11,682. MARSH AND VANDAM. Electric switches.
16,290. LEVY. Apparatus for closing and opening electric circuits, applicable to the temporary illumination of rocks on coasts, and of staircases and other analogous purposes.
20,288. WADDELL. Electrical indicating and measuring instruments.
25,295. FLEMING. Electrical resistance measuring instruments.
25,464. WESCHER and WOLLENHAUPT. Electric alarms.
24,184. NEWMAN and LEDWINKA. Electrically propelled vehicles.
24,824. HOWARD. Electric incandescent lamps.
24,970. SCHMUTZ. Electric hair brushes.
25,011. THOMSON (Fontaine). Primary electric battery.
25,019. SIEMENS BROS. AND CO. (LTD.) (Siemens and Halske Aktien Gesellschaft.) Safety fuses for electrical circuits.
25,432. THIERGÄRTNER. Electrically-actuated air douche apparatus.
25,449. BRITISH THOMSON-HOUSTON CO. (LTD.). (Davis and Potter.) Means for controlling electric motors.
25,594. EPPLER. Process of galvanically inlaying metal on materials.
25,721. PALLAVICINI. Plates for storage batteries.
25,744. BRITISH THOMSON-HOUSTON CO. (LTD.). (Reist.)
25,747. BRITISH THOMSON-HOUSTON CO. (LTD.). (Buck.) Safety devices for dynamo electric machines.
25,750. BRITISH THOMSON-HOUSTON CO. (LTD.). (Day.) Controlling electric motors.

1900.

27. LYON and TALBOT-CROSBIE. Electric arc lamps,
45. FEENY (Allgemeine Elektricitäts Gesellschaft). Electrical incandescence lamps of the newest type.
147. TATES and HEANY. Electric water filters.
176. LACHENMEYER. Current receiver for electric railways.
729. DORMAN SMITH and BAGGS. Electrical switches and cut-outs.
1,167. FABRE. Adjustable suspension device for electric lamps.
1,694. ROBINSON and FERGUSON. Treatment of carbon electrodes for electric arc lights.
1,863. HEYS. (Scott, Varley and Anderson.) Coils or helices for electrical purposes.
1,864. HEYS. (Scott, Varley and Anderson.) Method of winding coils or helices for electrical purposes.
2,120. WATERHOUSE and SIMPLEX STEEL CONDUIT CO. (LTD.) Electric switches.

COMPANIES' MEETINGS AND REPORTS.

Eastern Extension Australasia and China Telegraph Co. (Ltd.).

The report and accounts of the directors of this company for the half-year to Dec. 31 last will be submitted to the fifty-third half-yearly meeting of shareholders on Wednesday next.

The gross receipts have amounted during the half-year to £339,450. 4s. 10d., against £290,431. 1s. 9d. for the corresponding half-year of 1898. The working expenses, including £39,057. 12s. 6d. for maintenance of cables, absorb £116,935. 6s. 8d., against £100,085. 18s. 5d., leaving a balance of £222,514. 18s. 2d. From this is deducted £4,736. 12s. for income tax; £26,495 for interest on debentures, debenture stock, and contribution to sinking fund; £5,000 for reserve in connection with the proposed removal of head offices; and £500 towards the Transvaal War Fund, leaving as net profit £185,783. 6s. 2d., or with £13.299. 6s. 1d. brought forward, £199,082. 12s. 3d.

One quarterly interim dividend of 1½ per cent. has been paid for the half-year, and it is now proposed to distribute another of the like amount on 26th inst., making with interim dividends paid for the first half-year a total dividend of 5 per cent. It is also proposed to pay a bonus of 4s. per share (2 per cent.), making a total distribution of 7 per cent. for the year 1899. The balance of £86,582. 12s. 3d. has been transferred to general reserve.

The agreement with the Australasian colonies for the payment of subsidy in respect of the Australian duplicate cable expired by effluxion of time on Oct. 31 last; and, in terms of the trust deed, the balance of the company's 5 per cent. Australian Government Subsidy Debentures, amounting to £33,300 will be paid off at par on July 2 next. The Tariff Guarantee agreements with the Australasian colonies expire on 30th inst.

An agreement has been concluded with the Governments of South Australia, Western Australia, and Tasmania, for the establishment by this company, in conjunction with the Eastern Telegraph Co. of direct cable communication between South Africa, Perth, and Adelaide, which, with the third route recently opened between Great Britain and the Cape, will provide Australia with an alternative line to the existing service. The arrangement also provides for an immediate reduction of the tariffs between Great Britain and the contracting colonies to 4s. per word, with proportionate reductions for Government and Press telegrams; and, as the traffic responds, for the further lowering of the tariffs on a "standard revenue" basis down to 2s. 6d. per word. The tariff between the contracting colonies and South Africa will also be reduced from 7s. 1d. per word to about 2s. 6d. per word on the opening for traffic of the new cable. In return for these concessions the company is to exercise the right of direct dealing with the public in the capitals of the contracting colonies when the proposed Government Pacific, or other competing cable, is laid.

It is proposed to add to the number of directors by electing Sir John Wolfe Barry, K.C.B., to a seat at the board, and accordingly to increase the remuneration of the directors to £4,500 per annum.

Indo-European Telegraph Co. (Ltd.).

The directors' report for 1899 states that Mr. W. S. Andrews has retired from the post of managing director, in which he has rendered eminent services for the last 30 years, but remains a member of the board. He has been replaced as managing director by Mr. T. W. Stratford-Andrews. The directors have granted Mr. W. S. Andrews, subject to confirmation of general meeting, a retiring pension of £1,200 per annum. Sir W. R. Brooke, K.C.I.E., formerly Director-General of Indian Telegraphs, has accepted a seat on the board. The directors have been successful in obtaining an extension of the Russian and Persian concessions for 20 years from January, 1905, and the company has come to an agreement with the German Telegraph Department and is now in negotiations with the German Government for a similar extension. The lines of the company continue to work satisfactorily, including the Wheatstone system, which has now been established in the German, Russian and Persian sections. In order to strengthen its submarine cable communication through the Straits of Kertch, the company laid a new cable last autumn.

The revenue from all sources for 1899 amounted to £142,343. 4s. 2d., which compares with £134,642. 12s. 11d. for 1898, an increase of £7,700. 11s. 3d. The expenses were £36,148. 8s. 11d. on commercial and general account, and £33,508. 18s. 8d. on maintenance account (expenses and charges), total £74,657. 7s. 7d., against £74,346. 0s. 5d. for 1898, increase £311. 7s. 2d. Deducting this sum from the total revenue (£142,343. 4s. 2d.), there is a balance of £67,685. 16s. 7d., and after deducting income tax (£2,195. 4s. 8d.), and taking the amount brought from 1898 (£9,702. 0s. 9d) into account, there remains £75,192. 12s. 8d. From this £25,000 has been placed to reserve, and £10,625 has been paid as interim dividend, leaving an available balance of £39,567. 12s. 8d. The directors now propose a dividend for the six months ended Dec. 31 of 17s. 6d. per share, making (with interim) 6 per cent., and a bonus of 20s. per share (both tax free), making 10 per cent. for the year, carrying forward £7,692. 12s. 8d.

Oriental Telephone and Electric Co. (Ltd.).

The report of the directors for the year ended Dec. 31, 1899, states that the revenue account shows a credit balance of £11,738. 12s. 10d. Including £1,344. 8s. from 1898, and after deduction of £2,858. 8s. paid as interim dividend on Oct. 31, there remains £10,224. 12s. 10d. The directors recommend the payment of a final dividend of 8d. per share (tax free), making 5 per cent. for the year, to transfer to reserve £3,000, and to carry forward £1,507. 16s. 10d. The electric lighting branch of the company's business shows a small but increased surplus over 1898, which the directors propose to carry to suspense. The dividends declared by the Indian subsidiary companies have, as usual, been included in revenue account. Both companies have paid 6 per cent. for the year, and have carried forward substantial sums. The Telephone Co. of Egypt has declared the 6 per cent. dividend on its preferred shares, and has also been able to transfer a considerable amout to reserve. The China and Japan Telephone Co. has paid its debenture interest, but the past year's accounts have not yet been closed. The company's exchange at Hongkong is making satisfactory progress, and a branch exchange will probably be opened this year at Kowloon, the British possession on the mainland opposite Hongkong, which has recently been greatly extended. The directors have not been able to secure the concession at Shanghai for which they had tendered. No other tenders were received by the Municipal Council; yet, although all conditions were accepted, the Council decided upon imposing further onerous conditions which could not be accepted. The right was eventually given to local persons having influence with the Council, but it subsequently transpired that none of the onerous conditions were required of these persons which had been demanded of the China Co. The exchange at Shanghai was consequently closed on 31st ult., and the town will for some considerable time to come be without a telephone service.

BRITISH COLUMBIA ELECTRIC RAILWAY CO. (LTD.)—At the meeting of this company on Wednesday it was decided to increase the capital from £370,000 to £450,000 by the creation of 8,000 new preference shares of £10 each. The chairman (Mr. R. M. Horne-Payne) said this demand for extra capital was entirely owing to the great success which the company had met with, both in the railway and the lighting departments. The equivalent number of 8 c.p. lamps which they were supplying on April 1 last year was 32,000, and at end of February last 45,000, and there was little doubt that it had reached 46,000 on March 31, the end of their financial year. Though not in possession of the full details of the past financial year, he thought that the gross earnings would amount to $200,000 (approximately £40,000), compared with £33,000 in 1898. The works undertaken with the proceeds of the last issue of preference capital were considerably delayed, owing to the difficulty to get orders filled within a reasonable period. The whole of the extensions should have been finished by September, 1898, but the steam plant at Vancouver City was not completed until about a month ago. All the 1898 works and extensions were operating satisfactorily. The present plant was sufficient for their summer months' load, but the demand for lighting was steadily growing, and more electric plant was also wanted for the railway. Provision having been previously made for additional steam power, all that was now required was the actual electric lighting machinery. The expenditure necessary to enable them to meet the demands of the coming winter was calculated at about £16,000.

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DUDLEY, STOURBRIDGE AND DISTRICT ELECTRIC TRACTION CO. (LTD.)—The directors' report for the year to Dec. 31 states that the electrical equipment of the lines was officially inspected on July 25 last, and the lines have been worked electrically since that date. During the year £53,968. 8s. 11d. has been expended on electrical equipment, and this account has now reached £83,308. 8s. 11d., of which £71,173. 0s. 4d. is owing to the British Electric Traction Co. The directors propose to issue the balance of unissued 8,211 ordinary and 19,375 preference shares of £5 each in order to discharge this amount, and to provide capital for the completion of the Dudley light railways which are now in course of construction and will, it is hoped, be opened for traffic during the summer. The total revenue amounted to £11,504. 16s. 2d. and the total expenditure to £7,195. 15s. 3d., leaving a net profit of £4,309. 0s. 11d., which, added to £919. 8s. 8d. brought forward, makes a total of £5,228. 9s. 7d. available for distribution. The directors propose that this amount should be applied as follows: Dividend on the 5 per cent. cumulative preference shares to Dec. 31, £146. 5s.; dividend at the rate of 3 per cent. per annum on the ordinary shares for the year, £1,768. 7s.; depreciation, £1,000; forward £2,313. 17s. 7d. The depreciation fund now amounts to £6,079. 0s. 8d. An agreement has been entered into with the British Electric Traction Co. whereby that company agrees to transfer to this company the whole of the lines to be authorised by the Dudley Light Railways (Extensions) Order, 1899, when constructed, for £28,500. The agreement also secures to this company the right to work the Kinver light railways for a period of two years on the basis of actual cost, plus a clear profit of 10 per cent.

KIDDERMINSTER AND DISTRICT ELECTRIC LIGHTING AND TRACTION CO. (LTD.)—The report of the directors for the period from July 27 to Dec. 31, 1899, is issued. The prospectus of the company was issued in July, 1899, and 3,000 ordinary shares and 3,000 5 per cent. cumulative preference shares of £10 each were allotted. The total capital expenditure at Dec. 31, on account of buildings and plant for electric lighting was £6,676. 15s. 1d. The company hold 5,600 shares of £10 each of the Kidderminster and Stourport Electric Tramway Co. out of 5,720 shares issued, and had paid £22,400 on account of calls at Dec. 31. The gross profits, including the amount receivable from the Kidderminster and Stourport Co. for dividend amount to £1,558. 14s. 11d., and after deducting expenses there remains a net profit of £1,458. 9s. 4d. The directors propose the payment of the dividend on the cumulative preference shares to Dec. 31 (absorbing £312. 10s.), and to carry forward £1,145. 19s. 4d. The net profits in respect of the tramways amounted to £2,165. 14s. 11d., and this amount has been applied as follows: Dividend of 5s. 6d. per share on 5,720 shares, £1,573; depreciation, £500; carried forward, £92. 14s. 11d. The number of miles of tramways open is: route miles, 4m. 4f. 7ch.; and the number of passengers carried was 753,500. The work of installing the electric lighting plant is well in hand, and the directors hope to be able to commence a supply of current during the summer.

PARIS GENERAL OMNIBUS CO.—At the recent annual meeting of this company it was announced that the net profit for 1899 amounted to £310,925, and a dividend of 65f. per share, or at the rate of 13 per cent., was paid. The company's concession from the Municipal Council of Paris expires in 1910, and the municipality has resolved not to renew it, but to municipalise the undertaking, the company being required to hand over at cost price, to be settled by expert valuation, and without any compensation whatever for goodwill, the whole of its rolling stock, material and cattle, either to the city or to any new concessionaire appointed by the Municipal Council. The company was formed in 1855, with a capital of 17 million francs (£680,000), but the present capital represents about £2,680,000. The company has recently been authorised to issue a further 25 million francs of debentures to enable it to substitute mechanical traction for its horse traction lines. The company at the present time works 27 horse and nine mechanical (electric, compressed air and steam) lines, and 48 lines of horse-drawn omnibuses. Of the nine mechanical traction tram lines six are at present worked at a profit and three at a loss. The company is bound by its agreement with the municipality to keep all the services running. The routes cover a length of 120 miles in all. The experience of the company so far is that although the cost per mile run of mechanical is greater than with animal traction, the receipts are higher, owing to the public preference for mechanical traction. The company has therefore decided to gradually abolish horse traction for both omnibuses and tramcars in favour of mechanical (principally electric) traction. The conditions under which the company works its lines are said to be very onerous owing to the exactions of the Paris municipal authorities.

NEW COMPANIES, STATUTORY RETURNS, &c.

HATTERSLEY BROTHERS (LTD.)—This company was registered on April 9 with a capital of £50,000, in £1 shares, to acquire the business carried on under the style of Hattersley Brothers and Co., and to carry on the business of electrical and general engineers, founders, &c.

ERNEST HUTTON AND CO. (LTD.)—This company was registered on 10th inst. with a nominal capital of £5,000 in £1 shares, to carry on the business of electricians, electrical, mechanical and general engineers and contractors, and manufacturers of and dealers in electrical apparatus of all kinds. The subscribers are John E. Hutton, electrical engineer, W. Lockwood, W. Fowle, G. F. Williamson, W. G. Jackson, A. H. Curtis, electrical engineer, and W. George Hornsey.

MOTOR MANUFACTURING CO., LTD.—This company was registered on March 29 with a capital of £200,000 in £1 shares, to acquire and carry on the businesses of manufacturers of and dealers in electrical meters, plant machinery, &c.; producers and suppliers of electricity for the purposes of light, heat or power; manufacturers of and dealers in lamps, fittings, and electrical apparatus of every description.

WALSH, ASQUITH AND CO. (LTD.)—This company was registered on April 6, with a capital of £50,000 in £1 shares, to carry on at Shay-lane, Holmfield, the business of mechanical and electrical engineers, machinists, &c. The directors are Fred. Walsh and W. G. Asquith.

EASTERN TELEGRAPH CO. (LTD.)—The annual return to Feb. 8 gives the capital as £6,000,000, divided into £4,000,000 ordinary and £2,000,000 preference stock, of which £5,829,378 has been taken up and paid in full.

CITY NOTES.

MEMORANDA.—Bank rate 4 per cent. (since Jan. 25, 1900). Price of silver 27⅜d. per oz. (April 19). Consols (2¾ per cent.) 101—101⅛ for money, 101 5/16—101 5/16 for account; 2½ per cent. 98—98¼ (April 19). Stock Exchange Settling Day: Consols, May 4; Stocks and Shares Continuation Days, April 25 and May 14; Ticket Days, April 26 and May 15; Pay Days, April 27 and May 16; Mining Share Carry-over Days, April 24 and May 11.

BABCOCK AND WILCOX (LTD.)—A meeting will be held at 147, Queen Victoria-street, London, E.C., on 27th inst., for confirming the resolutions recently passed for winding up the company for reconstruction purposes.

BELL'S ASBESTOS CO. (LTD.)—The net profit for 1899 was £9,046, and, with £2,073 from 1898, there was a balance of £11,119 available. The directors recommend a dividend at the rate of 6 per cent. per annum, to place £2,500 to reserve, and to carry forward £1,419. The law suit with the H. W. Johns Manufacturing Co. of New York, has, it is stated, been settled in the interests of Bell's Asbestos Co.

BROMLEY (KENT) ELECTRIC LIGHT AND POWER CO. (LTD.)—The annual meeting of this company was recently held at Bromley. The directors' report stated that the profit for the year amounted to £1,099. 12s. 1½d., and a dividend at the rate of 2½ per cent. was recommended. The demand for current had largely exceeded anticipations, and consequently an increase of capital had become necessary. On the motion of the chairman (Mr. F. E. Gripper) the report was adopted, and resolutions, increasing the capital from £20,000 to £50,000, and authorising a further issue of 5 per cent. debentures to the extent of £10,000, were passed.

EASTERN EXTENSION, AUSTRALASIA AND CHINA TELEGRAPH CO. (LTD.)—It is notified that the balance of this company's 5 per cent. Australian Government subsidy debentures (333 in number) will be paid off at par on July 2 by Messrs. Barclay and Co., 54, Lombard-street, E.C. The fifty-third half-yearly meeting of the company takes place at Winchester House, Old Broad-street, E.C., on Wednesday, April 25, at 2.30 p.m., and notice is given that the register of transfers will be closed from 18th to 25th inst. inclusive.

ELEKTRICITATS ACTIEN GESELLSCHAFT VORM. SCHUCKERT AND CO.—The dividend for the year ended March 31 is the same as last year (15 per cent.).

EL CREDITO INDUSTRIAL GIJONES OF GIJON.—This new company has recently been formed in Spain to take over the Gijon Gas and Electric Works, and will undertake the construction of narrow-gauge mineral railways and the exploiting of electric tramway concessions. The company has purchased English patent rights for new methods in the manufacture of caustic soda, and is about to put down plant and apparatus in connection with these works.

GREAT NORTHERN TELEGRAPH CO. (LTD.)—The revenue account of this company for 1899 shows total traffic receipts of £433,573, and after deducting loss on exchange (£20,698) the net amount was £412,875. After taking into account interest, &c., and £61,417 from the previous year, the total amount available for distribution is £486,523. The expenses came to £87,010, and after paying debenture interest and interim dividend, the directors recommend the payment of a final dividend of 15s. per share, the transfer of £138,889 to reserve and renewal fund, £5,556 to staff pension fund, and the allocation of £1,500 for directors' remuneration; the balance (£64,319) is carried forward.

MUNICIPAL ISSUE.—The Newport (Mon.) Corporation are making an issue of £300,000 three per cent. redeemable stock at £97 per cent., for electric lighting, tramway construction and other works. Tenders to National Provincial Bank of England, 112, Bishopsgate-street, London, E.C., by 24th inst.

SOCIETE BELGE D'ELECTRICITE.—Under this designation a branch of the A.E.G. of Berlin has been formed in Brussels, with a share capital of 1,000,000fr.

SUBMARINE CABLES TRUST.—The trustees notify that, in accordance with the terms of the trust deed, 27 certificates will be redeemed from the surplus funds by a drawing to take place on Friday next, 27th inst., at noon, at the offices, 186, Winchester House, Old Broad-street, London, E.C., for payment at £120 per certificate by Messrs. Glyn, Mills and Co. 67, Lombard-street, London, E.C.

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WESTERN UNION TELEGRAPH CO.—This company have issued their report for the quarter ended Mar. 31, 1900. The following statement exhibits the condition of the company at the close of the quarter ended Dec. 31, 1899:—

Surplus Oct. 1, 1899, as per last quarterly report ...		$8,292,383 16
Net revenues, quarter ended Dec. 31, 1899		1,579,486 85
		$9,871,870 01
From which deducting for—		
Dividend of 1¼ per cent. paid Jan. 15 ...	$1,216,996 25	
Interest on bonded debt.....	224,120 15	
		$1,441,116 40
Left a surplus Jan. 1, 1900, of		$8,430,753 61
The net revenues of the quarter ending Mar. 31, based upon nearly completed returns for January, partial returns for February, and estimating the business for March, were about		1,250,000 00
		$9,680,753 61
From which appropriating for—		
Interest on bonds	$224,120 15	
Sinking funds	9,991 00	
		234,111 15
		$9,446,642 46
It requires for a dividend of 1¼ per cent. on capital stock issued, about		1,216,997 00
Deducting which leaves a surplus, after paying dividend, of		$8,229,645 46

In view of the preceding statements, the committee recommend that a dividend of 1¼ per cent. on the capital stock of the company be declared payable on and after April 16.

STOCK EXCHANGE NOTICES.—Application has been made to the Stock Exchange committee to appoint a special settling day in and to grant a quotation to the further issue of £150,000 5 per cent. perpetual debenture stock of the *British Electric Traction Co. (Ltd.)*. The committee has ordered £75,000 4½ per cent. first mortgage debenture stock of *Edmundson's Electricity Corporation (Ltd.)* to be quoted in the Official List, and application has also been made to the committee to appoint a special settling day in and to grant a quotation to the further issue of 20,000 ordinary fully-paid £10 shares (Nos. 100,001 to 120,000) of the *City of London Electric Lighting Co. (Ltd.)*.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	1900	£	£		£	£
*Birmingham Tramways.	Apl. 14	4,254	+ 389	15	59,768	+ 2,594
Blackpool Corporation...	„ 12	231	+ 41	2	357	- 416
Blackpool and Fleetwood	„ 14	488	+ 266	15	2,767	- 579
Bradford Corporation...	...	...	...	...	...	...
Brisbane Trams	Feb. 28	1,833	+ 576	22	45,207	+ 13,809
*Bristol Trams & Carriage	Apl. 13	3,034	+ 491	15	39,118	+ 611
*Buenos Ayres & Belgrano	Mar. 18	2,373	+ 145	11	25,837	+ 5,356
City & South London Ry.	Apl. 15	1,159	+ 108	15	18,477	+ 2,212
Dover Corporation	„ 14	210	+ 59	2	370	- 45
Dublin United	„ 13	3,995	+ 1,320	15	45,780	+ 7527
Dublin Southern Dist....	„ 13	1,168	+ 523	15	10,583	
*Glasgow Corporation ...	„ 14	9,030	+ 747	...	...	...
*Liverpool Corporation...	„ 7	7,178	+ 143	14	93,806	+ 10,761
Liverpool Overhead Rly.	„ 15	1,351	- 53	15	20,805	+ 702
*Sheffield Tramways	„ 15	2,051	+ 892	15	27,578	+ 8,616
*South Staffs. Trams.....	„ 13	671	+ 56	15	9,176	- 27

* Partly electrical.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, April 10.		Price Wednesday, April 18.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Eight Days Ending April 18.	
								£ s. d.		Highest	Lowest
			TELEGRAPHS.								
£110,800	100	4%	*African Direct Telegraph 4% Mort. Deb. (red.)	100	104	100	104	3 17 4	January and July.....	...	...
25,000	10	...	Amazon Telegraph.....	3	4	3	4	...	June and December ...	...	...
£125,000	100	5%	Do. 5 per Cent. Debentures	85	90	85	90	5 11 1	...	...	...
£275,520	Stock	15/0	Anglo-American.....xd	65	68	63	66	5 9 9	Feb., May, Aug., Nov.	164½	...
£2,063,240	Stock	30/0	Do. Preferred ..... xd	116½	117½	115	116	5 3 6	„ „	116	115¾
£2,063,240	Stock	27/0	Do. Deferred	14½	15	14½	15	9 0 0	...	14⅞	14 13/16
$10,000,000	$100	$1½	Commercial Cable Capital Stock	165	175	165	175	4 11 5	Jan., Apr., July, Oct.	...	...
£1,563,078	Stock	4%	* Do. 4 per Cent. Debenture Stock	102	104	103	104	3 17 0	„ „	103¾	103½
16,000	10	8/0	Cuba Submarine Ordinary	9	10	9	10	8 0 0	February and August	10	9⅝
6,000	10	10/0	Do. Preference 10 per Cent.	19	20	19	20	5 0 0	„ „	...	...
12,981	5	2/0	Direct Spanish Ordinary	4	5	4	5	4 0 0	April and October.....	...	...
6,000	5	5/0	Do. 10 per Cent. Cumulative Preference	9	10	9	10	5 0 0	„ „	...	...
£30,000	50	4½%	Do. 4½ per Cent. Debentures	101%	105%	101%	105%	4 5 9	January and July.....	...	...
60,710	20	3/0	Direct United States Cable	11⅛	12	11¼	12½	5 14 3	Jan., Apr., July, Oct.	12⅛	11⅝
£120,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red.)	100	103	101	103	4 8 0	June and December ...	...	...
£4,000,000	Stock	5%	Eastern Ordinary ....xd	152	157	151	156	4 9 9	Jan., Apr., July, Oct.	154	153
£1,796,000	Stock	3½%	Do. 3½ per Cent. Preference Stock .....xd	98	101	98	101	3 9 3	„ „	99⅞	99½
£1,452,268	Stock	4%	* Do. 4 per Cent. Mort. Deb. Stock (red.)	115	120	115	120	3 7 8	May and November ...	...	...
250,000	10	2/6	Eastern Extension	16	16⅛	16	16⅛	4 4 10	Jan., Apr., July, Oct.	16⅛	16 5/16
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	115	120	115	120	3 6 8	February and August	...	...
£6,700	100	5%	* Do. 5% (Austin. Gov. Sub.) Deb.,1900 (reg.) ...	100	103	100	103	4 17 1	January and July.....	...	...
£26,600	100	5%	Do. (Bearer)	100	103	100	103	4 17 1	„ „	...	...
£300,000	100	4%	*Eastern and S. African 4% Mort. Deb., 1909.....	100	103	100	103	3 18 5	February and August	...	...
£200,000	25	4%	Do. 4 per Cent. Mauritius Sub. Debs.(red.) ...	101%	104%	101%	104%	3 16 10	May and November ..	...	...
180,227	10	1/9	Globe Telegraph and Trust	11⅛	12	11½	12	4 7 6	Jan., Apr., July, Oct.	11⅜	11 5/16
180,042	10	2/0	Do. 6 per Cent. Preference	15½	16	15½	16	3 15 0	„ „	15⅞	15⅝
150,000	10	5/0	Great Northern of Copenhagen	33	35	33	35	3 11 5	January and July.....	...	...
£96,300	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb.(red.) ...	100	103	100	103	4 8 0	...	...	...
17,000	25	12/6	Indo-European.....	54	58	54	58	4 6 2	May and November ...	...	...
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904 ...	105	108	105	108	5 11 7	March and September	..	...
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red.)	102	105	102	105	3 16 9	June and December ...	...	...
11,839	8	4/0	Reuter's.....	7	8	7	8	5 0 0	April and October.....	...	...
3,381	£100 Cert.	6%	Submarine Cables Trust.....xd	126	131	124	129	4 13 0	„ „	...	...
15,609	10	...	West African Telegraph	2½	3½	2½	3½	4 9 3	December and July ...	...	...
£200,000	100	5%	* Do. 5 per Cent. Debentures (red.)	97	100	98	101	5 0 4	March and September	...	...
20,008	2½	...	West Coast of America.....	⅛	1	⅛	1	...	...	...	...
£150,000	100	4%	* Do. 4 per Cent. Debentures	100	103	100	103	3 13 7	January and July.....	...	...
88,321	10	6d.	West India and Panama	⅜	1⅛	⅜	1⅛	...	May and November ...	1⅛	...
34,563	10	6/0	Do. 6 per Cent. 1st Preference	9½	9⅝	9½	9⅝	6 3 1	„ „	9⅝	...
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	7	8	7	8	7 10 0	„ „	...	...
£80,000	100	5%	* Do. 5 per Cent. Debentures	104	107	104	107	4 13 6	January and July.....	...	...
£389,731	Stock	4%	Western & Brazilian 4 per Cent. Debenture Stock ...	100	104	100	104	3 16 11	June and December ...	...	...
207,930	10	3/0	Western Telegraph (late Brazilian Submarine)	14½	15	14½	15	4 13 4	Mar., June, Oct., Dec.	14⅞	14⅝
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1900)	108	109	105	108	4 13 10	June and December ...	105½	...
			TELEPHONES.								
44,000	£5	3/0	Chili Telephone (fully paid)	2	3	2	3	6 13 4	August	...	...
224,850	10s.	0/1½	Consolidated Telephone Const. & Manufacturing ...	⅛	¼	⅛	¼	4 15 3	July	...	...
72,680	1	2½%	Monte Video Telephone Ordinary	¾	⅞	¾	⅞	5 0 0	November	...	...
96,492	1	1/0	Do. 5 per Cent. Preference	¾	1	¾	1	5 0 0	„	...	...
490,000	5	3/0	National	5	5½	5	5½	5 14 3	February and August	5 1/16	...
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Preference ..	14	15	14	15	4 0 0	„ „	...	...
15,000	10	6/0	Do. 6 per Cent. Cumulative 2nd Preference ...	14	15	14	15	4 0 0	„ „	...	...
250,000	5	2/6	Do. 5 per Cent. Non-Cumulative 3rd Pref. ...	5½	5⅝	5½	5⅝	4 10 11	„ „	...	...
2,000,000	Stock	3½%	* Do. Debenture Stock 3½ per Cent. (red.)	97	100	97	100	3 10 0	June and December ...	97½	...
171,504	1	0/4	Oriental	¾	1	¾	1	5 0 0	April and October.....	...	...
58,000	5	2/6	United River Plate	4½	5½	4½	5½	7 2 10	July	...	...
16,639	5	1/4	Do. 5% Cumulative Preference	4½	5½	4½	5½	4 15 3	June and December ...	...	...
£179,947	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	103	106	103	106	4 14 4	„ „	...	...

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	NAME.	Previous Week's Price, April 16.		Price Wednesday, April 18.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Eight Days Ending April 18.	
								£ s. d.		Highest	Lowest
			ELECTRICITY SUPPLY COMPANIES.								
100,000	1	...	Bl'ckb'th & Gr'nw'ch D'st'ct Elec.Lt.Ord.(fully pd.)	⅝	¾	⅝	¾	...	...	...	...
6,000	10	10/0	Bournemouth and Poole Elec. Supply Ord.	11½	12½	11⅝	12⅝	3 11 3	...	...	...
6,000	10	4/6	Do. 4½ per Cent. Cumulative Pref.	10	11	10	11	4 1 10	...	...	...
19,661	5	3/6	Brompton & Kensington Electricity Supply Ord. ...	7	8	7	8	3 15 0	...	7⅝	...
12,000	5	3/6	Do. 7 per Cent. Preference	8½	9½	8½	9½	3 13 8	March and September	...	...
20,000	5	...	Calcutta Elec. Supply Ordinary (fully paid)	7	7½	7	7½	...	...	7½	...
50,000	5	5/0	Charing Cross & Strand Electricity Supply Corp. ...	9½	10½	9½	10½	4 5 9	February and August	10⅜	...
20,000	5	2/3	Do. 4½ per Cent. Preference	5½	6	5⅝	6	3 15 0	,, ,,	...	...
34,000	5	3/6	Chelsea Electricity Supply Ordinary	6½	7½	6½	7½	4 0 0	March	...	...
£150,000	Stock	4½%	* Do. 4½ per Cent. Debenture Stock (red.)	108	111	108	111	4 2 2	June and December...	110	...
$1,200,000	$1,000	5%	Chicago Edison 1st Mort. 5% 30 yr. Gold Bonds (red.) ...	100	110	100	110	4 10 11	April and October.....	...	...
60,000	10	8/0	City of London Electric Lighting Ord.	10	11	10	11	3 12 9	February and August	...	...
40,000	10	6%	Do. 6 per Cent. Cumulative Pref.	12	13	12	13	4 12 4	January and July.....	...	...
£400,000	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	122	127	122	127	3 18 9	June and December ...	...	...
40,000	10	8/0	County of London and Brush Prov. Ordinary	9½	10½	9½	10½	3 16 2	...	...	...
20,000	10	6/0	Do. 6 per Cent. Cumulative Preference	12⅝	13⅝	12⅝	13⅝	4 8 11	March and September	13¼	13¼
£200,000	Stock	4½%	Do. 4½% Deb. Stock Certs. (all pd.) (red.)	109	112	109	112	4 0 11	...	111½	1.0
15,000	5	10%	Kensington and Knightsbridge Ordinary	12½	13½	12½	13½	4 1 6	...	...	...
10,000	5	6%	Do. 6 per Cent. 1st Preference	7	7½	7	7½	4 0 0	January and July.....	...	...
110,000	3	...	London Electric Supply Ordinary	1½	2	1½	2	...	...	...	...
48,050	5	3/0	Do. 6 per Cent. Preference	4½	4¾	4½	4¾	6 6 4	...	...	...
£250,000	Stock	4%	Do. 4 per Cent. 1st Mortgage Debentures	100	102	100	102	3 19 3	Mar., June, Sept., Dec.	...	...
85,000	10	5/0	Metropolitan Elec. Supply Ord.	13½	14½	13⅜	14⅜	3 9 0	April and October.....	14⅜	13¼
£220,000	Stock	4½%	Do. 4½ per Cent. Deb. Stock First Mortgage ...	114	117	114	117	3 16 11	June and December ...	...	...
£125,000	Stock	24/8	Do. 3½ per Cent. Mort. Deb. Stock (red.)	93	98	96	93	3 11 10	...	...	...
6,452	10	8/0	Notting Hill Electric Ordinary	15½	16½	15½	16½	4 4 10	March	...	...
10,000	5	5/0	Oxford Electric Ordinary	6⅝	7	6⅝	7	3 11 5	,,	...	...
300,000	1	8%	Rand Electric	⅜	⅝	⅜	⅝	10 13 4	...	...	...
£130,070	Stock	5%	River Plate El.Lt. & Tr'ct'n, Ltd., 5% 1st Mor.Deb....	75	85	75	85	5 18 0	...	...	...
150,000	$100	$2	Royal Electric Company of Montreal Shares .....xd	170	190	170	190	4 4 2	...	...	...
£123,200	100	4½%	* Do. 4½ per Cent. 1st Mortgage Debentures ...	103	105	103	105	4 5 9	April and October.....	...	...
40,000	5	9/6	St. James's and Pall Mall Electric Ordinary	14½	15½	14½	15½	4 13 7	February and August	15⅜	11¾
20,000	5	3/6	Do. 7 per Cent. Preference	8½	9½	8½	9½	3 13 8	,, ,,	...	...
12,000	5	...	Smithfield Markets Electric Supply Ordinary	2¼	2¾	2¼	2¾	...	...	...	...
£50,000	Stock	...	Do. 4% Debentures.....	85	95	85	95	...	..	...	...
65,000	5	...	South London Electric Supply Ordinary (fully paid)	4	4½	4	4½	...	..	...	...
79,900	5	8/0	Westminster Electric Supply Ordinary	15	16	15	16	4 1 3	March and September	15⅛	15⅛
			ELECTRIC MANUFACTURING &c. COMPANIES.								
125,000	1	7½d.	Aron Electricity Meter 6 per Cent. Cum. Pref.	¾	⅞	¾	⅞	6 17 2	...	...	...
45,000	1	...	British Electric Works Co. Ordinary	⅝	1	1	1	...	...	...	...
50,000	1	...	Do. 5 per Cent. Cumulative Preference	⅝	1	⅝	1	...	...	...	...
£50,000	100	4¼%	Do. First Mortgage Debentures	99	101	99	101	...	...	...	...
40,000	5	15/0	British Insulated Wire Ordinary	11	12	11	12	4 3 4	...	...	...
27,500	5	3/0	Do. 6 per Cent. Preference	6	6½	6	6½	4 12 4	...	...	...
100,000	5	...	British Westinghouse 6% Preference	4⅜	5¼	4⅜	5¼	...	...	4⅞	...
90,060	2	1/2⅞	Brush Electrical Engineering	1⅞	2	1⅞	2	4 0 0	September	...	...
90,000	2	1/2⅞	Do. 6 per Cent. Pref. Non-Cum.	2⅛	2⅜	2⅛	2⅜	5 1 1	,,	2⅜	...
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Deb. Stock	108	113	108	113	3 19 8	February and August	...	...
£108,710	Stock	12/1	* Do. 2nd Debenture Stock (red.)	103	105	103	105	4 5 9	June and December ...	...	...
20,000	5	5/0	Callender's Cable Construction Ordinary	14½	15½	14½	15½	4 16 9	,, ,,	...	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5½	6	5½	6	4 3 4	...	5⅛	...
£90,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Deb. (red.) ...	112	116	112	116	3 18 5	November and May ...	...	...
300,000	1	0/9⅜	Castner-Kellner Alkali Co. (fully paid)	1⅛	1⅜	1⅛	1⅜	5 16 5	...	...	...
£150,000	Stock	7/)	Do. 4½ per Cent. First Mort. Deb. (red.)	99	102	99	102	4 8 3	...	...	...
60,000	1	0/7⅛	Chadburn's Ship Telegraph Ordinary	⅞	1⅛	⅞	1⅛	5 6 8	...	...	...
60,000	1	0/7⅛	Do. 6 per Cent. Cumulative Preference	⅞	1⅛	⅞	1⅛	5 6 8	...	...	...
32,098	3	1/9⅜	Crompton and Co. (Nos. 1 to 32,098)	3¾	4	3¾	4	4 10 9	January and July.....	...	...
£100,000	100	5%	* Do. 5 per Cent. First Mortgage Deb. (red.) ...	99	102	99	102	4 19 3	,, ,,	...	...
60,000	1	0/7⅛	Davis and Timmins 6 per Cent. Cum. Pref.....	⅞	1⅛	⅞	1⅛	5 6 8	...	...	...
99,261	5	1/9⅜	Edison and Swan United ("A" Shares) (£3 paid) ...	2	2⅛	2	2⅛	7 3 9	February and August	...	...
17,139	5	2/9⅜	Do. (£5 paid)	3¾	4¼	3¾	4¼	6 13 4	,, ,,	...	...
£344,023	Stock	4%	Do. 4 per Cent. Mortgage Deb.Stock (red.) ...	93	95	93	95	4 4 3	June and December ...	...	...
26,100	5	5/11⅛	Edmundson's Electric Corporation Ord.(fully pd.)...	4¾	5¼	4¾	5¼	5 14 3	Half-yearly	...	...
112,100	2	1/2⅞	Electric Construction Co. (Limited)	2⅜	2⅝	2⅜	2⅝	4 16 0	January and July.....	...	...
25,000	2	2/9⅜	Do. 7 per Cent. Cumulative Preference	2⅛	3⅛	2⅛	3⅛	4 6 2	July	...	...
182,500	Stock	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	101	107	101	107	3 15 2	January and July.....	...	...
91,195	1	...	Elmore's Patent Copper Depositing	⅜	⅝	⅜	⅝	...	...	...	...
30,000	5	11 0	Henley's Telegraph Works Ordinary	13½	14½	13⅝	14⅝	3 15 10	February and August	13⅞	...
30,000	5	1/6	Do. 4½ per Cent. Preference	5¼	5¾	5¼	5¾	3 18 3	,, ,,	5⅝	...
£50,000	Stock	4½%	Do. 4½ per Cent. Mortgage Deb.Stock (red.) ...	110	114	110	114	3 18 11	,, ,,	...	...
50,000	10	10/0	India Rubber, Gutta Percha, &c., Works	21	22	21	22	4 11 10	,, ,,	...	...
£300,000	100	4%	Do. 4 per Cent. 1st Mortgage Deb. (red.)	103	103	103	103	3 17 6	March and September	...	...
37,350	12	24/0	Telegraph Construction and Maintenance	36	40	36	40	4 9 11	March and July.....	37½	...
£150,000	100	4%	Do. 4 per Cent. Debenture Bonds, 1909	102	105	102	105	3 16 2	...	...	...
20,000	5	3/0	Do. Manufacturing Ordinary	9½	10½	10	11	3 3 7	...	10¼	...
20,000	5	2/6	Do. 5 per Cent. Cumulative Preference	5¼	5¾	5½	6	4 3 4	...	...	...
30,000	5	5/0	Willans and Robinson Ordinary	12	13	12	13	3 9 3	April and October.....	12½	...
30,000	5	3/0	Do. 6 per Cent. Cumulative Preference	7¼	7¾	7¼	7¾	3 17 5	,, ,,	7⅞	...
£100,000	Stock	4½%	Do. 4½ per Cent. 1st Mortgage Debentures ...	104	106	104	106	4 0 2	May and November ..	...	...
			ELECTRIC RAILWAYS, TRAMWAYS, &c.								
12,000	10	10/0	Blackpool and Fleetwood Tramways	17	18	17	18	4 8 11	...	...	...
£167,900	100	5%	Brisbane Tramway 5 per Cent. Debentures.....	104	106	104	103	4 14 4	...	...	...
50,000	10	8%	Bristol Tramways and Carriage Ordinary	22½	23½	22½	23½	3 3 10	February and August	...	...
25,000	10	4%	Do. Cumulative Preference (£8 paid)	8½	8½	8⅛	8⅛	...	...	...	...
£100,000	Stock	4%	Do. 4 per Cent. Debentures	117	118	117	118	3 8 5	...	...	...
12,000	10	...	British Columbia Electric Railway 5% Pref.	10	10½	10	10⅛	...	...	10¼	...
30,000	10	9/0	British Electric Traction Ordinary (Nos. 1 to 30,000)	17	18	17	18	3 6 8	...	17⅝	17 5/16
£15,000	10	...	Do. (Nos. 60,001 to 75,000)	16½	17½	16⅜	17⅜	...	...	17½	...
50,000	10	6/0	Do. 6% Cum. Pref. (Nos. 30,001 to 60,000) ...	12¼	13¼	12⅛	13⅛	4 10 7	...	13⅜	13
£200,000	Stock	5%	Do. 5 per Cent. Perpetual Debentures	124	127	124	127	3 18 9	...	...	...
40,000	5	1/9	Buenos Ayres & Belgrano 6% "A" Cum. Pref.....	4⅞	5¼	5	5¼	5 14 4	...	...	...
27,500	5	...	Do. "B"	4	4⅛	4	4⅛	...	...	4 1/16	4
320,000	Stock	5%	Do. 5 per Cent. Debentures	105	108	105	108	4 12 7	...	...	...
£120,000	Stock	...	Do. 5% 2nd Deb. Stks Prov. Certs (£57½% to be p'd.)	...	...	37	40	...	...	...	...
213,553	10	3/0	Central London Ordinary	10¼	10¾	10¼	10¾	2 16 10	June and December ...	10¾	10⅜
£855,000	Stock	1½%	City and South London Railway Con. Ordinary ...	67	70	67	70	2 13 11	January and July.....	68¼	6 ¼
37,500	10	...	Do. (Nos. 22,501 to 60,000) (£5. 10s. paid).....	6	7	6	7	...	...	...	...
£150,000	Stock	5%	Do. 5 per Cent. Perpetual Preference (1891) ..	140	145	140	145	3 9 0	January and July.....	...	...
x200,000	Stock	5%	Do. (1896)	132	137	132	137	3 13 0	...	...	...
£187,701	Stock	4%	Do. 4 per Cent. Perpetual Debenture	125	130	125	130	3 1 11	May and November ...	...	...
20,000	10	8½%	†Imperial Tramways Ordinary	22⅜	23⅜	22⅜	23⅜	3 6 8	March and September	...	...
10,000	10	6%	† Do. 6 per Cent. Preference	14⅜	15⅜	14⅜	15⅜	3 17 5	,, ,,	...	...
£300,000	Stock	4½%	† Do. 4½ per Cent. Debenture.....	113	115	113	115	3 17 11	January and July.....	...	...
30,000	10	1/3	Kidderminster & District E. L. & Tr'ct'n 5% Pref. ...	9½	10½	10	10⅜	4 15 3	May and November ...	...	...
37,500	10	2½%	Liverpool Overhead Railway Ordinary	8⅞	8⅞	8⅞	8⅞	4 4 6	February and August	...	...
10,000	10	5%	Do. 5 per Cent. Preference	13¼	13⅜	13¼	13⅜	3 14 1	,, ,,	...	...
125,000	Stock	4%	Do. 4 per Cent. Debenture	105	107	105	107	3 15 4	January and July.....	...	...
24,000	5	...	New General Traction Ordinary	3¾	4¼	3¾	4¼	...	...	...	...
30,000	5	6/0	Do. 6 per Cent. Cumulative Preference.....	5	5⅝	5	5⅝	5 9 1	May	...	...
4,000	10	...	Oldham, Ashton and Hyde Elec. Tramway Ord.....	16	18	16	18	...	February and August	...	...
4,000	10	5/0	Do. 5 per Cent. Preference	10⅜	10⅞	10⅜	10¼	4 13 0	,, ,,	...	...
13,334	10	...	Potteries Electric Traction Ordinary	11⅛	12⅛	11⅛	12⅛	...	...	...	...
20,000	10	5/0	Do. 5 per Cent. Cumulative Preference	10	11	10	11	4 10 11	...	...	...
£540,000	Stock	3%	Waterloo and City Ordinary	101	104	101	104	2 17 8	June and December ...	...	...

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.
† The London Stock Exchange Committee refuses to quote these.

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